

# **Critical Tools: Using Technology to Augment the Process of Literary Analysis**

by

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This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## **Statement of Contributions**

I would like to acknowledge the names of my co-authors who contributed to the research described in this dissertation, these include:

Travis Kirton, Hrim Mehta, Cayley MacArthur, Dr. Sheelagh Carpendale, Dr. Christopher Collins, and Dr. Mark Hancock.

## **Abstract**

When it comes to the arts and sciences, Northrop Frye argues that “it is clear that the arts do not stabilize the subject in the same way that science does. . . The stabilizing subject of science is usually identified with the reason; the unstabilizing subject is normally called the imagination”. Since the nineteen eighties, with the institutionalization of Humanities Computing research, there have been attempts at combining humanistic questions with technological innovations, and by extension, scientific concerns. Within the digital humanities there is a tension between these two positions that often results in the neglect of the human analyst and an elevated use of technology when applied to tool design. This can be seen in the current trend of distant reading, which is the batch processing and analysis of text corpora using machines. This approach stands in stark contrast to close reading which traditionally in English studies has entailed looking at individual words and their relation to a text as a whole in terms of not what the text means, but how it means.

In this thesis I argue that the bridge between technology and literary criticism can be built using digital tools as long as those tools allow access to both the reason of science and the imagination of art. I present four digital projects that each investigate this problem in a novel way: (1) I use an algorithmic approach to investigate T.S. Eliot’s own theoretical position in terms of his diction, (2) I designed and developed a visualization of the English language, LDNA, that can be recovered back into the original text, (3) I conducted a study with 14 expert literary critics to analyze their current methods and used these results to design a tool, MetaTation, that can be integrated into the literary critical process, and (4) I also demonstrated how evidence-based testing of literary theory can be done in the context of Engineering writing by conducting a study that tests the feminist theory of false universals in human-computer interaction literature. I use



these projects to present a hybrid approach that answers the question: How do we reconcile the specificity and human dependent nature of an unstable and imaginative close reading with the historic breadth and reason of a distant reading approach?

## **Publications**

The materials, ideas, tables, and figures in this dissertation have previously appeared in the following peer-reviewed publications. The chapters which make use of the material are noted.

1. Chapter 3: forthcoming. Adam James Bradley, *In the End was the Word - A Computational Approach to T.S. Eliot's Poetic Diction*, "Reading Modernism with Machines", Eds. Shawna Ross, James O'Sullivan. London: Palgrave Macmillan.
2. Chapter 4: forthcoming. Adam Bradley, Travis Kirton, Mark Hancock, Sheelagh Carpendale, *Language DNA: Visualizing a Language Decomposition*, Digital Humanities Quarterly.
3. Chapter 6: Adam Bradley, Cayley MacArthur, Mark Hancock, Sheelagh Carpendale. *Gendered or Neutral? Considering the Language of HCI*, GI 2015 Proceedings of the 41st Graphics Interface Conference, Pages 163-170.

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# Introduction

The focus of this dissertation is the intersection between technology and literary criticism, and how this middle ground can unify close and distant reading techniques. With the introduction into English departments of Humanities Computing research, there have been many attempts at combining humanistic questions with technological innovations, and by extension, scientific concerns. In this dissertation I present an interdisciplinary approach to this problem. My research and subsequently this document are hybrids of both humanistic and scientific study concerning language and technology. While this work had its genesis in humanistic thinking, after several years working closely with engineers and management scientists it has become apparent that English studies and Systems Design Engineering can influence each others' findings and more importantly their questions. What is presented here is a hybrid of both approaches that answers the question: How do we reconcile the specificity and human dependant nature of close reading with the historic breadth and computation of distant reading?

## Motivation

When it comes to the close reading of texts people have been doing analysis at a systematic level for over a hundred years. This type of analysis, looking at individual words and their relation to a text as a whole in terms of not what the text means, but how it means is an intense process that takes a long time. Typically a literary critic uses experience and intuition to make these connections, building a network of possible outcomes for how a text makes its meaning. The belief within the field of Digital Humanities (DH) has been that digital tools can help us with these processes [?]. There have been many interesting approaches to texts and their analyses that have arisen in the recent years including text visualization [Rockwell, 2015b, Rockwell, 2015a], distant reading [Moretti, 2013, Jockers, 2013], and topic modelling [Arriaga et al., 2013, Black, 2015, ?, Binder and Jennings, 2014]. Text visualization holds great promise for being able to see texts in new contexts. The idea is that by shifting the perspective by which we see texts that new and interesting views of literature will emerge. Distant reading applies algorithmic methods to large text corpora in an attempt to uncover previously unseen patterns and takes a holistic (using many texts at once) approach to viewing literary history. While topic models are in the very early stages of adoption, the promise is that these probabilistic methods can be used to uncover patterns in what texts mean. While there are many digital ways of interacting with literature, these processes are just starting to find their way into traditional literary criticism. These tools do have potential if they are created in a way that allows for human readers to still experience literature. Too often these digital tools leverage the power of the machine and remove the human critic from the process by either limiting the information available about these networks or by presenting all of the information available while limiting the experience of it. An example of this would be the

use of tag clouds to visualize texts. Tag clouds, while excellent for showing one dimensional data, dramatically limit what information can be shown. A typical tag cloud of a piece of literature would be able to show how often words are used within a text as one-dimensional data. For literary criticism, which is looking for complex networks of interactions in texts, this type of application of technology limits what is possible. This is problematic because at some level literary criticism is about the feedback loop that begins with reading, leads to interpretation, and then feeds back to a new reading with novel insights. Current digital tools remove this feedback loop and consequently remove the experience of reading a text. In this dissertation I am approaching this problem by creating ways to interact digitally with literary texts without removing this feedback loop. The main obstacles to creating these types of interactions are as follows:

- There is a trade off between spending time with a literary text and spending time with the data generated from digital processes.
- There is a large barrier to entry, namely to be a computer programmer and a competent literary critic.

Encompassed in this dissertation are four unique projects that each attempt to demonstrate how these barriers can be addressed. I will show how programming can be used to ask research questions about diction in the early twentieth century. This project, although not necessarily generalizable, shows what can be done by applying programming techniques to traditional textual criticism. The results highlight that these techniques can be used within the context of existing approaches. After confirming that these programmatic techniques can aid in these processes I ask how can we make these techniques more accessible, how can we use digital tools to understand



the process of interacting with texts, and how can we use digital tools to unlock more information about how we process language and meaning. The second project approaches visualizing texts in a way that has not previously been attempted. The process of visualization often destroys the original text in the process, which has the added effect of destroying the analyst/text feedback loop. While one way to address this problem is to include the original text in the interaction, I have encoded the original text in the mapping allowing the feedback loop to remain accessible and re-constructable with a close reading of the visualization itself. The third project is a study that sets out to understand the relationship between analyst and text within this feedback loop. I conducted a user study and applied grounded theory techniques to understand the process of interaction and developed a tool that enables the feedback loop to operate within the bounds of digital augmentation. And, finally I take a reverse approach where I apply literary tools and theories to help us reflect on the literature of Human Computer Interaction (HCI). The first three projects use digital tools and HCI processes, but in this final chapter I show that we can use HCI methods in the context of Humanities theories. I started with a close reading of HCI literature and noticed that the community was using words in ways that were intended to be non-gendered, but carried with them a gendered sub-text. I used a combination of HCI approaches and Humanistic theories to run a study that shows that this effect is present within HCI literature and produced a novel way of investigating these phenomena.

The Digital Humanities as a discipline suffers from a crisis of confidence. A recent call for papers for an edited collection entitled “Reading Modernism with Machines” expressed exasperation with the endless methods being produced within the discipline, and called for the start of publishable literary criticism developed from these methods [Ross, 2015]. In the early days of this dissertation I had the same inclinations: that new methods were rampant but few of

these methods resulted in the production of new perspectives on literature. What was needed was a better understanding of how to study people and processes and that is exactly what operating in the context of HCI has provided. The HCI community comprises many disciplines from Computer Science to Psychology, and the already established frameworks for study found within the discipline of Systems Design Engineering were perfectly suited to address the problems that I had uncovered within the Digital Humanities, namely the adoption of computational practices with a disregard for human experience. What I found in HCI was a mature field that already understood how to study people and how they interacted with technology. This is what is missing from Digital Humanities research. The interdisciplinary work presented here, while still rooted in humanistic thinking, shows how questions about language and literature can be approached through the framework of HCI. It has become apparent that this influence is bidirectional. The critical thinking and theoretical viewpoints often used and generated within the humanities can positively impact study design and thinking within Systems Design Engineering. This dissertation will highlight the mutual benefit that this type of interdisciplinary work holds for both epistemologies.

## Scope

The specific area of research that this dissertation addresses is *interacting with language using digital tools and processes*. Figure 1 shows how this research sits across the boundary of two disciplines: English and Systems Design Engineering. Within the discipline of English Studies this thesis is focused on two areas. The first is a critical practise known as close reading, a type of textual analysis that roots from the New Critical school of literary criticism and had its genesis in the early twentieth century. The second is the Digital Humanities (DH), a subsection of the

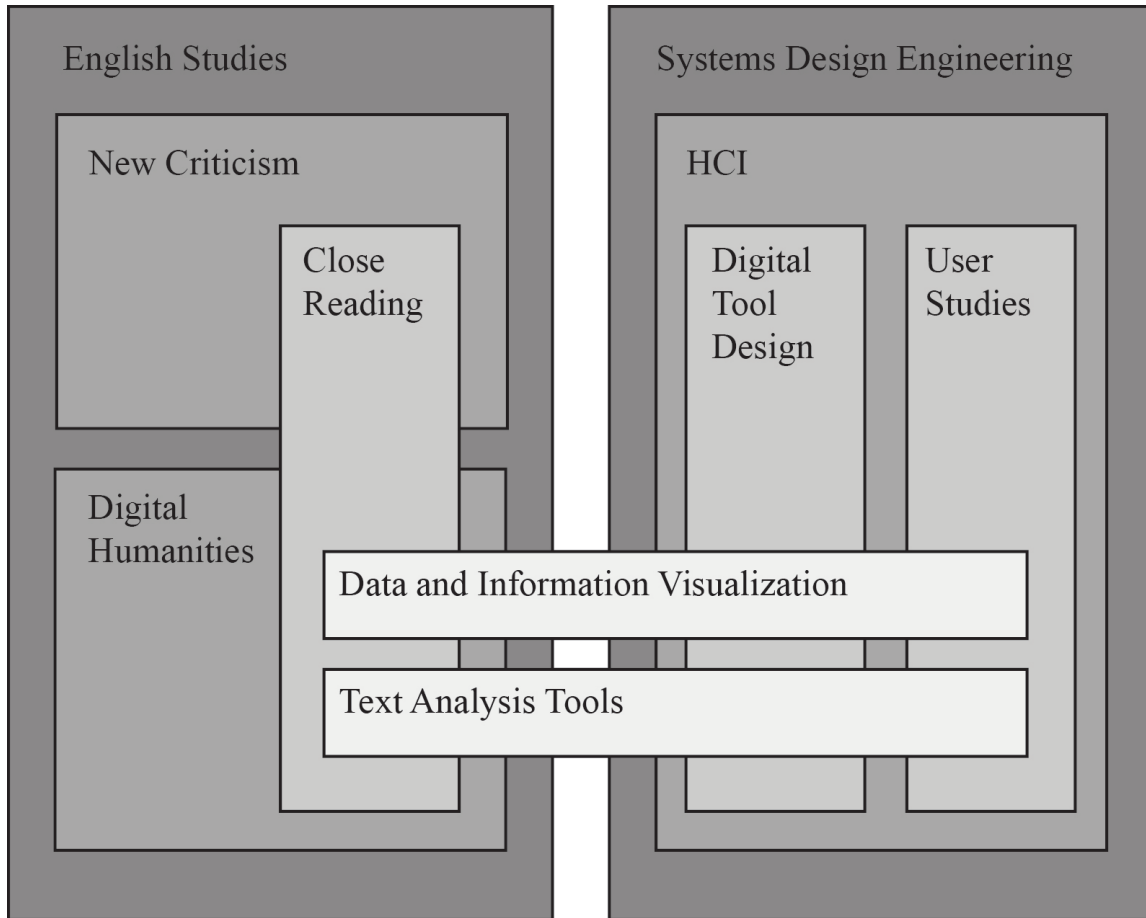


Figure 1: The context of my research

discipline that has been applying computational approaches to texts since at least the 1950s and institutionally since the 1980s. Within the broader subject of Digital Humanities this thesis deals specifically with language visualization and distant reading. In Systems Design Engineering this thesis connects Human-Computer Interaction with Data and Information Visualization, Digital Tool Design, and User Studies. Combining these two disciplines has enabled the application of Engineering principles to language and literature and also has afforded the opportunity to join the scholarly conversation of how language and technology interact in a technical context within the broader field of Engineering.

## **Issues**

Of the many epistemological issues that arise when designing and developing tools and processes across disciplines, in this thesis I focus on the following five issues:

### **1. There is no unified theory that defines what a technological literary criticism is.**

There is a need to define the space of a technological criticism and currently there is no theoretical definition. One of the problems that arises within this area is how to combine traditional literary practises with new technology. While many digital tools have been created in the digital humanities there has yet to be a theory that bridges past literary criticism and the use of digital tools. There is a need to be able to describe and discuss approaches to literary criticism using technology. In chapter 1 and chapter 2 I use Martin Heidegger's theory of technology to show that existing tools are incomplete in how they address people and their interaction with language. I build upon this understanding and provide a framework for how to describe and discuss a

technological literary criticism.

## **2. Digital tools are used as a first step, inverting the process of research question generation.**

Often in the applications of digital tools to literature the exact research question cannot be recreated. This is because there is a tendency to simply “throw” technology at a set of texts and see what happens. In chapter 3 I provide an example of how to use programming techniques and corpora analysis to answer a specific research question: Was T. S. Eliot’s realignment of diction in poetry a real thing, or was it simply rhetorical posturing? There have been papers that set the framework for studies like this [Clement, 2008, Witmore, 2016]. In chapter 3 I apply digital processes to what would be deemed a traditional literary approach.

## **3. Text visualizations destroy information while shifting perspectives.**

A lot of the visualization tools that exist tend to hide information with their mappings. This is really useful in a lot of visualizations; the limiting of available dimensions of information make it easier to understand what is being shown. What it leads to with language in particular is the complexity and the ability to make connections between words and their meanings become limited. To address this there needs to be a way to recreate the original texts. In chapter 4, I demonstrate a technique that allows the original structure of words to be mapped onto the visualization. This enables the freedom to remove the original text, opening up new visualization possibilities without sacrificing the potential for literary interpretation. The visualization I created provides access to words in a way that does not destroy this information while allowing for the shifted perspectives that visualization provides.

## **4. Digital tools for literary study focus on presenting all of the available information**

**and neglect the process of interaction.**

There are many digital tools created for dealing with text [Viegas and Wattenberg, 2008, Wattenberg and Viegas, 2008, Collins et al., 2009a, Paley, 2002, DeCamp et al., 2005, Hetzler et al., 1998, Lee et al., 2010, Viegas et al., 2009, Lin, 1992]. In spite of this, the question remains: how do we understand what parts of the text are important and what should be kept within the digital process? In chapter 5 I conducted a study to investigate how analysts interact with poems in their everyday work processes and then adapt the results of the study to the creation of digital tools. This chapter both sets out to understand how literary critics interact with texts and how that can be applied to digital tool design.

**5. Systems design engineering rarely takes humanistic theory into account when designing new systems or conducting studies.**

While there have been new developments like ecological interface design and proxemics interaction design that take into account more human centered measurements, the Engineering and Science based disciplines have traditionally valued evidence based practise over theoretical and rhetorical approaches to epistemology. The digital realm allows us the opportunity to test theories that were previously very difficult to test, helping to bring theory based ideas into the evidence based work. By looking at language as a system, it becomes possible to use interactive digital tools as a bridge bridge for looking at language and how it is used. In chapter 6 I demonstrate that just as the methods of HCI can be used to better understand literary study so too can literary theories be used to better understand HCI.

## Method

This thesis combines both English studies and System Design Engineering methods to define a middle ground from which theories of digital humanities can be produced and those theories can be tested and developed into working tools. From English studies this thesis is heavily influenced by the New Critics, specifically I. A. Richards and William Empson and their particular close reading approach to analysis. One of the charges against New Criticism is that it is ahistorical. The projects in this thesis try to remedy this problem by extending close reading into the realm of the 'distant'<sup>1</sup> using technology. These projects are equally indebted to Russian Formalism, the rhetorical theories of Kenneth Burke, and the work of Northrop Frye. The approaches found within this thesis are all drawn in some way from these areas of scholarship. The methods used from Systems Design Engineering include the iterative design process familiar in the domain of HCI [Nielsen, 1993, Buxton and Sniderman, 1980] grounded theory [Strauss and Corbin, 1990, Glaser and Strauss, 1967, Glaser, 1992], and user studies. Under the heading of user studies I have used a qualitative approach for understanding the work processes of participants and have applied quantitative analysis and statistics where applicable.

In chapter 1 and chapter 2 I review the previous literature in relation to technology and experience and I make an argument for a specific theory of technology and how that theory applies to previous work in the digital humanities.

Chapter 3 demonstrates a case study approach using a balance of literary criticism and computer programming to demonstrate novel insights about a set of texts. This chapter can be

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<sup>1</sup>This is in reference to Franco Moretti's approach to digital literary analysis that processes entire corpora in what he calls 'distant reading'

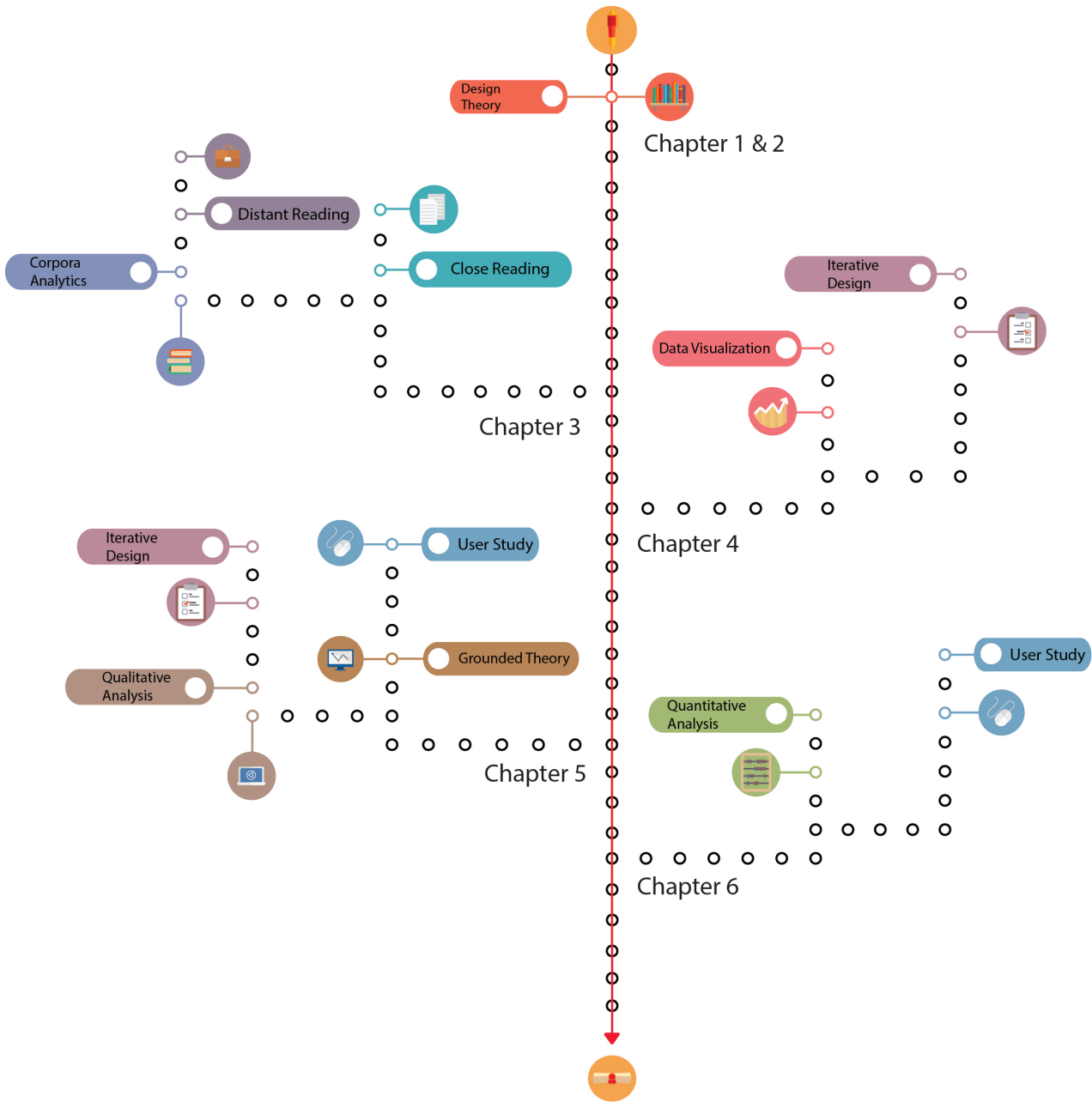


Figure 2: Methods used in this thesis. The centre line is how a reader would advance through the thesis. Each chapter has its own branch (other than chapter 1 and chapter 2 which are grouped together). Within each individual chapter, each branch shows a different method used within that section of the thesis.



considered an existence proof of the type of digital literary criticism I am calling for in this thesis.

What follows in chapter 4 is a complementary approach to the issues in chapter 3. If there is going to be a technological literary criticism we need a better representation of language. I used an iterative design process to come up a visualization mapping that has the properties of being able to encode any symbol system making it perfect for language and punctuation. The system is one-to-one, onto, and n-dimensional allowing for the stacking of meta data about words in multiple dimensions and the ability to recover the original text when necessary.

Chapter 5 is a user study and iterative tool design that tries to better understand how analysts interact with literature and how digital tools can support that process.

In chapter 6 I attempt to show how theoretical ideas can be tested in an evidence based framework. The method I used was a crowd sourced user study and statistical analysis to show that these approaches are not one-dimensional from HCI to literary studies, but can be reciprocal.

## **Contributions**

Each of the individual projects in my thesis uses a different lens to engage with the question of how we can interact with language technologically. They are all in some way addressing a direct research question, but each contributes to the meta question that asks, where are the boundaries of these two disciplines, and how can they be used together to develop an approach to language and literature that is technologically informed?

The main contributions of this dissertation provide methods for studying interaction with language in both the human (close) and machine (distant) worlds. I propose a better understanding

of the relationship between humanistic theories and HCI practise and show that both disciplines can benefit by adopting methods from the other. I make the following specific contributions:

- chapter 1 and chapter 2 contribute a theoretical framework for thinking about how literary studies and engineering work together, and more specifically how to theorize interacting with technology. Even more specifically I try to show that when it comes to language the processing power of the machine is relied upon too heavily and that we need to leave more room for human thought and experience.
- chapter 3 shows how to execute a programmatic approach to handling poetic diction. I specifically show how a literary research question can be explored and answered using digital tools. In this case the approach contributes to literary theory by testing intuitions that T. S. Eliot had about his own writing, which is historically important within the discipline of English studies.
- chapter 4 demonstrates a method for visualizing and comparing whole languages while encoding the original text within the mapping. Within this process it becomes evident that the mapping I have developed allows for an encoding that extends to all symbol systems creating the potential to compare relationships within language representations of any size.
- chapter 5 presents a method for designing and studying humanistic theories quantitatively and provides insight into the work flow of domain experts while they experience and interpret literary language (close reading). The main insights taken from the study is that literary critics think by doing, and that it is detrimental to the process to provide too much “information” to the user. This fueled our tool design which provides meta data in real time

to an analyst working on digital paper with an Anoto pen.

- In chapter 6 I present results from a study of how people experience supposedly gender neutral language confirming previous theories that these words that are supposed to thought of as non-gendered, in fact, carry with them a gender bias.

## **Thesis Overview**

This thesis is concerned with the concept of interacting with language as a system. It is an attempt to define a critical position, one that is content with the interpretive aspects of literary criticism, but also sees the value in augmenting that process with machines. This project is split into what can be characterized as two distinct parts. The first is a theoretical grounding in the humanities (chapter 1, chapter 2). The second is the application of this theory in three system design engineering research projects and a project focused on a more traditional approach to language rooted in English studies (chapter 3, chapter 4, chapter 5, chapter 6). By engaging with the system of language from two separate but related epistemologies, I hope to show that these approaches lead to new and augmented insights, not just into the research questions themselves, but also for each respective discipline.

Part one investigates the history of treating language as a system. I begin with a discussion of technology using Heidegger's theories on interaction as a loose analogy for what is required of an augmented literary criticism. This fits into the history of technological language systems such as the ones first developed by Ferdinand De Saussure and Charles Sanders Peirce as a way to understand how words have meaning. The formal beginnings of semiotics are treated as a

methodology for understanding systems of language. This idea was then extended into the early twentieth century with Russian formalists such as Viktor Shklovsky, who viewed literature as a system where individual aspects of a work of art distinguished literature from other human endeavors. For Shklovsky it is these parts that must be the focus of literary study, and I posit that these are the parts approachable through technological means. The formalist's secondary interest was the prioritization of "literary facts" over metaphysical concerns. This is laid out as the difference between ontological concerns, which information science defines as "a set of representation primitives with which to model a domain or discourse" [Gruber, 2009] (currently the focus of digital humanities work related to literature) and interpretive interaction (what I am trying to facilitate with this interdisciplinary approach). Buried within this dichotomy is a tension that can accurately convey the entire struggle of developing a humanities that is equally at home with physical texts and digital objects. It is the tension between these positions that lays the groundwork for a humanistic intervention into these processes using technology, as I will explain in detail in chapter 2

These "literary facts" were dealt with in many different ways in the early twentieth century. In reference to the ambiguous nature of these facts, Kenneth Burke writes, "what we want is not terms that avoid ambiguity, but terms that clearly reveal the strategic spots at which ambiguities necessarily arise" [1945, xvii] What Burke was describing was, in essence, the opposite approach to what has become current digital literary methods. Burke was looking for the gaps in meaning, the areas that were ripe for intervention and explication. This is in stark contrast to contemporary methods that model large amounts of data with little regard for the interpretive aspects of a text. He was interested in the places in texts where the human mind had to interject. A contemporary of Burke's, Northrop Frye, was also concerned with the relationship between words and people.

He theorized about a system of artful language that is characterized by the retelling of certain archetypes throughout the history of literature. Frye's position is relevant within this broader discussion because of his belief that there is a definite connection between that system (world of literature) and mathematics. He outlines this connection when he writes about "[t]he curious similarity in form, for instance, between the units of literature and of mathematics, the metaphor and the equation" [Frye, 2000, p. 352]. This position will be very important when trying to reconcile humanistic and computational epistemologies into a single approach. It will then be followed by a look into the history of Digital Humanities as it pertains to literature and literary criticism. Although projects that deal with literature are a small subset of DH as a whole, their theoretical grounding is fundamental to any project that attempts to approach literary criticism through technology. Digital humanists have traditionally been concerned with only one aspect of technology, namely its expression as technology, or as Heidegger would label it, instrumentality; this approach is difficult to reconcile with the concerns of textual literary criticism.

If part one of this thesis can be seen as theoretical, then part two is the praxis of this theory. The bulk of this work has been in the application of empirical methods to learn about the system of language, that is the technological aspects of the language that are created by human interaction with it. Each of the projects presented within this thesis attempts to combine humanistic ideas with engineering procedures to investigate a different part of the language system. These projects were conceived in an attempt to identify the points where humanistic study is able to co-exist alongside empirical investigations. Rosanne G. Potter described humanities computing research as needing "a principled use of technology and criticism to form a new kind of literary studies absolutely comfortable with scientific methods yet completely suffused with the values of the humanities" [1998, xxix]. The practical aspect of this thesis is an attempt to do just that.

The technological questions that can be addressed in a thesis of this size are by no means an exhaustive set. On the contrary, each individual study was designed to investigate a different portion of the language system in English, and each investigates different ways to close the loop between humanistic thought and technological processing. Each is driven by a specific sub-section of humanistic understanding. I have two goals for these projects: the first is to show that this type of approach can be used to produce humanistic work. The second is to participate fully within the engineering process. These projects were designed to stand on their own as Systems Design Engineering work while answering specific humanities questions. This is why treating language, and specifically artful language, as a system is the one fundamental premise of both parts of this thesis.

The first project (chapter 3) is a computational investigation into the diction of T.S. Eliot and the Georgian poets. I use the database of the OED as reference point for the first dates of word usage and I ask iterative literary questions to test whether the definition of modernity was found within the poet's use of diction. The results show that for Eliot it is a return to much older language that defines his Modernist diction. This chapter is a demonstration of what literary criticism can look like when both close and distant reading techniques are employed.

The second application (chapter 4) is a mathematically consistent whole language visualization technique. The design was born from a humanistic understanding of ambiguity, and in it I show, that it is possible to use mathematics to model humanistic understandings of language while still maintaining what Potter calls "the values of the humanities".

The third project (chapter 6) is a study of the work flow and habits of literary critics and their close reading practices. This is an attempt to address the need for user studies when designing

tools for literary practice and highlights some of the cognitive requirements that have previously been neglected in literary tool design. I show that the experience of literature is part of the cognitive understanding of a text and argue for a new methodology for tool design within the digital humanities that empowers this process and connects it with distant reading algorithms.

The fourth project (chapter 5) is a crowd-sourced study in semantics, and more specifically, an investigation into the ideas of false universals. In feminist theory, a “false universal” is a word that suggests a norm through unspoken connotations, even though it is supposed to encompass everyone (i.e. “mankind”) [Butler, 1988]. Bardzell writes “the interaction design process takes place independent of gender considerations, and even today the central concept of the whole field—the user—remains genderless” [2011a, p.1304]. In this study we asked participants to create a visual representation of the most used words that describe people from 2014 in the Computer Human Interaction (CHI) literature and then asked them specific questions about the gender of their drawings. What we showed was that within a non-expert population these words do carry with them a gender bias. This may not be revelatory, but up until this point has only been argued theoretically, and we have shown, using empirical means, that there is a significant phenomenon present. This study both shows that we can apply and test humanities theories to the study of HCI but also has provided insights into how we interact with language that can inform digital tool design for working with language.

# **Chapter 1**

## **Irrational Technology**



“ As traditionally trained humanities scholars who use computers, we have pointed out repeatedly that nothing in literary studies will be settled by an algorithm or visualization, however seductively colorful. ”

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Michael Witmore, *Wine Dark Sea*

“ The poet, however, uses these two crude, primitive, archaic forms of thought (simile and metaphor) in the most uninhibited way, because his job is not to describe nature, but to show you a world completely absorbed and possessed by the human mind. ”

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Northrop Frye, *The Educated Imagination*

## 1.1 Introduction

The use of technology to aid in literary criticism has been going on for centuries. What is now low-tech was at one time a great innovation. When we think of paper, pencils, ball point pens, and large machines like the printing press, there is a tendency to forget in the digital age that we now live in that these were all high tech advancements during their time. The high-tech digital tools we now have access to are often referred to in terms of their newness, but they can be seen as simply another stage in the technology that applies to literary studies. In this chapter, I suggest that an irrational technology is one that is accepted as being completely new with a disregard for history. What follows is my interpretation of the fundamental dichotomy central to this debate through the lens of Heidegger's definition of technology. This grounding helps to clarify the approach I use throughout the rest of this thesis to analyze literature. It is the basis of a human-centred approach to incorporating technology into the process of analysis. To start laying this foundation it helps to understand some of the differences between literary studies and engineering.

One of the main challenges of interdisciplinary work is the time it takes to understand and build a bridge between the different epistemological concerns and how they relate to each other. David N. Wear writes "the fundamental challenge to interdisciplinary communication is the different ways we see the world, that is our constitutive metaphors. The greater the divergence between these foundations, the more difficult it is for communication to be effective" [1999, p.299]. The simple act of attempting work across disciplines comes with the added challenge of understanding exactly how both approaches generate and disseminate knowledge. In the case of this thesis I take a conservative stance both in terms of language and literature and in the application of technology to approach what Wear calls the "divergence" between the foundations

of these two disciplines. I use the techniques of Systems Design Engineering to better understand humanistic questions, and use humanistic theories to better understand engineering practises. In terms of literary study I am interested in how words operate in relation to each other, and what that means for the interpretation of texts. The end point of this investigation is an augmentation by technology of the principles first adopted in early twentieth century textual criticism.

## **1.2 Augmented Criticism**

The implementation of a technologically augmented criticism has its own limitations within this type of cross-disciplinary context. The nature of the machine, which processes data immensely fast, but does little else that we can relate to in terms of ‘thinking’, demands that questions asked of it are appropriate for its capabilities. In this way the traditions of generating research questions from literary texts are fundamental to this process of augmentation. Recent approaches in the Digital Humanities, such as Franco Moretti’s distant reading (using machines to process text corpora), invert this process where research questions are generated from large amounts of data and processed before reading of the actual texts takes place. But this approach, as I will show, is problematic. It is not the idea of distant reading that I challenge, but the application of the technique. For literary criticism this has consequences that have led to the current state in the Digital Humanities of methods being published over insights into texts. To ensure that we are not simply finding correlations in literature, distant reading should only be used once the research question is generated; it is then that the machine can be incorporated into research to augment the process. It is the job of the literary critic to understand the relations and ambiguities within that text first, to understand how the individual parts of any text actualize themselves within the whole.

To develop a method for approaching texts through technology it is helpful to set up a model for understanding how texts and technology interact. Heidegger provides a useful analogy for understanding this relationship and I will lean on his conception of technology to identify how processing and interaction differ in terms of literary criticism.

### **1.3 Instrumentality and Anthropological Interaction**

In “The Question Concerning Technology” Heidegger<sup>1</sup> writes “[t]he current conception of technology, according to which it is a means and a human activity, can therefore be called the instrumental and anthropological definition of technology” [1982, p.2]. Although this framework (like any appropriated theory) is not perfect, it is useful to look at questions of technology and literature through the lens that Heidegger provides. When trying to bring together close and distant reading, the understanding of how technology functions as technology and how it functions in relation to the human using technology is of vital importance if we are to combine the two approaches. If we understand that the instrumental purpose of technology is as Heidegger writes “a means to an end”, we can decipher a much clearer conception of what our critical relation to technology should be. In terms of a technological object the means to an end is characteristic of its purpose in design. For example, a potato peeler as a piece of technology has an instrumental purpose of removing the skin from potatoes. In Humanities computing the computer has an instrumental purpose of processing data quickly. To confuse that with interpretation is to confuse computers

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<sup>1</sup>It has been hotly debated whether Heidegger’s Nazi affiliations should invalidate his work. For full studies of Heidegger that deal with both his Nazism and his approaches to technology, see Victor Farias’ book *Heidegger and Nazism* (1989), Tom Rockmore’s book entitled *On Heidegger’s Nazism and Philosophy* (1991), and Emmanuel Faye’s book *The Introduction of Nazism into Philosophy in Light of the Unpublished Seminars of 1933-1935* (2009).

with artificial intelligence.

But Heidegger is concerned with the revealing nature of technology and the relationships that humans hold to those revelations. In his essay he outlines technology as *poiesis*, a bringing forth of its own existence. In the words of Carl Mitcham and Robert Mckay, “Heidegger rejects the common conceptions of technology as applied science and instrument. . . [he] understand[s] technology as a special mode of discovery, and a transformation of being from one state to another” [1983, p.25]. To grasp this mode of discovery, what is necessary is an understanding that the expressed purpose of the technology itself (its instrumental existence) and our engagement with it (its anthropological potential) are separate parts of a technological whole. It is these parts that become a useful metaphor for how we should engage with technology to yield results that can be used for literary interpretation.

## **1.4 Technological Causality and Ambiguity**

Heidegger’s framework, specifically the conception of the instrumental properties of technology, is rooted in a type of causality. It is in this causality that meaning is generated by what the technology can do—can it peel potatoes? Can it process texts? The current trend in digital literary work is to leverage this part of the technology (the processing power of the desktop computer) and derive meaning from its results. But, when we get to moments of ambiguity, usually through interaction with language, we lose the sense of causality; we lose the one-to-one connections and the associations. In these instances the relationships are made metaphorically and become more abstract.

Heidegger's position is "[w]herever ends are pursued and means are employed, wherever instrumentality reigns, there reigns causality" [1982, p.2]. This causality is one of the driving forces of current technological literary studies, and the instrumentality of the machines when used to process texts is what becomes problematic for literary studies. When the irrational situations in literature arise, such as ambiguity or metaphor, the processing of these extra-textual elements becomes incompatible with the instrumentality of the machine. How do we describe something algorithmically when the exact expression of that phenomenon is still not understood? We can call these phenomena anthropological in that they create meaning only from human reception and interaction.

## **1.5 The Limits of Instrumentality**

Stanley Fish engages with the idea of directionality in literary criticism, which relates to a text-first approach versus a top-down application of theory. Fish writes that "The direction is the reverse in the digital humanities [from what he practices]: first you run the numbers, and then you see if they prompt an interpretive hypothesis. The method, if it can be called that, is dictated by the capability of the tool" [2002]. The capability of the tool that Fish describes is its instrumental nature. What is missing from Fish's critique is the understanding that the development of these tools are critical acts, the problem being that once the methods are programmed they become infinitely repeatable, but not malleable. The critical position of the digital humanist is literally codified into the program and thus any 'reading' by the machine will be the same no matter how

many times the program is run<sup>2</sup>. This is a top-down approach that takes as premise that all texts operate in similar ways. We are hard wiring a critical position into the code that cannot change.

This problem can be addressed by making many small and iterative scripts for text processing (see my method in chapter 3), where the critic has full control over what questions to ask of a particular work or body of work. Any tool design focused on literary studies must be robust enough to allow for changing critical viewpoints (see chapter 5), as I have demonstrated in my study of literary critics. Hard wiring critical positions into a code goes against the anthropological nature of language, and applies constraints to language that undermine the critical process. Fish goes on to write “[y]ou have at your disposal an incredible computing power that can bring to analytical attention patterns of sameness and difference undetectable by the eye of the human reader” [2002]. His point is that there are very real benefits to these approaches, but without hypotheses generated from human interaction with texts, the analyst in the digital humanities is speculating on shallow patterns. Instead we need to develop interactions with technology that allow for investigating hypotheses, not generating them. Understanding the instrumental nature of the machine will allow us to understand the limits of processing and at what point in the process interaction should occur.

An example of searching for these limits can be seen in the burgeoning discipline of computational rhetoric. The machine can be employed with great success to find rhetorical schemes that operate as direct repetitions, such as anadiplosis (a repetition of the last word of a clause and the first word of the following clause) and gradatio (multiple examples of anadiplosis in sequence). An example of this is from Shakespeare’s Richard III:

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<sup>2</sup>Because many of the distant reading techniques employ probabilistic algorithms the exact results may vary. It is the approach that is codified. In a close reading this approach is momentary, often changed within single passes.

My conscience hath a thousand several tongues,  
And every tongue brings in a several tale,  
And every tale condemns me for a villain. (V, iii)

The repetition of ‘tongue’ on either side of the clause followed by the repetition of ‘tale’ creates a rhythm and a reiteration that suggests connectedness within the passage; that each piece is in some way connected to the previous piece. It is a simple task to have the machine find these types of instances. But, ask the machine to find climax, which is a semantic rising of multiple anadiploses such as Kenneth Burke’s example—“[w]ho controls Berlin, controls Germany; who controls Germany controls Europe; who controls Europe controls the world” [1945, p.57] —and we are left with a far more complex problem. Unless the exact nature of the relationships are predefined, which due to the size and combinatorial nature of language may be impossible, there is no reasonable way to approach this problem. The problem is that we do not know what we are looking for. If we were trying to uncover all of the geographic climaxes in literature we could easily generate hierarchies of regions and test against those. But how do you approach a problem as vast as human imagination? How do you train a machine to find all possible combinations? The nature of literary art, especially poetics, is often defined by exceptions. The critical stance is anthropological, not instrumental and as such defining algorithms previous to reading becomes extremely difficult.

It is the interaction of a human agent with these schemes that helps to create meaning within the text. Michael Witmore et al. write “[o]nly traditional reading can identify those outliers with something to tell us about Shakespeare’s language. But iterative techniques applied to a digitized text can call attention to outliers, and potentially tell us more than ‘what we already know’ from



our own reading” [2010, p.274]. This is an example of the anthropological within the process. If we remove this and relegate the job to the instrumentality of the machine then we are removing meaning. The problem is anthropological, it is defined by its irrationality and we are not equipped to approach these areas with machines. For Heidegger it is the phenomenological or experiential end that cannot be predicted using the instrumentality of the machine, and this causes problems for an augmented criticism. In the case of the digital humanities, instrumentality can be expressed as the idea that texts are data and can thus be processed—the means and ends are technological. The anthropological are the moments that demand humanistic engagement with the text, or as I am labeling it, the irrational moments. Ambiguity, metaphors, and rhetorical tropes all fall into this category.

If we accept the difference between an instrumental and anthropological technology, and understand that in terms of an augmented criticism the structural or rational position can be characterized as those things that can be processed by machines, we must also look at the anthropological engagement as a necessary part of the process as a whole. We must close the loop between human interaction and computer processing, subsuming this type of interaction into our understanding of instrumentality.

## **1.6 Technique and the Rationality of the Machine**

Attempts to bring together literary criticism and technology, such as Franco Moretti’s work on distant reading or Matthew Jocker’s *Macroanalysis* have been inadvertently based around a model of human interaction with language that closely mimics the idea of homo economicus found in economic theory. Like a rational agent interacting with efficient markets, the premise is one that

treats language and literature as if it operates efficiently in its transfer of meaning. If we are to understand the current state of digital humanities projects in relation to this idea, it makes sense that a solely instrumental treatment of technology in service of an imagined wholly rational agent can explain how and why the digital humanities has not lived up to their promise of a technological criticism.<sup>3</sup> We must understand the anthropological or irrational possibilities that technology holds within it, and design and build tools and interactive processes that allow for the conditions of interaction under this rubric.

These concerns have been expressed about all technology. We are currently seeing the predictions of Jacques Ellul in the *The Technological Society* come to fruition in the digital humanities. Ellul outlines an idea of technique, which he defines as the “totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity” [1964, xxv]. Ellul also elucidates the problems of the machine when he writes “the machine is deeply symptomatic: it represents the ideal toward which technique strives. The machine is solely, exclusively, technique; it is pure technique, one might say” [1964, p.4]. The idea that we are trapped into rationality by technique is one of the foci of this thesis. Herbert Marcuse writes: “[r]ationality is being transformed from a critical force into one of adjustment and compliance” [1998, p.49]. This is what is being seen with digital projects that have their critical directionality confused. This extends to Heidegger’s view of technology not only being rooted in a making process but defined as a mode of revealing. Heidegger labels the actions of technology as Gestell, or ‘enframing,’ and writes “[e]nframing is not a tool or an apparatus, but... the very condition of possibility for the truth to be revealed, poetically, to man” [1982, p.293]. If we consider this revealing as the action of the irrational and one of the fundamental

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<sup>3</sup>This position is explored in detail in chapter 2

purposes of literary study, it then stands to reason that any approaches that exploit the instrumental foundations of technology but also interfere with the anthropological or the presencing of literature are undermining the critical approach.

We must be aware that this revealing is anthropological and that our technology is capable in itself only of instrumental work. Paisley Livingston in his book *Literature and Rationality* puts the problem this way: “even if one were to grant that rationality is a notion having some restricted value in the human sciences, this would not necessarily imply that it has any great relevance to literature” [1991, p.1]. If we are to imagine that homo economicus falls in line with the idea of rationality, then Livingston provides a counterpoint to this idea that is analogous to the anthropological nature of technology:

Rationality may seem a particularly inappropriate concept to bring into a discussion of literature: the prevailing tendency today is to associate literature with madness, dreams, and passion, not with reason. The homo sapiens of the sciences, then, is contrasted to the homo demens of literature. [Livingston, 1991, p.1]

Although Livingston is leaning towards a rationality within a discussion of literature, thinking of the reader as homo demens is a useful analogy for the human agent in relation to technology. It allows us to envision a technology that must support this type of user, one who is irrational and who is acted upon by words and literature in a way that is not systematic. But, what Livingston highlights is that there is also room within the paradigm for a type of rationality, this is the augmentation that I am calling for.

## 1.7 Defining a New Paradigm for Technological Criticism

As Heidegger tells us, technology has the potential to reveal itself to us anthropologically and to operate instrumentally at the same time. This is not the problem. If we consider literary art itself as a technology, then the instrumental aspects, or the rational, lead directly to the anthropological. There is a foundation already laid for this type of understanding of technology in relation to literature, within literature. In most cases the instrumental is so highly prized as some exemplar of truth that tools and investigations are based solely on that perception. The difficulty of designing experiments that expose the anthropological through technology is the challenge within this new paradigm.

Even failing at this has been described as worthwhile. Michael Witmore, Jonathan Hope and Michael Gleicher write:

We can now begin to see the need for interchange between digitally based and more traditional research techniques. There is no basis on which a purely iterative or algorithmic method can distinguish between genuinely interesting outliers (which are significant in a nonstatistical sense) and the expected but meaningless statistical blips any data set includes. [2016, p.357]

The traditional research techniques that Witmore et al. describe can be thought of as the anthropological engagement with the system of language as technology—for this is what literary criticism purports itself to be. We cannot escape from the ‘madness’ of language simply because we begin to involve a machine. We must search for ways to engage with the technology so that the structural and anthropological, the reasonable and irrational, the sanity and madness are allowed

to co-exist. We cannot set out a method that simply applies to homo economicus; if there is to be a truly technological criticism, it must also serve homo demens. But, this application cannot be at the expense of rationality. This is not an entirely new idea. Buried in much of the discourse around digital literary criticism is an understanding of the importance of interaction. Ray Siemens in “A new computer-assisted Literary Criticism” wrote in 2002:

In addition to being a flagship of sorts today for the work of humanities computing in the field of literary studies, electronic editions of several sorts . . . represent the culmination of decades of humanities computing work that has both supported and directly participated in interpretive studies. [p.260]

Support for these interpretive studies must come from the anthropological not the instrumental functions of technology. As Siemens points out there have been “decades” of work leading to what we now know as the Digital Humanities. In the next chapter I will outline how, in the recent history of digital literary scholarship, the structural components of the available technology have hindered progress towards what Siemens calls “interpretive studies”, and what I label augmented criticism.

## **Chapter 2**

# **The Quest for a Digital Humanities**

“ One says: *Technology is a means to an end. The other says: Technology is a human activity. The two definitions of technology belong together. For to posit ends and procure and utilize the means to them is a human activity.* ”

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Martin Heidegger, *The Question Concerning Technology*

“ They may have heard of the older analyses of vocabulary richness used in authorship detection studies by researchers with historical interests . . . and they surely know that computer concordances can be found cluttering up library shelves, but beyond these pinpoints of information, most critics are about as likely to quote a computer study as a biochemical one. ”

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Roseanne G. Potter, *Literary Criticism and Literary Computing: The Difficulties of a Synthesis*

## 2.1 Introduction

There is an epidemic within the current scholarship in the digital humanities that privileges machine processed collections of facts over human interpretation. In 1949, before the availability of computers in English departments and in what amounts to a warning for the current critical climate, Northrop Frye wrote “I understand that there is a Ph.D. thesis somewhere that displays a list of Hardy’s novels in the order of the percentages of gloom they contain, but one does not feel that that sort of procedure should be encouraged” [2000, p.19]. The purpose of this chapter is to address this trend that Frye anticipated, to examine the instrumental and the anthropological within the discipline, and to set the groundwork for the practical studies that follow. This chapter will examine several projects that can be considered exemplars of the technological approaches currently being employed to study literature. As a broad term the digital humanities spans multiple disciplines, many of which are more receptive than literary studies to digital interventions due to the nature of both their data and their discourse. These include but are not limited to History, Geography, Linguistics, and Library Sciences. In response to the treatment of literature as data, this chapter addresses the question: how do we balance scientific inclinations with humanistic thought?

Frye anticipated this line of questioning as well. He elucidates the difference between scientific and imaginative thinking:

Both have to use the entire mind; both have much the same difficulties in getting that very complicated machine to work. But when we consider the finished product only, it is clear that the arts do not stabilize the subject in the same way that science



does. . . The stabilizing subject of science is usually identified with the reason; the unstabilizing subject is normally called the imagination. [1970, p.46]

The two essential forces at work, as Frye points out, are reason and imagination. If we imagine a continuum with the hard sciences on one end and literary studies on the other, the digital humanities has historically pulled the critical discourse towards the stability Frye sees in the disciplines of science. If we agree with Frye that the goal of the sciences is to bring things into focus, to make clear an understanding of a subject, then the humanities are often positioned as the challenger to those stable viewpoints. Helen Small defines one of the main claims for value in the humanities that “they study the meaning-making practices of the culture, focusing on interpretation and evaluation with an indispensable element of subjectivity” [2013, p.4]. Small outlines a detailed history of the culture debate that has found antagonists in the likes of Aldous Huxley, Mathew Arnold, F.R. Leavis and C.P. Snow, and more recently in the publishing hoax where the physicist Alan Sokal placed an article on the social constructedness of gravity in the journal *Social Text*. Small’s justification for the humanities is “based on perceptions of their distinctive disciplinary character and their distinctive understanding of what constitutes knowledge” [2013, p.4]. The problem remains how to incorporate the “distinctive understanding” of different disciplines into a methodology that works for literary studies. If we keep in mind the difference between reason, an idea that can be associated with instrumentality, and imagination, an idea we can attribute to the anthropological, it becomes apparent that literary digital humanities often uses the machine in an attempt to stabilize its subjects, or more specifically to appear scientific in its range.

Before proceeding, it is important to define some terms that relate to literary digital humanities

(LDH). This study is concerned specifically with how to approach literary criticism through technology and not with the overarching project of defining what the digital humanities are. Many LDH approaches are characterized by a high degree of instrumentality, the idea that texts are data, and can be processed as such by computers. The means and the ends are technological. In his frequently cited book *Graphs, Maps, and Trees*, Franco Moretti firmly establishes this position when he writes: “[q]uantitative research provides a type of data which is ideally independent of interpretations, . . . and that is of course also its limit: it provides data, not interpretations” [2005, p.9]. Moretti is aware of the limitations of treating texts as data, but lauds the process as being ideal under the rubric of technological intervention. This has led Moretti to coin the term ‘distant reading’, which is simply a different way of naming the batch processing of texts and subsequent analysis of data produced by that processing.

Matthew L. Jockers compares the differences between close and distant reading to the differences between macro- and microeconomics. Coining the analogous “macroanalysis” and “microanalysis”, Jockers writes, “there is only so much material that can be accounted for using traditional methods of close reading and scholarly synthesis. The Macroanalytic . . . approach identifies larger trends and provides critical insights into the periods of growth and decline in the corpus” [2013, p.47]. The positions on literature and the interaction with literature are so divided by macro and micro methodologies that they may be considered separate disciplines. On the one hand you have distant readers who employ computational procedures to try to expose structures within large sets of textual data (Moretti) or methods of book production (McGann), and on the other you have literary critics like Michael Witmore, who combines technological approaches with Shakespearean criticism, or David-Antoine Williams, whose work on Seamus Heaney and the OED has been augmented by the capabilities of the machine. By tracing some of the major

LDH projects concerned with microanalysis from the genesis of the discipline we can get a better sense of how instrumentality became favored over anthropological interaction, and how these ideas can be reconfigured into projects that use technology to destabilize their subject matter in the way that traditional humanities enquiries do.

## 2.2 Origins of the Digital Humanities

The fable of origin for the digital humanities concerns Father Roberto Busa. Busa was an Italian Jesuit priest who was one of the first humanists to employ computers for the purpose of processing texts. Pulling from Busa's *Index Thomisticus*, a concordance of the complete lemmatization of the works of Thomas Aquinas, Geoffrey Rockwell points out how this foundational project was developed as a natural progression through a developing information technology. Busa, he says,

...began by using index cards, moved onto analogue technology in the 50s and migrated to electronic computers as they became available. The published results were finally delivered in the 1970s with a CD released in 1992. [2003, p.210]

The concordance, a comprehensive list of words in a text with references to each instance in that text, can be thought of as a primitive search engine. The first concordances were created from religious texts and were major undertakings. Hugh of St. Cher in the 13th century employed 500 monks to create the first concordance of the Vulgate Bible, and Rabbi Mordecai Nathan<sup>1</sup> took ten years to create a concordance of the Hebrew Bible, which he completed in 1448. The

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<sup>1</sup>There is controversy around the precision of this name.

first concordance of an English Bible was published in 1550. The creation of these tools and their use has always been thought of as separate projects. But with the invention of computers, concordance projects, which relied sometimes on the work of hundreds of people, became no more than a processing task and the labor needed to create them fell to almost zero. For the first time in history, the users of the tools had the power to create them themselves.

Tool creation for the field of study known as textual analysis also shifted along with the access to evolving technological innovations. The discipline had its institutional genesis in the 1970s on mainframe computers designed for creating concordances. Some of the first programs were COCOA (Count and concordance generation of the atlas) and OCP (The Oxford Concordance Program). With the development of desktop computers in the 1980's these programs migrated from laboratories at large research institutions to the desk of home offices. These programs included micro OCP, The Brigham Young Concordance program (later re-branded WordCruncher), and TACT, a processing system developed at the University of Toronto.

It is not surprising that these were the first projects undertaken by the new digital revolution. The concordance already existed in a form that was well suited for digitization and could benefit from the processing speed of the computer. Of course, the work of generating the concordance was always so labor intensive that the speed at which the computer could perform the same work was a signal of a burgeoning revolution. But there was a mistake in conflating the making of the concordance and the using of the concordance. The former is nothing more than counting on a grand scale<sup>2</sup>, perfectly suited for intervention using machines, and the latter is based in interpretive work, rooted in human imagination. Naturally with the early adoption of technology

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<sup>2</sup>I in no way intend to demean the early creators of these texts; these projects were foundational and highly influential in their time. With the invention and adoption of digital technologies the process has simply become obsolete

it was reasonable to apply this newly found power to problems for which it was perfectly suited. No individual literary endeavor benefited as much from digital intervention in the reduction of person-hours as the creation of concordances.

## **2.3 Consequences of the Shift to Digital Technology**

Rockwell lays out three important consequences of this shift to digital technology from the analog world. The first is availability. In the early 1980's any scholar looking to work with text analysis tools was booking time on a mainframe computer at a research institution. The shift to desktop computers simply gave greater access and removed the barrier of time, which previously hindered the process.

The second was whether the arrival of digital technology allowed for the asking of "new" questions. Rockwell writes,

with interactive tools and a more mature community of users we began to realize we could ask new types of questions that print concordances could not support ... We can do so much more now than find words in a string. We can ask about surrounding words, search for complex patterns, count things, compare vocabulary between characters, visualize texts and so on. [2003, p.209]

It is somewhere within this shift that the project of producing tools, such as concordances, for the purpose of exegesis has been subjugated by the work of producing tools for tools' sake. Rockwell believed, rightly, that new questions were being asked but the literary criticism that

one would expect to follow from such questions did not materialize. Over time this suggests a disconnect between the kinds of questions that can be asked of texts using technology and the kinds of questions that can be useful to literary analysis.

And the third consequence of the shift to digital technology was a re-imagining of the electronic text “as being fundamentally integrated into the literary critical process”. That these new processes would simply help critics to produce new insights into texts. Rockwell writes,

the logic of the tools, despite (or because of) their tendency to become transparent in us, can enhance or constrain different types of reading, which in turn makes them a better or worse fit for practices of literary criticism including the performance of criticism. [2003, p.210]

Speed has been the main benefit of the technological revolution as it applies to Rockwell’s third consequence. A reader can look up a word in an e-text with greater speed than in a codex, but there is an assumption that the improvement in speed carries no associated costs. Geoffrey Hill in a conversation with the Archbishop of Canterbury, Rowan Williams, in 2008 warned:

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elocity is increasing exponentially, and it is velocity that will destroy memory, and when memory has been destroyed the whole dimension that you need for meaningful criticism is destroyed also. In that respect I am not very hopeful, because the one thing computer technology does is in fact a velocity thing—you now do in two seconds what earlier scholarship would have taken two or three years to do. A plethora of

information speedily acquired is the sort of velocity that will destroy criticism, and it is a very frightening prospect. . . I think there are things built into the information culture which are destructive of the very things it seeks to gain information about.

It is almost by default that speed is thought of as an improvement because it is the easiest difference to demonstrate between analog and digital approaches. We must be willing to consider that speed may hinder the process of reading, turning it into something instrumental, something that stabilizes texts instead of creating spaces for us to think in. This may be nowhere more detrimental than in the reduction of texts to data.

## **2.4 Reducing Texts to Data**

One of the problems with LDH approaches to literary texts is the appropriation of natural language as data and how this reinforces the instrumental approach over the anthropological. Willard McCarty writes a nuanced explanation of how this should work:

In operational terms, when humanities research is computerized the source materials become data—that is, computable information—and the research methods resolve into some combination of software and markup. What happens intellectually is neither solely computational nor autonomously human but a combination or interaction of both—a thinking with, and against, the computer. [2002, p.104]

McCarty is at the forefront of this transition, but the shift of literary texts into “data” has garnered undue attention as to shift the critical sensibilities of the discipline towards the instrumental. This

is where the attempt to amalgamate textual criticism and processing power goes awry. The minute we consider our texts as only data, we lose the ability to differentiate between the useful and the trivial when it comes to interpretation. What this leads to are analyses that have very little to do with close reading, even though they situate themselves within that realm of inquiry. McCarty defines the process as two-fold: a choice of what to consider to be the data and a perceptual shift required to see the materials as data. This has led to analyses where there is a single belief that everything within a text is “data” that is useful for literary criticism. This is simply not the case. LDH projects often take stock of what makes up a text while neglecting that at its most base level literary criticism has historically been about relationships between parts of a text and their interaction with a human reader, not simply the occurrence of pieces of data. Those pieces of data are there. Most of them just do not contribute meaningfully to the process of a human reader interacting with a text. This is the position that the small group of dissenting voices rally behind.

## **2.5 Systems and Literature**

One of those voices belongs to Adam Kirsch. Kirsch describes DH as emerging from/relying on a “false analogy between the humanities and the sciences”, concluding that “[i]t makes no sense to accelerate the work of thinking by delegating it to a computer when it is precisely the experience of thought that constitutes the substance of a humanistic education” [2014]. Two fundamental epistemological axioms will guide such a system:

1. The machine does not read; it processes.
2. The critic reads, but reads differently every time (see chapter 5).



This requires that the environment offered for performing literary analysis must be dynamic. The current approaches often lock in one critical way of engaging with a text and multiply that over an entire corpus. Examples of this are rampant. Poem Viewer, a project developed at Oxford University, instantly creates visual lists of every kind of relationship you can imagine within a poetic structure; it uncovers hundreds of ways that the words in a poem are connected to each other. At first this seems as though it could be useful, but what Poem Viewer does not allow for is the simple act of a reader discovering these things for themselves. It neglects that the act of discovery, no matter how slow, may actually be one of the purposes of reading poetry. Proponents of these tools will say you can still discover whatever you want within what Poem Viewer shows you. In fact you might discover more, since you have more to inspect. But what this viewpoint overlooks, and what I have seen in my study of literary critics (chapter 5), is that how these relationships unfold in time is at least as important for meaning-making as their ontological relationships. The singular viewpoint that arises from these programs is that the algorithms themselves become critical stances. What is programmed becomes what you can investigate. In our tool design we tried to develop a system that allowed for an analyst to highlight whatever they wanted in a text and then we tried to augment those highlights with additions. It is a small change, and one that is by no means fully realized, but the attempt is to not interfere with the process and allow anthropological interactions to unfold organically with reading.

Systems that support the process of literary criticism have been called for before. In 1996, at the text analysis software planning meeting at Princeton, Michael Sperberg-McQueen, argued that

we need an open, extensible system. . . [whose] architecture, if we insist on calling it that, will be an emergent property of its development, not an a priori specification. We

are not building a building; blueprints will get us nowhere. [McCarty, 2002, p.107]

Part of what Sperberg-McQueen said is still correct twenty years later. We must imagine a new type of interaction, one that does not impede the actual cognitive processes of literary critics, including meaning unfolding over time, but allows for greater access to information that is momentarily needed to continue with the work of interpretation. But it is possible to create blueprints for this type of interaction. The challenge is not to define what that interaction is, but to create space in technology for the types of interactions that literary critics participate in.

Secondarily, the approach to these systems is too broad, often with consequences that are inexcusable. A perfect example of this is an article entitled “Ranking Contemporary American poems”, [2013] by Michael Dalvean. Dalvean writes,

The upshot of identifying the characteristics of high-quality poems is that we can then come up with a means of placing poems on a continuum according to how much a poem exemplifies the characteristics of an amateur poem or, at the other extreme, a professional poem. We can then use this continuum to rank professional poems and, in doing so, we can make some objective statements about which poems are ‘better’.

His premise is that based on diction, it is possible for the machine to rank “professional” versus “amateur” poems. The very simple response is: why would you ever want to do this? We have been through almost 200 hundred years of literary criticism as we now know it, we have been privy to generations of scholars who have questioned the structure of texts, authorship, cultural perspectives, and agency, and in none of those realms is it possible to imagine that a rank of poems on the criteria of professional and amateur is critically useful. This is an example of all “data”

being treated as “good” data, which is categorically false when considering the literary critical project. If Dalvean is intending to create a new form of literary criticism, I imagine that a lot more work than simply running an algorithm on a corpus of poetry is going to have to be done.

As an answer to this charge there is often a type of false logic used that justifies the existence of certain approaches. Geoffrey Galt Harpham argues that. . .

. . . literary study, which seeks to describe, categorize, analyze, and interpret works of literature. . . seems clear enough—but what is literature?. . . If the boundaries of literature cannot be clearly demarcated, then the kinds of evidence that can be used in literary scholarship must be limitless. [2013, p.512]

What is neglected by this statement is that it has not even been the case that “any” evidence is usable in a literary argument, regardless of what literature has been defined as. This debate has been taken on by Marjorie Perloff when she writes,

much recent “empiricist” study allows for little generalization about poetic modes and values: the more thorough the description of a given poem’s rhythmic and metrical units, its repetition of vowels and consonants, its pitch contours, the less we may be able to discern the larger contours of a given poet’s particular practice, much less a period style or cultural construct. [2009, p.2]

Perloff is questioning whether “data” can provide us with the necessary information from which we can make literary arguments. Her claim is that the type of data produced is too esoteric to reveal any kind of larger breadth. And, more importantly, whether or not we can glean anything

from these empirical studies. This is in direct contrast to the position of those who practise distant reading who are trying to develop broader pictures of literature. The confusion here becomes much clearer if we consider the approaches in terms of their instrumental and anthropological weight. Perloff uses the word “empiricist” in the same way I employ instrumentality, implying that the motivations and uses of the technology are misguided. In this way it is not whether the approach is esoteric or general, it is what is being asked of the approach that matters. Ranking poems may be the most empirical study ever produced, but that does not make it useful for literary studies.

One of the difficulties of addressing this problem is that the answer sits somewhere in the middle of two disciplines. The challenge of a unified approach becomes even greater than simply combining different epistemologies. Within the modern university it means combining different faculties, funding sources, and even buildings on different sides of campus. The separation is physical, financial, institutional, and intellectual. The counter point to Perloff’s position, that humanistic investigations are superfluous, is often made just as strongly and exemplifies this separation between disciplines. In 1956, C. P. Snow wrote,

The traditional culture, which is, of course, mainly literary, is behaving like a state whose power is rapidly declining—standing on its precarious dignity, spending far too much energy on Alexandrine intricacies, occasionally letting fly in fits of aggressive pique quite beyond its means, too much on the defensive to show any generous imagination to the forces which must inevitably reshape it. [2001, xxv]

The rhetoric attached to LDH is very much in the vein of what Snow outlined sixty years ago. There is a presumed credibility that comes from empiricism, and the digital humanities leverages

this quite effectively to drive their literary projects. At some point with the two epistemologies, humanist and scientific, the pursuit of one undermines the pursuit of the other. In a technological criticism these conflicts must be avoided at all costs. The four projects that follow in Part 2 are all in some way trying to identify where these conflicts occur and solve problems by avoiding that unstable ground.

The identification of what can and cannot be used from each of these ways of knowing must always be in relation of one to the other. In my thesis I argue that we must consider each discipline as having its own tenor and vehicle in relation to its overall goals. As I. A. Richards used those terms to describe metaphor, they can be appropriated for the relationship between the two disciplines. If the goal is to produce literary criticism then the tenor must be traditional literary practices and the vehicle would be science and/or technology that help to satisfy the requirements of those goals, including human interaction. If the opposite is true then the standards of science must be upheld and the vehicle becomes those things that can be appropriated from a humanistic perspective and incorporated into design. We cannot think of the relationship as equal because the goals of the underlying epistemologies do not allow this to happen; you cannot stabilize and de-stabilize a subject at the same time. What we see in LDH projects is an intent to balance the two cultures, but the legitimacy of empiricism tends to unbalance the scales towards the scientific. In this way all “data” becomes good data but only because the anthropological is extremely difficult to measure. This naturally ends with neglect towards the subtleties of language and the human interaction within that system.

## 2.6 DH example projects

There are projects that attempt to bridge this gap. In the well-received work of Tanya Clement entitled “A thing not beginning and not ending: using digital tools to distant read Gertrude Stein’s *The Making of Americans*”, she produces one of the few concrete examples of computational analysis that leads to a useful re-reading of a text. Published in 2008 the article analyses n-gram<sup>3</sup> repetitions in Gertrude Stein’s text to try to respond to critical viewpoints that posit that the text is unreadable and has no discernible structure. What Clement shows using her methods is an approach to the text that highlights repeating structures on a chapter scale that were previously unknown. Clement demonstrates,

that *Making* is structured as a determinate object that progresses with its two distinct halves as interdependent forces. These new mappings of the text are important when considering *The Making of Americans* as a modernist text, since from this new perspective (afforded by the digital analysis of the larger text) it can be argued that indeterminacy is not privileged as an essential reading. [2008, p.373]

In response to this article, Natalia Cecire writes,

It would not be accurate, of course, to suppose that Clement’s method consists simply of feeding a text into a machine; human analysis is crucial to the process. It is not so much that nothing is being read by a human as that *The Making of Americans* must first be translated, via frequent pattern analysis algorithms and co-occurrence

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<sup>3</sup>n-grams are groupings of sequential words where n is used as a variable for how long the chunk of text is. A bi-gram would be sets of 2 words and a tri-gram would be 3.

visualizations, into several data sets that are themselves readable by humans in a way that the novel is not. Clement reconstitutes a problem of style—the repetition that characterizes Stein’s “‘a rose is a rose is a rose’ style”—as a problem of scale, to which counting and graphing are a good solution. [2015, p.299]

Clement calls her own work “distant reading”, but according to Moretti’s definition what she has done is not “distant read” the text at all. She has used the machine to perform, as Cicere writes, a translation of a macro-structure within a single text. It is also important to note that the process of distant reading was started with the hypothesis that a structure was present where previous thought had indicated to the contrary. Clement’s early attempt does skirt the line between instrumentality as an operation of analysis and anthropological engagement as interpretation, but the nature of the investigation itself is limiting. What Cecire highlights is that the reason this approach worked at all was because the text itself was created with a style that this type of analysis was appropriate for, and Clement had the inclination to ask a research question in regards to structure before processing the text.

The dynamic nature of one’s relationship with a text is in direct conflict with the static nature of processing and analyzing texts as data. What is misunderstood is that the use of artful language, and perhaps all natural language, is always open for re-interpretation, which Clement does with the machine. But, this may only have been possible with Stein’s text. The success of the approach may have been a function of the text and not of the method.

## 2.7 The State of Close Reading

Rosanne G. Potter, in her article “Literary Criticism and Literary Computing” put forth this idea:

Practitioners of literary computing must consider whether we wish our work to be taken seriously in the larger field of literary criticism or whether we are by default simply opting out of criticism. [1998, p.91]

This context is and always has been in relation to the individual critic. Although often not explicitly stated, especially in the latter half of the twentieth century, the agency in relation to criticism always lies with the critic. The belief that data visualization somehow negates this relationship is problematic. Design decisions themselves, which are necessary parts of any visualization, are critical decisions. What you choose to look at is what will be shown. The design of a good visualization is not that different from the design of a good poem. Its purpose is to redirect attention and to highlight connections that were otherwise unknowable in a different form. Sarah Jones, in her article “When Computers Read: Literary Analysis and Digital Technology”, says outright that interpretation no longer needs reading when she writes,

The basis of interpretation shifts from reading to seeing, from qualitative analysis to quantitative. The reader’s role is transformed, as well, from following the critic’s path of thinking to actively exploring a network of multisensory and interdisciplinary information. The distinction between the authoritative presenter/critic and the learner/explorer is blurred. By inviting literary scholars to ask different questions for computational analysis, digital technology and visualization inspire innovative investigations and enable new insights. [2012, p.28]



It is not enough to simply see something new in a data visualization; this newness must be described in relation to the original artifact. Stephen Ramsay proposes

we create tools— practical, instrumental, verifiable mechanisms— that enable critical engagement, interpretation, conversation, and contemplation. It proposes that we channel the heightened objectivity made possible by the machine into cultivation of those heightened subjectivities necessary for critical work. [2011, X]

Ramsay is correct in his assessment that technology should be used not to create viewpoints, but to open up the spaces where criticism can occur. This is not accomplished by treating all data as good data; it is achieved by maintaining the fundamentals of literary critical practises within a new paradigm that involves technology.

What follows are four projects that attempt to demonstrate the places where this type of work is possible. In chapter 3 I attempt a case study approach, asking a specific research question of a set of literary texts first and using the computer to try and produce an answer from a set of larger texts. Specifically I ask whether the modernist poet T.S. Eliot realigned his poetic diction in the way that he and several literary critics claimed he did. In chapter 4 I outline a new data visualization technique that attempts to reassign agency back to the critic keeping the project balanced between the instrumental and the anthropological. In chapter 5 I conduct a study of the work flow of literary critics to try and set out a framework for digital tool design that allows for the type of anthropological interaction I have describe in chapter 1 and in this chapter. And, finally, in chapter 6 I show how theoretical ideas can be tested in an evidence based framework. The method I used was a crowd sourced user study and statistical analysis to show that these approaches are not one-dimensional from HCI to literary studies, but can be reciprocal.

## **Chapter 3**

**In the End was the Word - A**

**Computational Approach to T.S. Eliot's**

**Poetic Diction**

“ For last year’s words belong to last year’s language / And next year’s words  
await another voice. ”

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T.S. Eliot, *Little Gidding*

“ Coleridge is apt to take leave of the data of criticism, and arouse the suspicion  
that he has been diverted into a metaphysical hare-and-hounds. His end does  
not always appear to be the return to the work of art with improved perception  
and intensified, because more conscious, enjoyment; his centre of interest  
changes, his feelings are impure. ”

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T.S. Eliot, *The Sacred Wood*

## 3.1 Preface

This project<sup>1</sup> is an attempt to demonstrate the directionality that I discuss in chapter 1. The technological approaches used in this chapter were generated in service of a hypothesis that came from literary studies. This chapter is an expression of both technological interventions into poetic corpora and the text-first approach described in chapter 2. The method that is outlined is a demonstration of how the close reading of texts can lead to questions that can be answered with distant reading algorithms. What is described below is a closed loop where close and distant reading techniques, used together, feed back to produce new questions and ultimately new insights.

The essay that follows is included in this thesis because it is a demonstration of the type of augmented criticism that I suggest is necessary to combine the literary and the technological approaches to texts. The research questions were generated first by ‘literary intuition’ and then were answered by algorithmic and programmatic means. It is a demonstration of what it takes to be a literary critical hacker, someone who approaches humanistic questions with high-tech tools.

## 3.2 Introduction

Five words in T. S. Eliot’s poetic works are cited by the Oxford English Dictionary<sup>2</sup> as first documented usages: “polyphiloprogenitive”, “inoperancy”, “juvescence”, “laquearia”, and “piaculative”. Although the neologism (first documented usage) is a small mechanism in the workings of poetic diction, each of these words lends a perspective on the innovations of 20th century

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<sup>1</sup>This chapter makes up the bulk of an essay that is forthcoming in an edited collection entitled *Reading Modernism with Machines* published by Palgrave Macmillan. The collection is edited by Shawna Ross and James O’ Sullivan.

<sup>2</sup>For this project a combination of data was used from the database of the OED2 and the Online OED3.

verse. The word “polyphiloprogenitive”, capitalized and lineated on its own, is laid out as an announcement at the start of “Mr. Eliot’s Sunday Morning Service” (1920):

POLYPHILOPROGENTIVE

The sapient sutlers of the Lord

Drift across the window-panes.

In the beginning was the word.

The allusion to John 1:1 is appropriate to the setting of the poem, but lineated in this way it also asks us to contemplate the poem’s own strange opening. “Polyphiloprogenitive” is both a sign of its own definition (as all words are) and also the orthographic embodiment of its own history, a semantic möbius strip which periodically returns to its own beginning, and to the question of beginnings. Buried in its etymological formation is one of the main concerns of Eliot’s theory of diction—tradition. In “The Three Provincialities”, he writes:

Such knowledge facilitates his task of giving to the word a new life and to the language a new idiom. The essential of tradition is in this; in getting as much as possible of the whole weight of the history of the language behind his word. [Eliot, 2014b, 392]

The idiom he speaks of is rooted in the giving of “new life” to old words. In the case of polyphiloprogenitive, we can see this in action. Eliot’s prefix denotes the senses “many” and “much”, and can be understood to mean “a lot of”. This prefix is joined to the word “philoprogenitive” (of or relating to love or care of offspring; showing love for one’s offspring), its usage first recorded in the *London Times* in 1842. Showing love for one’s offspring in the sense of Eliot’s “new life”, the word evokes the role of the artist as creator, but, when paired with the biblical allusion that

concludes the stanza, the word creates a tension between the idea of an all-knowing God and the power of the poet. The word, found originally in the Wycliffe Bible c1384, is formed from “progenitive”, which was first recorded in 1769. It roots from “progenitor”, A person from whom another is descended; an ancestor, a forefather. As we unpack the word “polyphiloprogenitive”, it becomes apparent that its genesis and its use are both indicative of the tradition Eliot espouses—the tradition that artistry is held in those words that our words are descended from.

To press the investigation further, the word “progenitive”, itself a compound, is formed from the classical Latin “prōgenit-”, past participial stem of “prōgignere” (to beget, bear, bring forth). The word “polyphiloprogenitive” contains within itself an entire pathway, a set of stepping-stones through the language and a bringing forth of the tradition from whence it came. The word that opens up “Mr. Eliot’s Sunday Morning Service” becomes itself a sermon on the history and power of words that form the tradition within English verse.

“Piaculative”, also from “Mr. Eliot’s Sunday Morning Service”, is constructed from the English “piaculum”, (1. A sin, crime, offence; 2. An expiatory offering; a sacrifice), which roots from the Latin “piāculum” (expiatory offering, act of atonement, action which calls for expiation, or sin). The two existing English senses of the word are marked “rare” and “obs.” (obsolete) in the OED. Eliot endeavors to reinvigorate the etymon by ignoring the existing adjective “piacular” (making or requiring expiation or atonement, in use from the early 17th C), in favour of the never-used “piaculative”. The suffix -ative stands in for the idea of something or someone possessing a particular attribute, and Eliot uses it to charge a handful of pennies with metaphoric weight:

The Sable presbyters approach

The avenue of penitence;

The young are red and pustular  
Clutching piaculative pence.

The act of the young “Clutching” these coins suggests both childish timidity and a reluctance to walk the “avenue of penitence” or, perhaps more appropriately, buy their atonement. The contrast of the red and pustular young with the church elders dressed in sable black, a heraldic symbol of mourning, the children themselves are both mourning their sin and the money that will atone for that sin. The red faces are both a sign of embarrassment and also a representation, to go along with the youthful pustules of adolescence. In this way Eliot imbues the image of the young with an innocence that holds itself in a tensive force of these two lines, themselves being clutched to the previous two lines by the semi-colon. Considering that all of this is held in opposition to the established age and ability of the church elders, a simple shift to the adjectival suffix -ative allows Eliot to create these dichotomies between the old, the young, and the economic power of sin. Note that the children themselves are not piaculative, but it is the “pence,” giving function to the previously inanimate object. Although using the form piacular would enact the same function, it falls one beat short of piaculative and would disrupt the 8 beat lines of the stanza. As is the case for useful poetic neologisms, Eliot conjures “piaculative” out of both a formal and metaphoric necessity. His allusion both calls to tradition and begins his own tradition anew.

### **3.3 T.S. Eliot and Tradition**

In no small part due to the influence of Eliot’s early critical prose, the question of tradition pervades the discourse of 20th century poetics. When Eliot coins new words, he is enveloped in

the history of the language; in the cases of “polyphiloprogenitive” and “piaculative”, he has created words that embody the very tradition that he pursues. It is this focus on a particular tradition that sets Eliot apart from his contemporaries, especially those poets labeled as “Georgians”. The modernists, presenting themselves as experimentalists, portrayed the Georgians as dabbling in the leftovers of Romantic sensitivity and Victorian mores. Robert Graves, represented by 18 poems in the set of anthologies known as “Georgian poetry,” published by Harold Monroe out of his Poetry bookshop in London and edited by Edward Marsh, spoke of “the foul tidal basin of modernism” [1967, p.14]; as Cuda and Schuchard write in their introduction to Eliot’s *Collected Prose, vol.2*, Eliot was of the view that “[t]he rustic, pastoral themes of Wordsworth had become, by the early twentieth century, the parochial, self-satisfied verse of the Georgian poets” [2014b, xxii]. Harriet Monroe echoes this critique of stale Georgian verse in her review in *Poetry*:

The ‘Georgians’ live in the twentieth century, no doubt, but their subjects, ideals and methods follow the old standards of English song. . . [A]lmost nothing in the book reminds us of the age we live in. [1920, p.108]

While the Georgians are criticized for their attachment to the recent generations of English poets, modernists are praised for their return to traditions much older. It appears as though there are two types of traditions at play here: those of the immediate predecessors, who for Eliot have become stale and unproductive in their use of idiom; and those poets of what we can call the long tradition, whose words have the potential to be reinvigorated within modern verse. But there were also those trying to rid themselves of tradition altogether. At the Poetry Banquet held in his honor in Chicago on 1 Mar 1914, William Butler Yeats addressed the room about the rhymers club and their attempts to rid themselves of Victorian rhetoric and diction:



We were weary of all this. We wanted to get rid not only of rhetoric but of poetic diction. We tried to strip away everything that was artificial, to get a style like speech, as simple as the simplest prose, like a cry of the heart. [2014a, p.611]

In these lines we hear the echo of William Wordsworth's call for "a selection of the language really spoken by men", made in his Preface to *Lyrical Ballads* [2008, par.13]. Eliot, too, speaks of his diction in connection with Wordsworth's oft-quoted lines:

I myself can remember a time when some question of 'poetic diction' was in the air; when Ezra Pound issued his statement that 'poetry ought to be as well written as prose'<sup>3</sup>; and when he and I and our colleagues were mentioned by a writer in *The Morning Post* as 'literary bolsheviks' and by Mr. Arthur Waugh (with a point that has always escaped me) as 'drunken helots'. But I think that we believed that we were affirming forgotten standards, rather than setting up new idols. Wordsworth, when he said that his purpose was 'to imitate, and as far as possible, to adopt, the very language of men', was only saying in other words what Dryden had said.<sup>4</sup> [1933, p.71]

While Eliot sought to write within the bounds of a new poetic diction, the New Critics, working at roughly the same time, reasoned that poetry was a subset of language itself. They were fixated on the idea that verse was a function of its own medium. For I. A. Richards, this differentiating attribute lay in ambiguity, a figure his student William Empson would most fully elaborate and

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<sup>3</sup>This is from Pound's essay, "A Few Don'ts of an Imagiste", *Poetry*, March 1913.

<sup>4</sup>Eliot is referring here to Dryden's intro to his didactic poem "*Religio Laici*", in which he writes: "the expressions of a poem designed purely for instruction ought to be plain and natural, yet majestic". *The Cambridge History of English and American Literature in 18 Volumes (1907–21). Volume VIII. The Age of Dryden.*

taxonomize. As Elder Olson writes in *Modern Philology*, “[a]pparently he [Empson] reasons that, since poetry is language highly charged with meaning, the poetic word must invariably stagger under the full weight of its dictionary significances” [1950, p.224]. Olson points out that “the instrument by which he detects the possible meanings of words is the Oxford English Dictionary; although it is seldom mentioned by name, its presence everywhere is neither invisible nor subtle” [1950, p.224] . Empson would have used the 1933 OED 1, which is wholly contained in the OED 2. The analysis that follows originates from within the tradition of Richards and Empson, although now with the help of the machine, modernist literary critics have the ability to access the “staggering weight” of words in ways previously impossible.

### **3.4 New Criticism and Technology**

Olson’s objections to Empson’s methods provide an important caution to those who would augment the New Criticism with the help of technology. Olson charges Empson with employing a “mechanical method. . . capable of all the mindless brutality of a machine” [1950, p.255] , a critique that will be familiar to many engaged in digital humanities enquiries. Olson writes,

The theories of Richards and Empson illustrate a tendency, very prevalent among critics who rate diction as important, to rate it as entirely too important. In the order of our coming to know the poem, it is true, the words are all-important; without them we could not know the poem. But when we grasp the structure we see that in the poetic order they are the least important element; they are governed by everything else in the poem. [1950, p.230]

Olson's caveats notwithstanding, the question of diction has nonetheless been omnipresent in the modernist discourse of poetics. Graves writes, "powerful and restrained language" meant "nouns and verbs outnumbering the adjectives" [1967]. Ezra Pound, in his Imagist manifesto "A Few Don'ts by an Imagiste" [1913] rallied against using superfluous words, especially adjectives. Eliot himself conjectured about adjectives in poems, including in "Verse Pleasant and Unpleasant", his review [1918] of Marsh's *Georgian Poetry*:

"Fountains", with the exception of a few adjectives, is a success. "Promenades" is not tight enough. . . ([T]he "rich" is superfluous). "Prospect Road" tends to dissolve into its constituent adjectives and substantives, and "gigantic" should not be followed by "immense" in the next line. . . "London" shows Mr. Sitwell in risk of becoming descriptive. [2014b, p.681]

For decades after the Modernist project had withered, criticism saw Eliot and Pound as the exemplars of modernity. Eliot took it upon himself to define what was "modern" and the critics were apt to follow. C. K. Stead writes that critics have been disposed to view the Georgians "through spectacles provided . . . by the later, more vigorous movement led by Pound and Eliot" [1979, p.81] . But Georgian and Modernist motivations tended to be quite similar at the outset. Myron Simon writes that

Both Georgian and Imagist recoiled from Victorian doctrinizing, from turgid and ornate poetic diction, and from enervated sensualism. The popular poetry of this time was mutually unacceptable to Marsh and Pound. Thus, they found themselves briefly in accord as to the poetic habits and mannerisms that were to be discarded. [1969, p.121]

Modern poetics for the Georgians “meant poetry which concentrated on the removal of archaic diction and pompous language from its text”, and “valued plain language and subject matter which reflected the mundane and pastoral in contrast to the more complex language and philosophical speculations of the modernists” [Quinn, 1996, p.332]. According to Sir Henry Newbolt, by the turn of the new century, Robert Bridges was urging “the great need of modern poetry for a fresher diction and a broader freedom” [1932, p.194] . Ultimately, then, it seems fruitful to extend the vision of Richards and Empson and investigate Eliot’s work in relation to Georgian poetics, for they were both concerned with freeing themselves from the shackles of Victorian usage, or as Eliot put it, we need to “stimulate the worn nerves and release the arthritic limbs of our diction” [2014b, p.324]

### **3.5 Twentieth Century Diction**

After my short review of tradition and poetic diction in the first half of the twentieth century, I am left with questions concerning the validity, as it pertains to diction, of the claims levied against the Georgians. Why was Eliot thought of as an exemplar of the time, and how did the differences in his and the Georgians’ use of words affect our definitions of modernism? Due to the size of the enquiry these questions are difficult to answer without augmenting our critical practices. Taking account of all the word use in large corpora can take years, but with digital texts and a computer we are able to ask questions in regards to poetic diction that were previously so labour intensive we would first need to develop an entire concordance to even begin. We can distill three claims from the existing criticism that lend themselves to quantitative verification. These are:

1. The Georgians express themselves in an idiom characteristic of the Romantics and Victorians (Eliot, Monroe)
2. The modernists look to older traditions to inform their verse (Eliot, Pound)
3. Poetic diction is of subsidiary importance (Olson)

The first step in any enquiry such as this is to organize and pre-process one's materials. All of the scripts for this project I wrote in Python (a programming language well suited for working programmatically with texts) and were written individually for each stage of the following investigation. I sourced digital copies of the corpora in question, which luckily do exist, and all of the headings, page numbers, and line markings were removed.<sup>5</sup> Because Eliot and his contemporaries were so critical of the Georgians—by the 1920's they were calling them “week-end poets”—I chose Eliot, the great beacon of modernist poetry, and juxtaposed his work with the whole selection of poets taken from Marsh's Georgian Poetry anthologies. All five Georgian poetry volumes (1912, 1915, 1917, 1919, 1922) were used for comparison . These compilations were first published by Harold Monroe, out of the now famous Poetry Bookshop in London, and edited by Edward Marsh, who in his preface to the first edition wrote, “[t]his collection, drawn entirely from the publications of the past two years [1911-12], may if it is fortunate help the lovers of poetry to realize that we are at the beginning of another ‘Georgian period’ which may take rank in due time with the several great poetic ages of the past” [1912] . There is a great disparity between Marsh's expectation and the critical reception. The expectations set by Marsh for his poets were never quite realized, and the individual fame of artists like Graves overshadowed

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<sup>5</sup>A saving grace in any of these efforts is to find professionally published pdf versions of files. OCR is a poor choice for scanned books, but published PDFs have easily recognizable text that can be manipulated algorithmically with almost no trouble.

the movement. This tension tends to be described by critics in the difference, newness, and modern expression of Eliot and his cohort. The digital investigations that follow are employed to identify whether this proposed tension is rooted within the texts themselves or were simply critical posturing.

### **3.6 The Modernist Vocabulary**

For Eliot, I used a PDF version of the complete poems. Because the idea of modernity was so prevalent in the critical discourse that surrounds both Eliot's poems and the Georgian anthologies, I first wanted to see how different, if at all, the collective vocabulary of the two selections were. I made a concordance of each corpus, tokenizing and lemmatizing<sup>6</sup> each set of texts. Based on the probabilistic nature of the algorithms, I was concerned that the consistency of the lemmatizers currently in use are not efficient enough to produce results accurate for literary critical conclusions. To try to negate some of this variance I included the original words alongside their lemmatized versions in the concordance. This decision was ultimately reached on the basis that catching more of the vocabulary would be a more accurate representation of word use across the corpora, though either approach was going to be imperfect. I then wrote a script that would parse the meta-data from the OED2 for each word entry found in each concordance.

What does tradition, as Eliot lays it out, mean in terms of diction? To try to unpack this idea of tradition, I began by taking all of the words used in the selected corpora and organizing them by the first known date of usage in the OED. This way it could be tested as to whether the "tradition"

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<sup>6</sup>The porter2 stemmer was used for this project. Any time that stemming is being used we must realize that the process is probabilistic and hand editing of the results may be necessary.

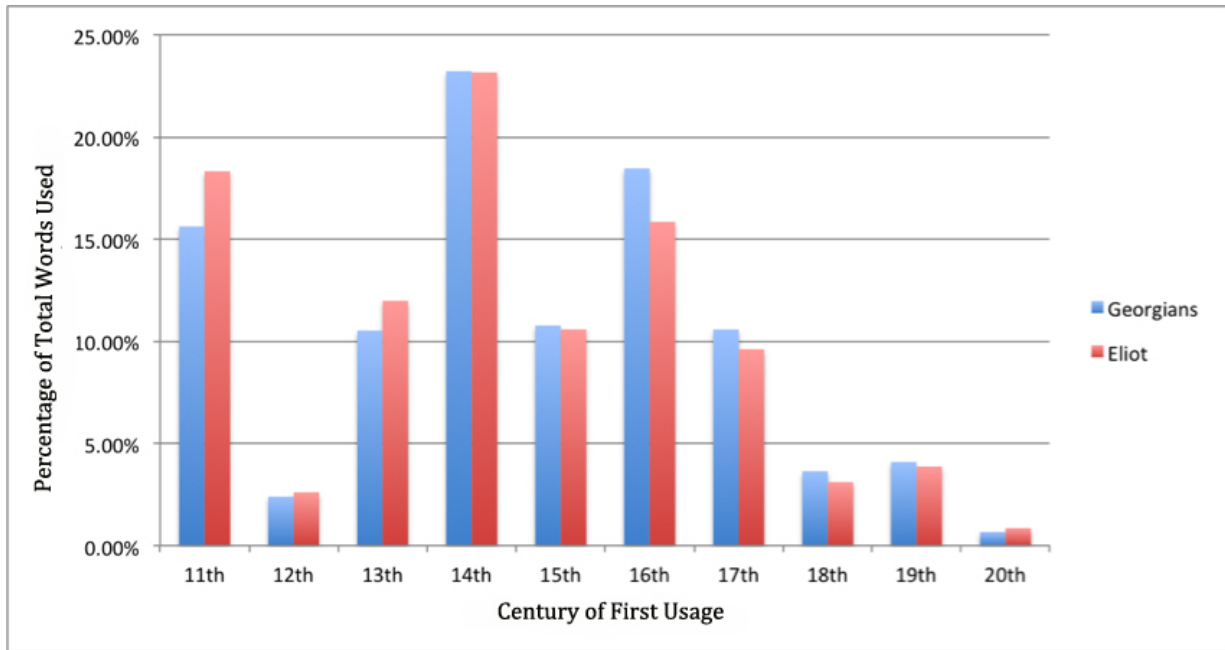


Figure 3.1: Percentage of total words used by century of first usage

has to do with the relative ages of words used. Although this date may or may not be the actual date of coinage, it is the first recorded usage in print that was available to the compilers of the dictionary. I categorized the output by century because my original hypothesis was that the diction of modernity would be found in the difference between the usage of twentieth century words that Eliot and the Georgians were writing and those of the past. At first I calculated their vocabulary in terms of their individual totals to yield a percentage (Figure 3.1).

The similarity of the results was unexpected and encouraged me to reexamine my original hypothesis. The OED2 contains 615,100 word forms defined and/or illustrated, so I quickly dismissed the notion that this similarity was a defect of the dictionary—although it should be noted that due to the history of our language development and the availability of documentary evidence some centuries (e.g., the 12th century) are noticeably sparse. Was this simply a function

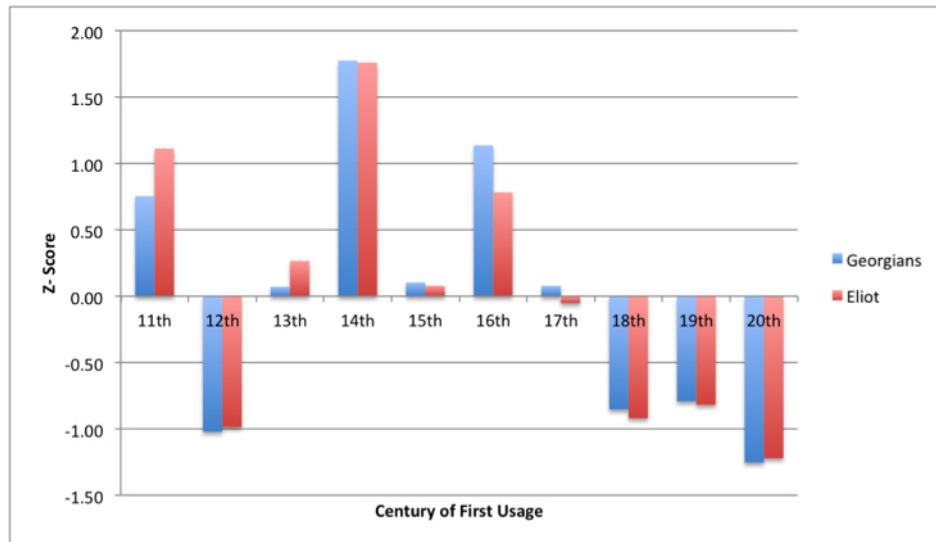


Figure 3.2: Z-scores for total usage by century

of the English language, shared by all who use it? And, in terms of my original question in relation to 20th century usage how close were Eliot and the Georgians to each other in the use of words that came into English in the 20th century?

Because the total numbers of words in each corpora was different, to arrive at a comparable measure *Z*-scores were calculated for each author and each century. When I compared the Georgians and Eliot, the resulting percentages were still very close (Figure 3.2),

although Eliot noticeably over-uses words introduced in the 11th century, while the Georgians use 16th century words more frequently. That the relative ages of vocabularies were so similar across corpora is unexpected, given the extent to which literary criticism has insisted on difference. The 11th century, where one of the discrepancies is situated, was a watershed seeing English double its vocabulary. This epoch is the source of nearly all our most common words, and within a poetic analysis could indicate an unnatural vocabulary by its underuse. The common idiom, that



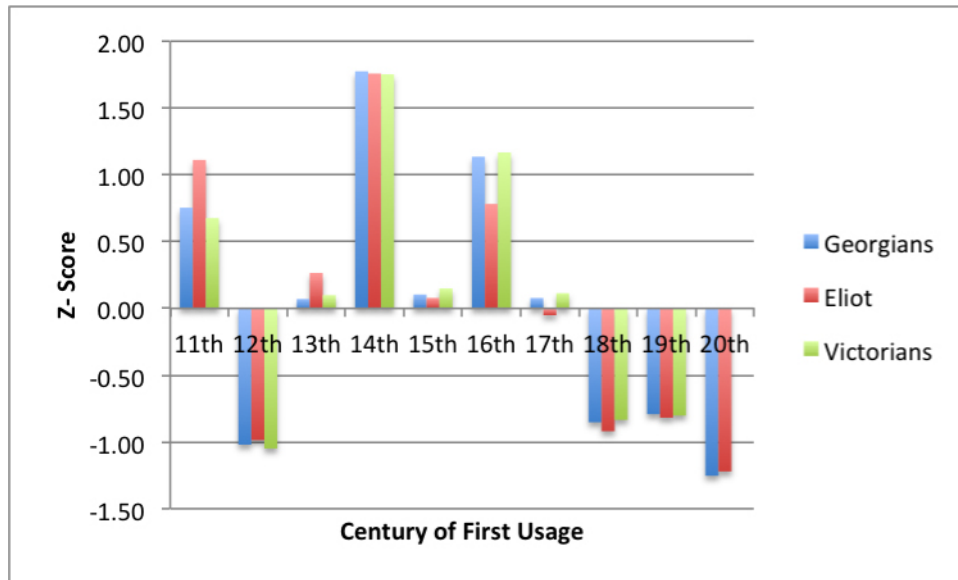


Figure 3.3: Z-scores for total usage by century (with Victorians)

Eliot and Pound were searching for words that would certainly be found in the 11th century (this century is where we find the origins of most English prepositions and other words commonly referred to as ‘stopwords’), and the charges against the Georgians of being antiquated in their diction can be explained by their lack of use in older but more common words.

To investigate further, I decided to test the Victorians against both the Georgians and Eliot, as one of the main criticisms of Georgian poetry has been that they are leftover Victorians. I therefore sourced a PDF copy of the Penguin Book of Victorian Verse and tested its vocabulary against the other two (Figure 3.3).

All three sets of lines are virtually identical with again Eliot using more 11th and 13th century words and the Victorians and Georgians using more 16th century words. What appears to be shown is that in terms of vocabulary, with very few exceptions, the Victorians, the Georgians, and Eliot use the same distribution of words from each century (regardless of total usage) when

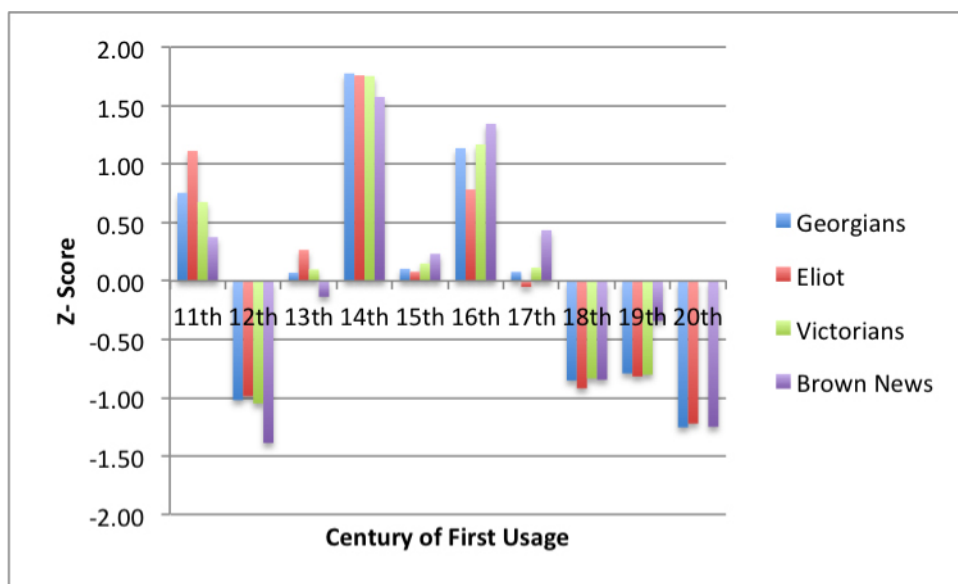


Figure 3.4: Z-scores for total usage by century (with Brown News Corpus)

writing poetry. This may simply be a function of normal vocabularies—that what we are seeing is a representation of how everyone uses the language—but it may also contain within it evidence that all poetry may tend towards this type of distribution. To fashion a control group to explore this admittedly bold speculation, I compiled the same data using only original words from the each text and added in the Brown News Corpus<sup>7</sup> (Figure 3.4),

which I chose because it was of a recognized different genre. Compiled in 1962, it was also chronologically the closest corpus I could source to the decades when Eliot and the Georgians were writing.<sup>8</sup>

<sup>7</sup>This is the newspaper selections from the larger Brown University Standard Corpus of Present-Day American English

<sup>8</sup>Finding reliable corpora is simply part of the task of this type of approach. Within the digital humanities digitizing texts is a constant project and often the choices available are not ideal. Problems arise with proprietary data concerns and often even if a corpora exists it may be inaccessible. The decision made here was based on availability and consistency.

The data shows that when considering genre, a glaring difference in usage emerges, based on the ages of words. If we accept the New Critical idea that poetry is a subset of language as a whole, then this is to be expected. The difference that it does show is that the poets rely much more heavily on the words coined in the 11th, 12th, 13th and 14th centuries, whereas the newspaper articles use many more 16th, 17th and 19th century words (perhaps because those words were culturally important by the time they were writing).

In terms of vocabulary, two points are clear. The Victorians, Georgians, and Eliot (with few exceptions) all use a set of vocabulary that is virtually identical across the history of our language, and when this set of poets are balanced with a corpus from a separate genre, it becomes apparent how similar their vocabulary distributions really are. These distributions are not affected by the omission of lemmatized versions of these words. From these results, we are left with two outliers: the underrepresentation of 16th century words in Eliot's poems and the overrepresentation of 11c words. To investigate the first question, I employed a similar methodology as before, only instead of generating a concordance of words for each corpus, I simply accounted for all words.<sup>9</sup>

The totals words used were as follows: Victorians, 152,092; Georgians, 134,378; Eliot, 30,648; Brown Corpus, 89,658. I then calculated the Z-scores for each corpus by the relative ages of the words used (Figure 3.5).

What is interesting here are that the discrepancies between the poets virtually disappears, meaning that Eliot uses a greater distribution of individual words from the 11th century than the Georgians, but they use theirs more frequently. This suggests then that the difference between

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<sup>9</sup>Accounting for all words counts total usage. If the stop word "it" was used 100 times, the concordance method accounts for the words existence once and accounting for all words counts all instances. The former gives us a metric related to vocabulary and the latter produces a measure of usage.

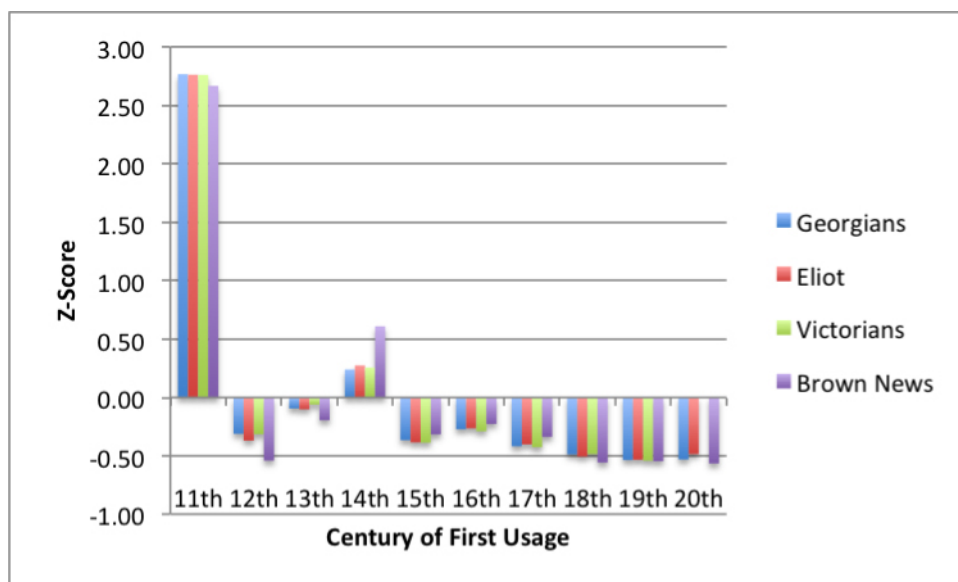


Figure 3.5: Full table of Z-scores for total usage by century

the two samples is situated in their vocabulary and not their usage. Many of the most common words English language speakers use are early remnants from the language, words such as “an”, “and”, “as”, “at”, “be”, “but”, “for”, “from”, “had”, “have”, “he”, “her”, “his”, “I”, “in”, “it”, “of”, “on”, “that”, “the”, “this”, “we”, “were”, “that”, and “who”, which are all from the 11th century and can account for the disproportionate spike<sup>10</sup>. One possible explanation involves the average number of denotative meanings per word. The higher percentage use of 11th-century words could explain this discrepancy based on the fact that many of those words are prepositions and conjunctions, which tend to have above-average number of senses per entry in the OED.<sup>11</sup> This phenomenon would speak to the Imagist mandate towards direct language, which Henry Newbolt labeled as trying to “break through the crust of poeticisms which enclosed the Edwardians and

<sup>10</sup>In most NLP approaches stopwords are removed because their use is grammatically required to be abundant. In this case the comparison of that abundance is being looked at.

<sup>11</sup>The word “that” has the most number of senses and sub-senses in the OED2, 512—83 of which are marked obsolete.

Georgians” [Newbolt, 1932, p.194]. What is counter-intuitive about this is that the modernity that may be enclosed in their vocabulary and usage is not simply using new words: it is the reinvigoration of old words, to which Eliot’s greater use of 11th century verbiage attests.

Admittedly, corpora-wide analyses are quite limited in their interpretive possibilities, but it is within those limits that the potential to witness small phenomena of language arises. My original question about the Georgians and Eliot (whether ‘modern’ language is defined by newer words) is still unresolved.<sup>12</sup> This is where the use of machines must combine with the use of critical inquiry. I originally wanted to know about 20th century words and because those subsets are so small, I generated a word list for Eliot and the Georgians usage from that time and went to the OED by hand—that is, I consulted each relevant OED entry—to investigate further. I found that the Georgians used 58 words coined in the 20th century, and Eliot used 36. Words such as “weatherwise”, “Quebec”, “quiring”, “rattled”, “sputtered”, “sweeney”, “tiens”, “waldo”, and “waves”—which all have 20th century variants in usage, meaning that these words were appropriated into slang or used in new ways without the form of the word changing at all—were removed by hand from the datasets. This left seven words used by the Georgians coined in the 20th century: “Bloomsbury”, “gah”, “rhodes”, “rilled”<sup>13</sup>, “sacramented”, “verboten”, and “vespering”. After applying the same process to Eliot, twelve words coined in the twentieth century remained that were not reinvigorated variants of older words, five<sup>14</sup> of which were his own coinage. These words include “gotta”, “grimpen”, “inoperancy”, “juvescence”, “laquearia”, “ltd”, “piaculative”, “polyphiloprogenitive”, “rolls-royce”, “citroen”, and “taxi”. The usages of 20th century words for

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<sup>12</sup>The previous pages have been about setting up a framework to answer this question.

<sup>13</sup>Rilled, actually coined in 1899 according to OED2, is included because any usage after coinage would technically fall in the 20th century.

<sup>14</sup>inoperancy, juvescence, laqueria, piaculative, polyphiloprogenitive.

Eliot and the Georgians are nearly identical in relation to their overall diction, further confirmation that Eliot's modernity was not found in recently coined words.

Instead, it is in the underrepresentation of 16th century words that we can start to review the idea of modern vocabulary. Accordingly, in "Tradition and the Individual Talent", Eliot begins discussing the realignment of English poetic tradition when he says that modern poets "must be very conscious of the main current, which does not at all flow invariably through the most distinguished reputations" [2014b, p.107] . This line of enquiry extends to Eliot's Essay "The Metaphysical Poets", in which he writes of metaphysical poets, "the meaning is clear, the language simple and elegant. It is to be observed that the language of these poets is as a rule simple and pure; in the verse of George Herbert this simplicity is carried as far as it can go—a simplicity emulated without success by numerous modern poets" [2014b, p.378] . This emulation, when approached from a whole-corpus perspective, shows a strong connection between Eliot and Herbert. Their usage appears to be in line with the poetic vocabulary generally used in English, but for Herbert and Eliot, there is a dramatic shift found in the absence of 16th century usage. Eliot writes, "[T]he language went on and in some respects improved; the best verse of Collins, Gray, Johnson, and even Goldsmith satisfies some of our fastidious demands better than that of Donne or Marvell or King. But while the language became more refined, the feeling became more crude" [2014b, p.381] .

And what of Donne? Eliot on many occasions championed the verse of John Donne, writing that "[a] poet like Donne, or like Baudelaire or Laforgue, may almost be considered the inventor of an attitude, a system of feeling or of morals" [2014b, p.309] . I procured both Herbert and Donne's complete poetry and ran the same vocabulary and usage scripts on them, and what resulted was quite extraordinary. Not only did Eliot speak of realigning the poetic tradition, but intentional or

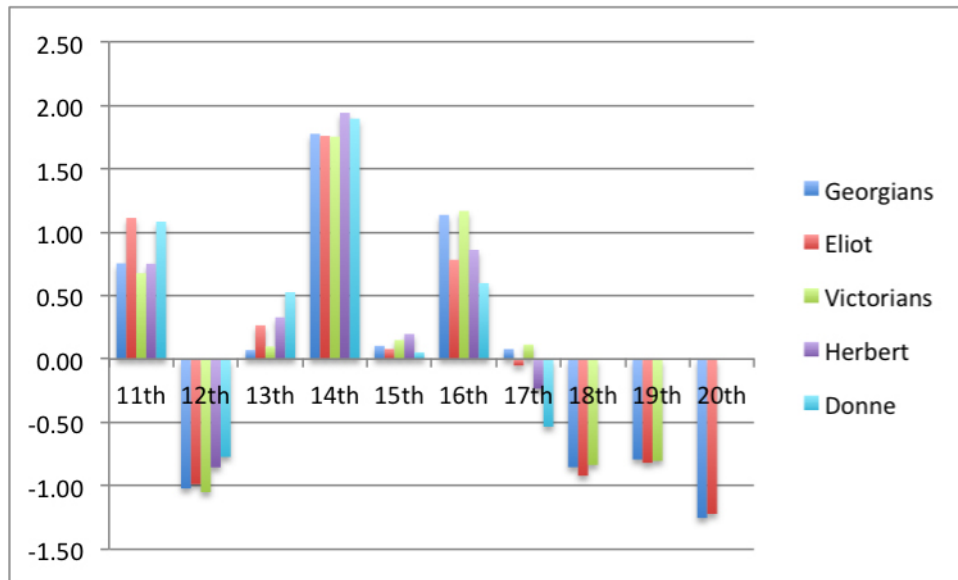


Figure 3.6: Z-score vocabulary across centuries

not, he also emulated the 16th-century vocabulary usage of Herbert and Donne. It can be seen (Figure 3.6) that Eliot and Donne use more 11th-century words, and those two (with the addition of Herbert) fall below the Victorians and the Georgians in 16th-century usage. One might expect this result, given the lag of centuries; there is less time for words to catch on. For Eliot, it appears that one way of approaching modernity was actually by returning to the past and realigning the vocabulary with the tradition that he saw as “modern”. For Eliot, this modernity ran through Marlowe, Ben Johnson, Herbert, Donne, Marvell, and Dryden.

By approaching questions of modernity through a whole-corpus approach, trends otherwise only intuited can be shown to have real effects in comparison. Eliot wrote, “[M]y business is, I believe, to endeavor to determine what is meant by ‘modern’ poetry, and to trace, among the variety of currents and eddies, what is the line of true poetry, as distinguished from mere novelties” [2014b, p.212] . For Eliot, this process was partially enacted by limiting his own

vocabulary and aligning himself with the English tradition he saw as the foundation of being modern. The difference between the Georgians and the Modernists may be one of subtlety. Their usage and vocabulary are, with respect to the qualities measured here, identical in other than the 11th and 16th centuries. Eliot made claims that he was realigning English poetics many times, and empirically, when it comes to diction, it appears that this is the case. But these inquiries are only the beginning; much work is needed to decipher how, and in what ways (if any), this vocabulary played out in the actual lines of extant poetry. The machine can aid us in generating new hypotheses or confirming previously intuited lines of reasoning, but it cannot do the work of literary criticism. We must heed Olson's warnings of becoming too machine-like, but understand that the processing of texts and the interpretation of outputs are two separate parts of a larger process. When it comes to the pre-processing and processing of texts to investigate hypotheses, being machine-like is an asset. But, for the literary critical work, we must employ an augmented criticism, one rooted in humanistic enquiries that maintain humanistic goals. Just as Eliot tried to do in his poetry, we must turn our sights back on the tradition of criticism while carving out our own.



## **Chapter 4**

### **Language DNA: Visualizing a Language**

### **Decomposition**

## 4.1 Preface



Figure 4.1: All words in the Oxford English Dictionary in 1D along the top row, and beneath, zoom levels that identify the word “applesauce”.

<sup>1</sup> In chapter 3 I showed how to approach literature from the stand point of asking literary questions and processing texts to find the answer. Within language studies there is another set of problems that exists, namely that we do not have viable models to work with language on higher levels. In this chapter I demonstrate a technique for visualizing language and asking literary questions that can be considered a whole language approach as opposed to a technique for investigating corpora and individual texts. I also present the results of an informal evaluation of this technique done with fourteen designers, engineers, and artists. The specific motivation for this work was to figure out a way to ask literary questions using a system that displaces meaning from the Roman alphabet to a consistent numerical system. The purpose of this is to try to free ourselves, so to speak, from language so that we can consider how it works abstractly. By creating a system that consistently changes symbol systems into numbers we can achieve several things:

1. Shift the viewpoint of the literary critic to be able to ask abstract questions
2. Allow for a new type of visualization that allows easy viewing of very large corpora

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<sup>1</sup>This chapter makes up the bulk of a paper that has been accepted for publication and is forthcoming from Digital Humanities Quarterly. It has been co-authored by Travis Kirton, Mark Hancock, and Sheelagh Carpendale. Whenever I switch to the plural first person within this chapter it is an indication of collaborative work.

3. Create a mathematical representation of language that an analyst can think with
4. Develop a technique that encodes the original text within the mapping

## 4.2 Introduction

One of the goals of the literary critic is to analyze language and its embedded complexity. For example, when literary critics examine a poem's form, they consider many characteristics of the words it contains, including the similarities and differences in orthography, sound, the visible pattern it produces, rhythmic structure, and countless others. Nearly all of this information is available through visual inspection of the poem and contained in what may already be our greatest visualization technique—the written word. However, this same inspection carries with it the biases introduced by the semantic meanings of the words themselves: it is difficult to pay attention to the parts of the word “apple” without imagining the fruit it represents.

One possible method of aiding in the process of literary criticism is to provide an alternate representation [Simon, 1988] of the words contained within the text to help separate the meaning from the structure, or to provide a different vantage point from which to examine the work. By providing this alternate view, structural aspects of the poem that may be difficult to recognize when obfuscated by the meaning of the words themselves may be easier to observe and analyze. I caution that this understanding will likely not be valuable unless a connection can be bridged between the alternate representation and the original piece of literature, and I stress that this approach is to be considered an augmentation to existing practices. The goal of the research presented in this chapter is to provide an information visualization that provides alternate representations of texts



the text in the mapping was our initial motivation.

## **4.3 Related Work**

This chapter is an examination of how to visualize language in ways that can build ontologies of words based on the needs of the literary critic. Much work has been done in the area of text visualization but none have yet approached a level that can produce whole-language interactions. My work builds on previous work related to gender and on text visualization techniques while expanding on the scope of information that can be shown in our system, Language DNA (LDNA).

### **4.3.1 Text Visualization**

Previous text visualizations fall under several categories. For instance there are visualizations of documents [Collins et al., 2009a, Paley, 2002], of selected subsets of words [DeCamp et al., 2005, Hetzler et al., 1998], and repetition in context [Hearst, 1995, van Ham et al., 2009, Wattenberg and Viegas, 2008]. There are also visualizations for grouping and clustering documents [Collins et al., 2009b, Wise et al., 1995]. However, they do not approach whole language visualization. Most approaches to text visualization whether coming from the Information Visualization (InfoVis) community or the digital humanities, are often aesthetically pleasing, but have not been demonstrated to have utility for literary criticism or linguistics. This limitation can be seen in text visualization projects such as tag clouds [Lee et al., 2010, Viegas et al., 2009] word associations [Yatani et al., 2011, van Ham et al., 2009], topic modeling [Chen, 2006, Gardner et al., 2010, Gretarsson et al., 2011, Hall et al., 2008], and text document comparison [Collins et al.,

2009a, Lin, 1992, Smalheiser et al., 2009, Wise et al., 1995].

### **4.3.2 Visualizing Language in the Digital Humanities**

Within the domain of digital humanities, there are three main streams of visualization that tend to pervade the literature. All three types are based in text analysis but approach the problem from different directions. The first is the Geographic Information System (GIS) tools for organizing spatial data in the humanities [Jessop, 2006, Jessop, 2008, Wood, 1992], specific example of this type of work include Bingerheimer et al.'s visualization of the biographies of Buddhist monks [2009] in which there are examples of multiple types of quantitative and qualitative data presented in a GIS format.

The second category involves tools used to augment reading: text analysis tools that highlight relationships in texts, often with visualizations. This category includes work such as Clement's distant reading of Gertrude Stein [2008] and Wattenberg et al.'s work on using tree visualizations for visual concordances [2008]. Projects such as TAPoR [Rockwell, 2015a] also provide data mining tools for literary and textual analyses. The aim of these projects is to allow for interesting portions of large texts to be marked up and visualized for comparison.

The third category of research is the straight visualization projects which are of two types: The first are the projects that use toolkits such as Voyant tools [Rockwell, 2015b] to explore their research task. The second are the projects that create on-demand visualizations specific to their research problem. The second type of these includes Moretti's work on visualizing interactions and character movements in literature [2005], Bingerheimer et al.'s social network visualization from TEI data, which uses text encoded data to produce networked relationships among textual elements

[2006], and Gould's use of network tools for historical data analysis [2003]. This can also be seen in the TextArc project, which uses radial graphs to show contents and relationships between words in texts [Paley, 2002], and Writing without Words [2013], Stephanie Posavec's graphs of sentence structures and themes in Kerouac's "On the Road". Also, Marc Alexander's work on the Oxford Historical Thesaurus and mapping semantic relationships in language over time [2012]. Also, we find a movement to projects that use art to approach these problems, highlighting that aesthetics may be itself a critical tool. Installations such as TextRain [Utterback, 2015], an interactive art piece where gallery goers interact with falling text, and Word Collider [Heller, 2015], an artistic project modeled after pictures from CERN's Large Hadron Collider, where parts of words when "smashed" together produce effects like those seen in images from particle accelerators.

#### **4.4 Motivation - A Literary Critic's Perspective**

In his book "Anatomy of Criticism", Northrop Frye asks the question, "what if criticism is a science as well as an art?" [2000, p.7] The development of the visualization technique presented here was driven by this exact question. My intention is to facilitate a different approach to Frye's domain-specific question about literary criticism: can we use mathematical and visualization techniques to incorporate science into a literary criticism? These questions have a long history in the humanities and were born out of the general notion that arose in the renaissance when the likes of Locke, Bacon, and Descartes defined a practice that separated and solidified science from the humanities in the 20th century, structuralists suggest that this position is reconcilable, that all literature and language is systematic. This idea—that language is systematic—is approachable via visualization. In previous chapters I have explained the idea of instrumental versus anthropological

approaches to technology. In this chapter I lay out a mapping for creating text visualizations that leave open the possibility of re-constituting the original text. In terms of visualization, the ability to displace language into abstract structures and return to the original text allows for the space of anthropological interaction. Leveraging the machine to produce visualizations is an example of instrumentality that can be very helpful, but the act of literary criticism needs space for the anthropological as well and this technique allows for that possibility. The algorithm we present can accommodate as much or as little information that a critic could want, giving the possibility of visualizing as little as a single letter, as much as entire corpora, or even the language as recorded in the OED. If we are to imagine a space where the literary critic or linguist can experiment using a language-based mathematics, it must have these three characteristics: (1) consistency and reversibility, (2) infinite plotting space, and (3) layering.

#### **4.4.1 Consistency and Reversibility**

First, a visualization algorithm is needed to encode language such that we can create a space that is both consistent and reversible. In mathematical terms, this would be referred to as one-to-one and onto. The need for consistency and reversibility arises from the requirement in the analysis process of preserving the ability for human interpretation of the words. In order for the visualization to be “readable” by a critic, each word must be consistently mapped and that mapping must be reversible into the original work. Most existing visualization techniques distort the original texts without providing an avenue for reconstituting them. This is problematic when studying subjects like poetics, where the spacial and structural components of the text are integral to its meaning.



#### **4.4.2 Infinite Plotting Space**

Second, it is important that the algorithm uses a plotting space that is infinite. Imagine that we were to approach the problem of metaphor. As an example, in theory we do not know if the chain of meaning created by metaphoric relations between words is finite. It stands to reason then, that without an understanding of the full requirements of a system that an infinite space is a safe decision. If we are to start to approach these types of questions our lack of knowledge should not limit the size of possibilities. Specifically, the critic must be able to analyze words and literature that are perhaps not known to the visualization designer. With our technique, we can encode anything from one letter to an entire language, to the entire literature of one language, and even multiple languages, in a space where each point belongs to one individual piece of original information. The infinite space means that in creating “experiments” the literary critic is not limited to our present representations of words, but has the potential to map relationships between words as well.

#### **4.4.3 Layering**

The third requirement is the need for the ability to layer symbols in order to make comparisons. For instance, it should be possible to overlay a poem within the context of the entire language or other poetry. The need for layering arises from the analogic basis of most types of literary critical and linguistic inquiries. This should extend to any types of symbols, as comparisons are not always rooted in the Latin alphabet. Based on what we recognize as the possible requirements of such a system, we designed our Language DNA visualization with the three characteristics of consistency and reversibility, infinite plotting space, and layering in mind.

## 4.5 Defining LDNA

An important property of our mapping is that the words be recoverable from the visual space. Mathematically, this requires that the mapping be a bijection (i.e., that words both map to a unique place in the visual space, and that each point in the visual space maps back to a word). We introduce a mathematical translation of words to numbers that relies on the lexicographical ordering of letters. This is essentially a mapping of alphabetical order and is one of possibly infinite ways to group the data. We have chosen this technique as a first demonstration because we are all familiar with the way we order a dictionary. We define the mapping  $g$  so that each letter is mapped to its position in the alphabet, as follows:

$$g : A \rightarrow \mathbb{Z}$$

where  $A$  is the set of alphabetical characters  $\{ a, b, \dots, z \}$  and:

$$g(a) = 1, g(b) = 2, \dots, g(z) = 26$$

Note that this mapping is currently written using base 10 numbers for the integers (1 to 26, with an implied 0 for no character), but our mapping requires a base 27 representation (or more generally base  $N+1$ , where  $N$  is the number of characters in the language), which for convenience we will symbolically represent as follows:

$$1_{10} = a_{27} \text{ (i.e., 1 in base 10 is represented as 'a' in base 27)}$$

$$2_{10} = b_{27}$$

...

$$26_{10} = z_{27}$$

Thus, we can define our mapping of words to a one-dimensional number line as follows:

$$f : W \rightarrow (0, 1)$$

where  $W$  is the set of alphabetical words (e.g., “apple”, “dog”, “the”, etc.) such that for each  $w \in W, w = x_1x_2 \dots x_n$ , and:

$$f(w) = 0.(x_1)g(x_2) \dots g(x_n)$$

For example, for  $w = \text{“dog”}$ , we have  $x_1 = \text{‘d’}$ ,  $x_2 = \text{‘o’}$ ,  $x_3 = \text{‘g’}$ , therefore:

$$f(\text{“dog”}) = 0.dog$$

Note that this is a base 27 number, but could be converted to base 10:

$$0.dog = 4 \times 27^{-1} + 15 \times 27^{-2} + 7 \times 27^{-3} = 0.1690799_{10}$$



Figure 4.3: All words in the English language visualized along a number line from 0 to 1, and the specific word “dog” (represented as a red vertical line) would appear  $0.dog_{27} = 0.1690799_{10} \approx 16.9\%$  of the way in.

If we relax the restriction that each word needs to end (i.e., we allow words to have an infinite sequence of letters), it becomes clear that  $f$  is a bijection, since every word generates a unique

base 27 representation (one-to-one: the property that if two words map to the same number, they must be the same word) and each number between 0 and 1 can be converted to base 27 to recover the sequence of letters (onto: the property that every number has a word that can map onto it).

### 4.5.1 Using the 2D Visual Space

The mapping above describes how an arbitrary word can be mapped onto a number line, which already allows the visual mapping of words onto an axis in 1D space (similar to a lexicographical axis). Here, we describe a method, inspired by Cantor’s Diagonalization, to map an individual word onto 2D space directly (and more generally onto  $n$ -dimensional space).

According to Cantor’s method, each 1 dimensional number can be turned into an equivalent to dimensional number by splitting every other digit into either the x coordinate or the y coordinate. Since we are treating words as a one dimensional number line, this method can be extended to language and we can split the word in two by considering every other character, for instance “InFoViS” would become “IFVS” and “noi”. Thus, we can take the base 27 representation of the mapped word and create two dimensions as follows:

$$f_2 : W \rightarrow (0, 1)^2$$

$$f_2(W) = f_2(x_1x_2 \dots x_{2n}) = (f(x_1x_3 \dots x_{2n-1}), f(x_2x_4 \dots x_{2n}))$$

For example, if our word is “applesauce” Figure 4.4:

$$f_2 = (\text{“applesauce”}) = (0.0592410, 0.6100587)$$

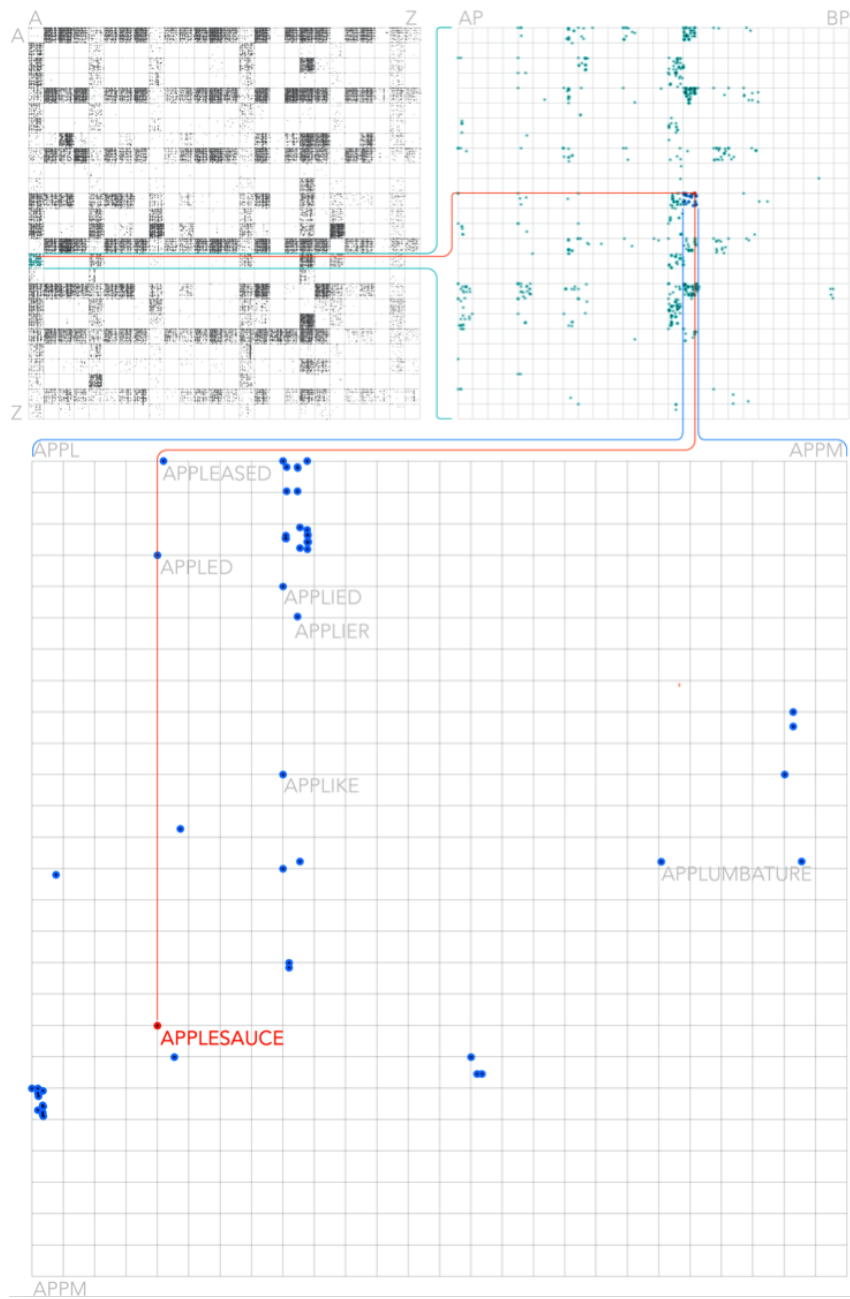


Figure 4.4: The entire English language can also be visualized in 2D (top-left). The result is what appears as a grid of letter pairs, so that one can zoom into words that begin with AP (top-right), and within that square, words that begin with APPL (bottom).

This mapping can easily be extended to  $n$  dimensions by taking every  $n^{\text{th}}$  character in the base 27 representation of  $(w)$ .  $f_2$  is also clearly a bijection, because every word can be split into alternating characters to generate two base 27 representations (one-to-one) and each pair of numbers between 0 and 1 can be converted to base 27 to recover the two parts of the word, which can then be reassembled (onto). Thus, every word in the English language can be mapped onto a 2D space using  $f_2$ , and every 2D point can be mapped to a ‘word’, where a word is a sequence of possibly infinite letters which may well not have associated semantics.

## 4.5.2 A Note on Scale

Since whole natural languages are large, it is important to discuss scale, both of what is being visualized and the size of the resulting visualization. We can base a visualization size calculation on the number of words being visualized, and then determine the length of a 1D LDNA visualization that draws at a density of a single pixel for each word or unit (it is important to remember that these calculations are for orthography, they will change depending on the symbol system used). Two measures are needed to accomplish this: the smallest and the largest distance between two words. Since our algorithm already normalizes words in 1D to be between 0 and 1, we can assume that the difference between the largest and smallest words is approximately 1.0 (with the words ‘a’ and ‘zyxt’, this is already correct to 1 decimal place). In our analysis of words from the Oxford English Dictionary (OED), the two closest words using our algorithm are “abandoner” and “abandoning”, with the first seven letters in common and the next being very close in the alphabet. The difference in values from our algorithm for these two words is:

$$0.abandoning_{27} - 0.abandoner_{27} = 1.37 \times 10^{-11}_{10}$$

Thus, to present a number line from 0 to 1 with numbers only  $1.37 \times 10^{-11}$  apart represented as different pixels would require:

$$\frac{1.0}{1.37 \times 10^{-11}} = 73.1 \text{ billion pixels}$$

Note that in 2D, our algorithm fares far better. This same pair of words would be broken down into two pairs of coordinates:

$$(0.aadnn_{27}, 0.bnoig_{27}) \text{ and } (0.aadnr_{27}, 0.bnoe_{27})$$

which has at most four letters in common for each dimension and would require only:

$$\frac{1.0}{0.aadnr_{27} - 0.aadnn_{27}} = \frac{1.0}{2.97 \times 10^{-7}} = 3.6 \text{ million pixels}$$

To put this into perspective, a 1D visualization using our algorithm would require the width of 38.1 million 1080p screens ( $1920 \times 1080$  pixels) placed side-by-side, and a 2D visualization would require 6.2 million 1080p screens arranged to form a rectangle.

## 4.6 Illustrating LDNA

We start with three examples to demonstrate how LDNA can be used to visualize language. The first is a dictionary mapping for the English language, the second is a view of multiple languages, and the third is a mapping of English phonemes to illustrate the applicability of this approach to any set of symbols<sup>2</sup>

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<sup>2</sup>We present only three simple possibilities here. It must be stressed that the algorithm works for any symbol system or combination of symbols systems.

## 4.6.1 Visualizing the Oxford English Dictionary

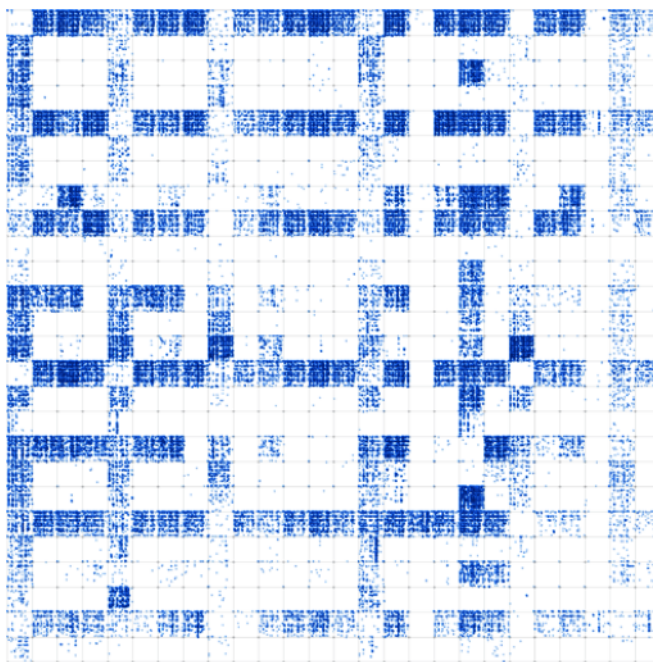


Figure 4.5: The Oxford English Dictionary in 2D LDNA

Figure 4.5 shows all 370,624 words parsed, with criteria that eliminate diacritics and punctuation, from the Oxford English Dictionary, rendered using the algorithm described above (i.e., using the coordinates provided by  $f_2$ ). The result is a mapping that privileges the first two letters of each word. That is, the x-axis can be read as an alphabetical ordering of the first letters of words, and the y-axis can be read as an alphabetical ordering of the second letters. This makes the top left box “AA”, where you would find words such as “Aardvark” (note that few words begin with two A’s, which is why this box is quite sparse). This property is recursive, so that within each box, the third and fourth letters are similarly privileged. For example, in the “BA” box, there is an “NA” box, which has another “NA” box that contains the word “BANANA”. This initial



visualization shows how we can start to understand where each word belongs within the 2d whole.

Because our algorithm privileges the spelling of words, this 2D representation can be thought of in this specific application as a form of 2D orthography. It is essentially a two-dimensional layout of alphabetical order. This version of LDNA reveals a “bird’s-eye view” of the language that was not previously available to the literary critic, linguist, or lexicographer; a critic could previously flip through a dictionary’s pages or even a list of ordered English words, but this visualization instead provides a new 2d spatial location for each word in this dictionary.

#### 4.6.2 The Multiple Language LDNA View

Our second example compares multiple languages (English, French, German, and Spanish). Figure 4.6 shows these four languages each represented in 1D on the 0 to 1 number line using our algorithm, stacked for comparison. Visual inspection reveals a similar sparseness in the ‘Q’ portion of the line for all languages (i.e., few words begin in any of these language with ‘Q’ and any letter other than ‘U’), but additional sparseness in French, German, and Spanish exists near the end of the alphabet (‘W’, ‘X’, ‘Y’).

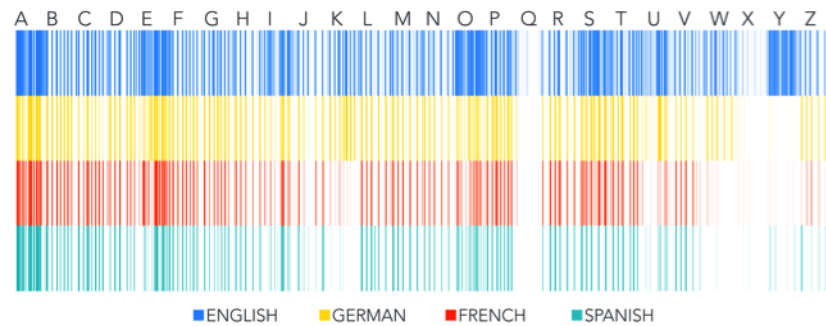


Figure 4.6: Four languages in 1D stacked.

Figure 4.7 also shows a side-by-side comparison of multiple languages in 2D, and Figure 4.8 overlays these four languages. These side-by-side comparisons or overlays allow for elementary analogic comparisons and can be expanded on with more complex symbol encoding.

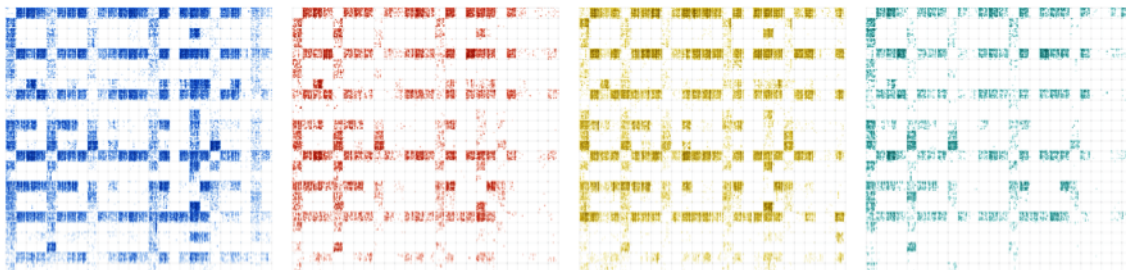


Figure 4.7: 2D LDNA of English (blue), French (red), German (amber), Spanish (aqua)

The images above and below were generated with the constraint that we only had access to open source dictionaries for languages other than English (for which we have university-wide access to the OED). The French (red) has 197,954 words, the English (blue) has 370,624 words, the German (yellow) 425,501 words, and the Spanish (green) has 160,442 words.



Figure 4.8: Overlaying the dictionaries of the 4 languages (English, French, German and Spanish) in 2D LDNA.

## 4.7 English Phonemes in LDNA

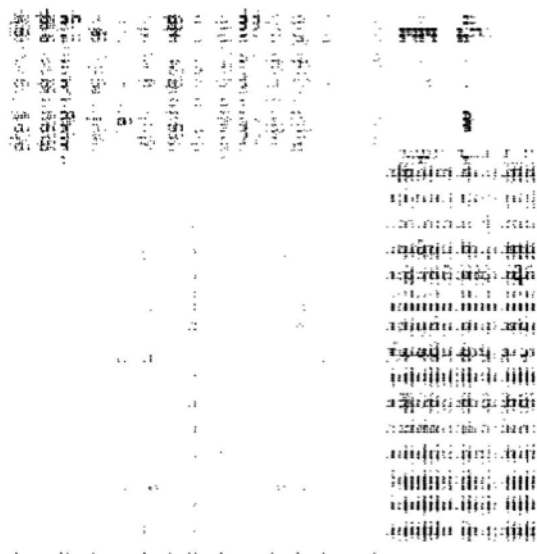


Figure 4.9: English Phonemes showing the Phoneme map of 370,624 words used from the OED in 2D mapped by sound types (i.e. fricatives, stops, etc.)

We chose the next example (figure Figure 4.9), English phonemes, to demonstrate the robustness of the technique to arbitrary symbolic representations of language, and to create an analogue between the spellings of words and the sounds of words. The mapping is organized in like sound units: vowels (e.g., “AA, AE”), semivowels (e.g., “W, Y”), stops (e.g., “B, D, K”), affricates (e.g., “C, H, JH”), fricatives (e.g., “D, SH, V”), aspirates (e.g., “HH”), liquids (e.g., “L, R”), and nasals (e.g., “M, N, NG”).

By organizing words into phonemes, some interesting observations can be made. It appears clear that a portion of the phonemes are used primarily for the first syllable and another distinct set is used primarily for the second syllable. This can be observed through the densely populated top and right columns, with the majority of the bottom-left part of the image containing almost no

English words. In addition, the top-right corner is mostly empty, with the exception of a few very dense groups, representing the few phonemes that are used for both the first and second syllables.

## 4.8 Poetry

The final example that we created was to insert a single poem into the space that we created for English words and phonemes. This is a first step in being able to use these spaces for analogic comparisons.

Some interesting patterns can be observed in the poem through visualizing it in this manner. Firstly, in terms of orthography (Figure 4.10) it becomes possible to identify visual rhymes by cluster groups within the image. In Figure 4.11, this same phoneme visualization can be used to identify rhyming patterns within a poem. As the phonemes group together it is possible to see the types of sounds being repeated in the piece. Although this is easy to do with a 16 line sonnet, it becomes much more difficult with a poem of any significant length (e.g. Milton's 10,000 + lines of verse in "Paradise Lost") and this technique could help to highlight "macro-structures" in poetry. Each diagram below is laid out in two dimensions. This is a decision made during the encoding process and can be  $n$ -dimensional based on the amount of information you wish to build into the model. In this case we have chosen to show 2D representations for simplicity. In Figure 4.10 we present what we label our alphabetical order visualization where we represent words by their spellings. A visualization of spelling alone may not lead to many insights, but is useful for simple demonstrations. One area where this simple encoding could be used would be to visually compare irregular spellings in Elizabethan drama. It would provide quick visual access to the places in texts that differed and needed an editor's attention. The real power in this

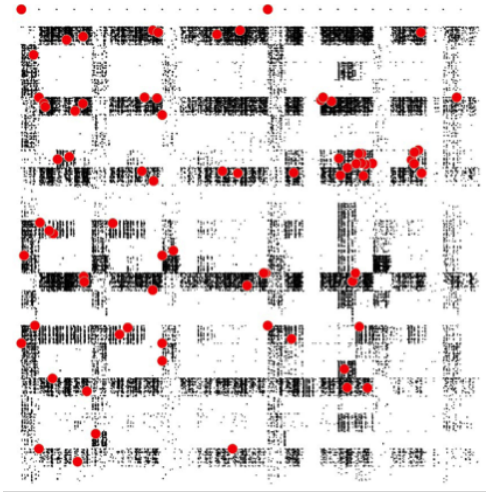


Figure 4.10: The text of John Donne’s “O my black soul” sonnet visualized with the OED.

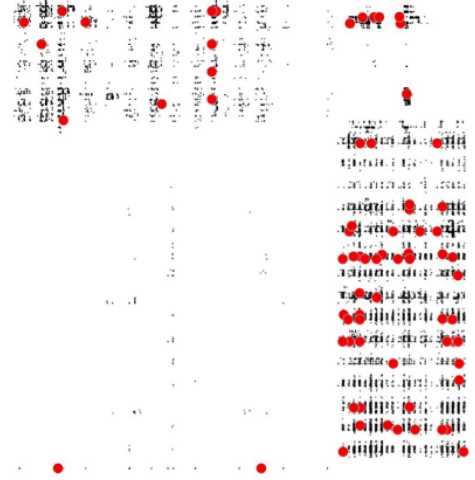


Figure 4.11: The text of John Donne’s “O my black soul” sonnet visualized with English Phonemes.

method comes from being able to encode as many connections as desired. Work has been done in the digital humanities and computer science in the last few years in word embedding models, and the consistency of our method could aid in the process of detecting connections in texts by using vectors. In Figure 4.11, we have graphed phonemes in two dimensions. Any highlights that form vertical lines are showing alliteration in the poem. An example is in the line from Donne’s poem: “Or like a thiefe, which till deaths doome be read”. The words “deaths” and “doom” line up vertically to indicate alliteration in this particular encoding. If we wanted to visualize rhymes we would simply encode the phonemes in reverse, privileging the final phoneme and we would generate a similar graph. The  $n$ -dimensional nature of the models allows for as much or as little data coding as needed, including relations between words. The only limitations on the questions that can be asked are the imagination of the analyst.

## **4.9 Initial Feedback**

We wanted to discuss this project with a cross-section of scholars to develop a better understanding of how people understood LDNA and whether or not they saw potential uses for their research. Our goal was to gain insight into whether this technique could inspire reactions and possibly spark interest in the approach.

### **4.9.1 Participants**

We intentionally sought participants from a variety of disciplines. We had fourteen participants which included one visual artist, three literary critics, one rhetorician, two digital media critics, one database programmer, one business analyst, one linguist, two interaction designers, one graphic designer, and one marketing specialist.

### **4.9.2 Procedure**

Each participant took part in a thirty-minute interview and was first shown LDNA visualizations that we had intentionally left void of any legends or axis labels, so that we could ask questions about their initial interpretations. After showing the image in Figure 4.5, the mapping of the OED in two dimensions, we asked what they thought the image might be. We then showed participants Figure 4.6, four languages plotted in the same space, and the interviewer gave a thorough explanation of the how the algorithm works and what they were seeing. We took time to make sure they were comfortable with the explanation and asked about their understanding. We then showed them Figure 4.7 to be able to further explain LDNA and asked questions based on the

participants' understanding. We also asked participants to complete a post-interview questionnaire. Five questions were asked on a 5-point scale, with an opportunity to provide free form answers:

Q1. Once explained, to what extent is the visualization readable?

Q2. Do you think the white space has meaning?

Q3. Is the white space necessary?

Q4. Does representing languages by colour and words as points work well?

Q5. Does this spatial representation of language trigger new ideas?

The following three questions asked for free form answers only:

Q6. What are your initial interpretations of this visualization?

Q7. Can you imagine a more suitable or readable structure?

Q8. Please provide any criticism you have about this visualization.

## **4.10 Results: Scale-Based Questions**

The scale questions were answered as follows. For Q1, 6 out of 14 participants told us the visualization was clear after the explanation (5 out of 5 on the scale). FOR Q2, 9 out of 14 people said that the white space carried meaning to them (5 out of 5) and 6 participants thought that this white space was completely necessary. For Q4, 7 out of 14 people ranked a 5 out of 5 for the visualization approach. 10 out of 14 participants said that the visualization triggered new ideas for research (5 out of 5).

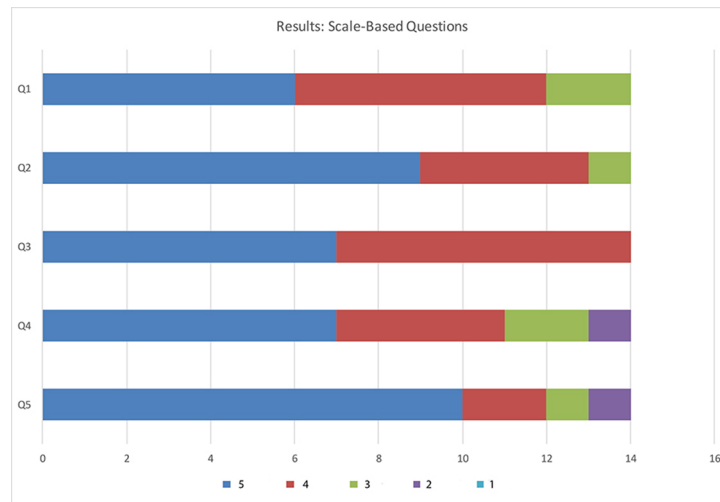


Figure 4.12: Likert Scale results for our informal evaluation

## 4.11 Discussion: Free Form Questions & Interviews

We have formulated our discussion around the free-form questions. Since our participants were experts from a variety of fields and domains, the similarities in answers in some cases are particularly interesting, and in other places it is the difference in answers that encourages us as researchers in terms of the potential of LDNA as a tool for approaching research questions about language. In this discussion we include the questions and a discussion of the general themes that arose in the responses.

### 4.11.1 The Power of Representation

Interestingly, when shown the images without any labels, participants tended to engage in metaphoric comparisons of what they were seeing. The omission of a legend led each participant to find something that was cognitively analogous to what they were seeing. For example,



some responses were:

*“Is it zoomable? It has a DNA look or sort of ummm a matrix data flow and I feel the urge to zoom it. It looks like I am really far away from an unbound book, like how a book would be printed in sheets. It has that type of aesthetic”.*

*“Well, it reminds me of DNA, like a screening test, it also looks like a stamp, like someone has stamped something. It is a very tactile image, I want to touch it”.*

*“It’s kind of like DNA. Like, uh, people show these images that visualize DNA”.*

In response to this process, five out of fourteen (26%) of our participants from varying backgrounds and fields described Figure 4.5 as resembling DNA—the inspiration for the name of our technique. This result also demonstrates the power of representation held within LDNA. Some of the responses received from participants included references to stamped or fading paper, city grids, abstract art, and digital clock faces. Because we were trying to create a space that could handle an ontology of words, the DNA metaphor was highly applicable based on the implications of describing parts of a long chain of information.

#### **4.11.2 White Space**

In our interpretation of the study data, the questions about whitespace (Q2-Q3) produced perhaps the most interesting results. It was during this question that most of the participants began to hypothesize about the “space” in the languages they use every day. Essentially the parts of the

visualization with an absence of dots inspired thought, because they were in stark contrast to the actual dots drawn on the screen. This result strongly indicates the analogic or comparative possibilities of this technique—the literary critic can begin to understand what makes a word English by recognizing what is not a word, or by investigating what words poets or writers use that push the boundaries of language. The response of our participants to the relationship between the whitespace and the space occupied by words creates a relationship that gives insight into what sets of symbols we use and which we do not use in our language. The sheer size of the whitespace in comparison forces an understanding of how few of the possible arrangements of letters we actually use. With further work we think it is possible to show that more complex mappings will produce more complex analogues.

It was generally agreed upon by our participants that it was the relation of the empty space to the marked space that created meaning and inspired insight into what the visualizations were showing and what they could show.

*“the white space gives you a sort of ground against which it makes sense . . . without it it might be even less evident”*

It was in the white, or the lack of spellings, that our participants saw the potential for growth in the language, or commented on the enormous range of letter combinations that we do not use in English. This is encouraging because as we build “meaning” into these visualizations we expect the response to be comparative, and we expect new interpretations will result from these comparisons. Initial reasons were as follows:

*“Every letter can start a word, but does that mean that there’s combinations of letters that don’t turn into words . . . you don’t have words that start with trsz is that why*

*there would be space . . . Maybe it means that language is primitive, not as evolved as it could be”.*

*“I’m almost more interested in the dots in the white space... if there’s one I want to know what that is...the outliers are more interesting”.*

*“What it does is show what the common letters are and common overlaps”.*

For the researchers this result was surprising, but was explainable. Without “meaning” being built into this version we were simply showing a part of orthography (spelling) and, in this stripped down version of the possibilities of the space, it was the comparison between what was empty and what was marked that sparked the interest of our participants. This is exactly the response we were interested in and we anticipate with more complex representations we will be able to see more complex analogies. Some of the responses to this whitespace analogy are as follows:

*“I think the uniformity of the gaps are startling. It seems oddly uniform and consistent. I think that potentially symbolically the gaps can sort of be a formative quality of language and words will start to fill in those gaps”.*

*“Well, I guess it kind of goes to show how constrained we are in language, which shows how some things just are not possible with spelling, which is kind of cool. There is soo much blank space particularly along certain lines, you get some sense that our alphabet constrains us, which is why we have poets”.*

These responses were typical of all our participants and are very promising for future work.

### 4.11.3 Reluctant Inspiration

When asked if the images they were seeing inspired any new thought processes, they proved to be exciting to our participants and the answers that follow show the breadth of their thinking:

*“You could map to any narrative, I would like to see this map out, A Tale of Two Cities, it looks like a genetic footprint, like a genetic phonetics, you get to see this formal genetic blueprint, it is more like an autopsy of the text”.*

*“Yes, from a design and a fine art point of view. I think it is, again, if you look at it as a design issue does it solve any problems, not yet, but then again you are deconstructing something that already has that problem solved so you are raising questions instead of solving problems and you are raising interesting and meaningful questions”.*

*“Well, I mean my initial instinct is YES (emphasis given by the participant), but I am not sure what that would be yet, I think it could lead to a lot of productive conversations about how language operates or the way someone creatively uses language”.*

*“These are important questions. Literature departments have always performed as if they were in the shadows of the sciences and... [i]t seems to me that this kind of work, although seemingly scientific, should be the domain of literature department. It would be very important work for us to do”.*

Interestingly the 1 person out of 14 who said no to being inspired (included below) touched directly on the fact that the simplicity of our representation of orthography was limiting but suggested in his negative response that it could be interesting for literary criticism if we could find a way to include meaning, which is fruitful ground for future work and possible with the three criteria we laid out above for the development of the technique:

*“I’m not sure it’s useful for literary theory or criticism because it seems to explicitly set aside the question of meaning in favor of orthography”.*

*“Oh yea, um this is only for spellings well things get really interesting when you get into phrases, rhetorical aspects of language organization, the whole question of nuance which we like to think we are studying as literary scholars. Once you get into these things and away from mere spelling and into points that have meanings you can start to clump together interpretation to different meanings”.*

#### **4.11.4 Criticism from Participants**

Our participants were in some cases critical of the design of LDNA. In particular, the most common criticism centered on making the technique interactive, which is a clear (and previously planned) next step in our iterative design process. Another criticism was that the encoding we used was arbitrary, and its meaning was not immediately clear:

*“The mechanism by which you map words to spatial locations, it’s kind of arbitrary (maybe that’s not the right word). Mostly you see the first two letters, and when you*

*zoom in you're seeing the space of subsequent letters. I guess what this mapping is lacking is the Meaning of words, or the semantics. They end up being distances from one another but . . . the distance between related concepts, synonyms. I'm not necessarily saying this is a bad visualization because of that. It just doesn't encode the meaning of words. Which is much harder. But, this is a legitimate way of putting words in a consistent space".*

*"The way that it is right now, that it's static, it's getting in the way of itself. It demands explanation. It needs to be paired up with something very practical, like reading a word or reading a sentence and how that gets paired up in the system".*

We see this interactivity as the next step in developing an application for these types of interactions and it is in that interactivity that the objections to the arbitrariness of the design will be addressed. We hypothesize that being able to investigate the space dynamically, and by defining other symbol systems to encode, the literary critic will be able to explore the types of meaning and associations being looked for by our participants.

## **4.12 Study Response**

From our qualitative study, the overwhelming result was the importance of the white space in our visualizations to the entire group that was interviewed. This result has influenced the direction of our future work. This result demonstrates that this space can be used for the types of comparisons that we are interested in, namely those that lead to interpretive possibilities. We recognize that we



Figure 4.13: Density map of the English language in LDNA.



Figure 4.14: Inverted density map of the English language in LDNA.

have presented a simplified form, but the technique itself allows for infinite complexity. Some of our participants talked about the need to include information that gives meaning to relationships and that is the next step in developing mappings that can solve the original problem of creating a space that can be experimented in with language and literary theory.

#### 4.12.1 Prioritizing Whitespace

In response to the discussion with participants about the interest in whitespace and the lack of density in certain regions, we produced a density and inverted density map to highlight the white spaces, shown in Figure 4.13 and Figure 4.14. This was in direct response to comments from our participants such as:

*“Yeah. But, one thing I was going to say... the UNIFORM inclusion of the whitespace is interesting. But I wonder if there’s a better representation of density and overlap”.*

In this iteration of our design, instead of rendering each word in the language we instead cluster groups of words into the boxes representing pairs of words (“AA”, “AB”, etc.), and render the box using transparency that corresponds to the density of words therein. The inverted version of this mapping highlights all of the non-English words, which were clearly of interest to participants.

#### 4.12.2 ygUDuh

We have discussed how the blank spaces are compelling and how the absence of words in these spaces generally seems to intrigue people.

It is interesting to note that this space is and has been filled in many interesting ways. For example, E. E. Cummings poem ygUDuh does not contain a single English word, yet it can be read as English, where the ‘words’ take on the sonic characteristics of English when read out loud. For example, the first few lines of the poem are:

ygUDuh

ydoan

yunnuhstan

That when read allowed becomes a phonetic map for a type of early 20th century urban slang exemplified by the poem:

you gotta

you don't



you understand

In Figure 4.15 we have plotted ygUDuh overlaid on the OED grid. Note how these ‘non words’ exist largely on the edge of the word spaces and the white spaces. This may be because, while they are not English words—hence the white space proximity—they have similar vowel and consonant structures to English words. By seeing these words overlaid on the whole language, we can see a visual representation of Cummings’ craft, of the attempt to make non English words that sound like English when read aloud. The fact that all of the non-words are situated on the edges of heavily populated space tells us that these arrangements of letters that we try to make into words when reading the poem are “closer” to English words than we think.



Figure 4.15: ygUDuh overlaid on the OED grid.

### 4.12.3 Instant Messaging

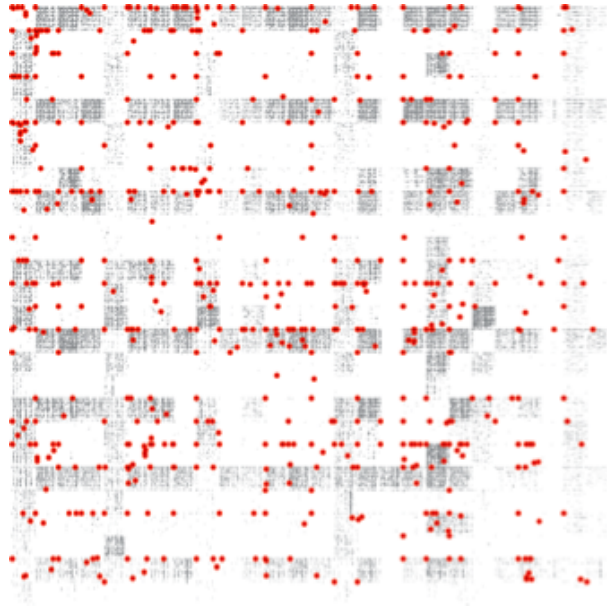


Figure 4.16: MSN ‘words’ overlaid on the OED visualization.

Another example where new types of ‘words’ or at least English communications are evolving is in instant messaging, text messaging, and social media. It seems that for ease and speed, we can give up many letters—chiefly the vowels—in words and still retain meaning. Figure 4.16 shows words taken from MSN messenger (an instant message application) overlaid on the OED visualization. It is interesting to note that many of the new “words” (marked with red dots), fall in the spaces where very few or no words exist. This demonstrates that even in a type of shorthand, like the one used in instant messaging (e.g., ‘btw’, ‘lol’, ‘t tyl’, etc.) that many of the newly created words are spelled with letter combinations that simply don’t exist in the language. This is partially a result of the volume of acronyms used in instant messaging but it becomes obvious by “reading” the image that many of the words used fall on the top line of each row suggesting (such as with

row A, and row I) that many of these “words” and acronyms begin with those letters. In this way our technique produces visuals that allow us to ask further questions about the organization of our data.

#### **4.12.4 Interaction**

We have also begun to integrate interactive elements into our visualization, some of which were planned prior to our qualitative study, and some of which were inspired by our results. In particular, we have already created a version of LDNA which incorporates a brushing technique that presents the “words beneath the cursor”, both when dragging across words and when dragging across the whitespace. We have also created a version of the density map Figure 4.13 that allows zooming into the recursive letter pairs. For example, it is possible to click or tap on the “BA” square, then the “NA” square, then another “NA” square to then see the word “BANANA” as shown in the static image of figure Figure 4.4.

### **4.13 Conclusion**

In this chapter I have introduced LDNA and presented the findings of a qualitative study of its design. In LDNA, we have developed a mapping of symbol systems to visual space, which we have demonstrated using language. Our formulation has several properties which are valuable for the analysis of language that are not available in some other common visualizations of language.

LDNA has the following important features:

1. The LDNA space is capable of handling any symbol string from a null string to a string of infinite length. LDNA can be used in 1, 2, or  $n$  dimensions.
2. LDNA space is infinite in that between any two points (words) in the space there exists another word—though it may not have semantic meaning.
3. The LDNA space is one-to-one and onto (bijective). Every unique coding maps to a unique position and, in reverse, words (or any original information) can be recovered uniquely from the visual space.

The alphabet may be one of the best visualizations ever produced. It is efficient in its representations, easily produced, and has maintained its longevity of use as technology has changed over time. As I show in chapter 6 language brings with it its own set of associations and biases. Creating a visual mapping for language that can be reconstituted back to the original document was an attempt to model a space that could be explored without these types of associations. Visual representations have their own rhetoric and affect readers in their own unique way, but the overall idea is that by placing familiar structures in unfamiliar space, that we ‘read’ in different ways. Because we can easily undo the process, LDNA becomes a system that can be used to ask iterative research questions. It is instrumental in its scale and visualization potential, using the machine to display  $n$ -dimensional and infinite scale visualizations, but it also allows for interplay between our human reactions to language and a displaced version of those same textual relationships. This is the anthropological piece. The ability to move in and out of the system between how we experience language in texts and how we experience texts in the visualization

create a potential space for asking research questions. This system is essentially a go-between for close and distant reading. If the original text is what is used for close reading and instrumentally produced visualizations can see language and corpora from a shifted and distant view, then the LDNA mapping is a literal bridge between these two ideas. The LDNA mapping is mathematically sound, but admittedly quite abstract. In the next chapter I try to bridge the gap between close and distant reading in a way that doesn't change the work flow of a literary critic (like this visualization), but tries to augment existing practices to build this bridge in another way.

## **Chapter 5**

### **MetaTation: Connecting Close and Distant**

### **Reading through Tool Design**

“ If we who are here today do get involved, collectively or individually, in the development of other software to enable scholarly primitives, this is an important principle to retain: software intended to enable these primitives should be developed and tested in the context of real scholarly use ”

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John Unsworth, *Scholarly Primitives: what methods do humanities researchers have in common, and how might our tools reflect this?*

“ The curious similarity in form, for instance, between the units of literature and of mathematics, the metaphor and the equation. ”

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Northrop Frye, *Anatomy of Criticism*

## 5.1 Preface

<sup>1</sup>In chapter 4 I showed how to create a space that is mathematically consistent and allows us to think about language in a displaced context that is easily reversible. This was an attempt to understand the relationship between close and distant reading by mapping out a system that mathematically connects the spaces where those critical acts occur. This chapter builds on that idea by investigating the same connections between close and distant reading in a more practical way. If chapter 4 was the instrumental approach to understanding these connections, using the computer and mathematics to define the connections between these spaces, then chapter 5 is an attempt to define that space anthropologically, by studying human interaction and how that affects our understanding of these relationships. These two chapters work together to produce a better understanding of the connections between these two systems.

In this chapter I take the ideas laid out in chapter 1 in regards to instrumentality and anthropological interaction and create an interactive system. The study and subsequent tool design presented here are an attempt to close the loop between close and distant reading in a single tool. The study of literary critics performing close readings is used to define the interaction technique (which in this case simply adopts annotation as an accepted practice) and uses the work of the critic on paper to fuel distant reading processes. By generating distant reading queries from close reading interactions it becomes possible to bridge the gap between the two approaches. Finding this bridge will allow us to reunite the instrumental with the anthropological when it comes to tool design.

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<sup>1</sup>This chapter is the result of collaborative work between Hrim Mehta, Chris Collins, Mark Hancock, and myself. Parts of the argument and several tables and images found here appear in Hrim Mehta's M.Sc thesis (2015). This work has been submitted to TOChi, ACM Transactions on Computer-Human Interaction and is currently under review. Any switch in this chapter to the first person plural indicates work that has been done collaboratively.



## 5.2 Introduction

Literary criticism can be conducted through a multitude of approaches. One of the traditional approaches involves the application of close reading techniques that permit a critic to identify syntactic, semantic, structural, rhetorical, and phonetic connections within a single text and analyze how these features function as a whole, leading to the generation of a ‘reading’ of the text. This process had its genesis in I.A. Richards’ book *Practical Criticism: A Study of Literary Judgment*. It is this process of discerning the function of a text that researchers within the digital humanities community have been trying to augment with close reading based analysis tools such as, WordSeer [Muralidharan et al., 2013], PoemViewer [Abdul-Rahman et al., 2013], and Myopia [Chaturvedi et al., 2012], with limited adoption by the literary community.

An alternative approach to literary criticism, greeted with much excitement in the recent past, is that of distant reading. Championed by Franco Moretti [2005] and Matthew Jockers [2013], distant reading employs computation to process large corpora of text for mining patterns of interest across literary history. In this chapter, we explore the possibility of bridging close and distant reading through the use of digital literary support tools.

At first glance, it might appear that the practise of annotation when it comes to literature is straightforward. But, when asked to analyse a poem, we found that literary critics participate in a very complex cognitive ‘shorthand’ for trying to make sense of the many layers of meaning within a text. It is this process of discovering these meanings that designers within the digital humanities have been trying to augment with tools based on close reading. Tools like PoemViewer [Abdul-Rahman et al., 2013] do an excellent job of presenting meta information in a highly stylized and visually appealing way, but neglect the idea that part of the discovery of these meanings is by the

The image shows a two-panel interface. The left panel displays the text of Sonnet 129 by William Shakespeare with various words in bold (e.g., **expense**, **spirit**, **Savage**, **extreme**, **rude**, **cruel**, **straight**, **Past reason hunted**, **Past reason hated**, **bait**, **purpose**, **pursuit**, **quest**, **extreme**, **bliss**, **proof**, **proved**, **proposed**) and small colored dots below them. The right panel has a yellow header labeled "Alliteration" and a green footer labeled "Assonance". The text in the right panel is identical to the left panel but with some words highlighted in blue boxes (e.g., **expense**, **spirit**, **waste**, **lust**, **perjured**, **sooner**, **despised**, **straight**, **Past reason hunted**, **sooner**, **swallowed**, **purpose**, **pursuit**, **quest**, **extreme**, **bliss**, **proof**, **proved**, **proposed**).

Figure 5.1: The MetaTation interface. The left worksheet viewer panel shows annotated words in bold, and available query results are indicated by colour-coded dots below the words. The right panel shows a stream of metadata tiles which present query results.

critic themselves experiencing the language. This is further complicated by the fact that literary critics perform multiple readings of a single text with a shifting focus. In this chapter I present a study and subsequent tool design that addresses the problems posed by the practise of close reading and offer a framework for connecting this process to distant reading with the machine. The problem of designing for experience is addressed by generating meaningful meta information, like many other tools. It is by presenting this information within literary critics' existing workflow that it becomes apparent that this process is not simply about information (instrumentality), but that meaning is generated by interaction (anthropology) and must be supported for a tool of this nature to be successful. Secondly, with the ability to operate within a closed loop of close and distant reading, it becomes possible for the technology to work in both instrumental and anthropological ways at the same time.

This study presents the results of an observational study of literary critics' work flow when performing close readings of poetry and subsequent design implications for the development of literary analysis tools that reconcile this approach and that of distant reading. We extend previous work on cognition and the role of annotations therein to the domain of literary criticism and provide evidence that the act of close reading for the purpose of interpretation embodies the cognitive processes essential to the sense-making of a single text, indicating the need for supporting close reading techniques when using digital literary analysis tools in addition to distant-reading-based corpora analysis and comparison techniques.

We also describe the design and implementation of a tool, MetaTation, based on these design guidelines. MetaTation allows literary critics to interact with a text using pen and paper, and processes the free-form annotations they make during close reading as implicit cues for identifying and generating supplementary metadata relevant to their current thought process in real-time (see

Figure Figure 5.1).

Existing tools [Abdul-Rahman et al., 2013, Chaturvedi et al., 2012, McCurdy et al., 2015, Muralidharan et al., 2013] in this domain generally do not support the practice of annotation and present supplemental information up front, before any work has been done by the analyst, essentially limiting the possibilities for the types of cognitive engagement required by the task. While some of these tools support exploration of patterns in large sets of texts, the exploration is generally disconnected from the actual text that prompted further analysis. What this means for the analyst is that they are given all of the options for the connections within a text and asked to worked with that information. It is not that this information is without use, but our study has shown that the timing of the presentation of that information is important to how interpretations are made. By presenting the data, often at the wrong time in the thinking process, it becomes a hindrance to the work flow.

Instituting a subtle shift in design from offering information before the active work flow has started, to after the critic has already conveyed components of interest, not only allows for augmenting the close reading process with minimal disruption but also helps constrain the distant-reading-based queries to be more relevant to the critic's current line of investigation. Moreover, while existing tools provide meta information through an automated analysis of the text being analysed, MetaTation interprets the free-form annotations being made on the poem by the critic, using Anoto<sup>2</sup> pen and paper, in real time, to present information relevant to only those features of the literature that are being currently noticed and analysed by the critic. This shift from presenting information up front, to presenting metadata based on critics' sense-making practices is based on the results of our domain specific observational study, and differs from the prescriptive design

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<sup>2</sup><http://www.anoto.com>

guidelines of previous work.

While the main contribution of this approach is the development of a tool that bridges the gap between close and distant reading, other smaller contributions arose during this process of study and development. They are as follows:

- We present the results of an observational study of expert poetry critics as they analyse poems, providing insights into the sense-making process involved when conducting a close reading.
- We provide design guidelines for the development of digital tools for supporting both close and distant reading based literary analysis.
- We designed and implemented a prototype system, MetaTation, that provides context-specific meta information to a critic in real time based on the derived design guidelines.
- We present the results of a preliminary expert review of the developed tool.

Our work builds upon research in digital humanities and human-computer interaction to provide digital tools for literary analysis that bridge the gap between close and distant reading. By focusing on integrating this technology into existing work practices of annotation, we can support sense-making while augmenting information available to the critic with little disruption.

### **5.3 Related Work**

There are several areas of work that are most related to the development of interactive language tools: tools to support literary analysis, studies of annotations, use of annotations for computation,

and the use of pen and paper vs. digital documents in active reading.

### **5.3.1 Literary Analysis Tools**

Close reading is the practice of comprehensive analysis and interpretation of a single text. This type of literary analysis focuses on paying close attention to linguistic, spatial, and structural features of a text and their interactions with each other, followed by reasoning through the observations made to produce a reading of the text. This process is inherently experiential—interpretations of the text vary from one person to another as well as from one context to another. Close reading can be contrasted with the approach of distant reading [Moretti, 2005, Jockers, 2013] which harnesses the power of computation to aggregate and quantitatively analyze massive amounts of text corpora for the purpose of literary historical analysis. Tools for distant-reading-based literary analysis present broad overviews of huge collections of text to support exploration of trends across documents. Janicke et al. [2015] present an in-depth survey of existing literary analysis tools based on both close as well as distant reading.

Tools focusing primarily on supporting literary analysis of prose often look to demonstrate patterns across huge collections of texts. Text visualization tools like TextArc [Paley, 2002], Docuburst [Collins et al., 2009a], WordSeer [Muralidharan et al., 2013], and Compus [Fekete and Dufournaud, 2000], aim to support exploratory analysis of literary texts through distant reading. These tools present broad overviews of massive amounts of text corpora based on quantitative linguistic analyses, while also supporting exploration of finer connections that reveal patterns within and between documents. Our work presents an alternative approach, focusing on close reading and the relationships between parts of a single text, the results of which are then extended

to guide distant-reading-based exploration of text corpora.

Poetic language often defies the general rules of syntax and semantics observed in prose, resulting in a complex dynamic system that exhibits a variety of highly charged features. Several visualization tools have thus been developed specifically for supporting the analysis of poetry. PoemViewer [Abdul-Rahman et al., 2013] supports close reading of poetry by allowing an exploration of semantic and phonetic relations in a poem through the use of rule-based visual mapping techniques. It visualizes semantic relations, such as word repetitions, parts-of-speech, and sentiment, and presents various types of phonetic relations, such as assonance, consonance, alliteration, end rhyme, etc., in addition to providing information about the physiology of sound production. Myopia [Chaturvedi et al., 2012], a visualisation tool for close reading of poetry, presents poetic elements such as meter, sound, syntax, metaphor, and personification to support literary analysis of the TEI (Text Encoding Initiative)—encoded<sup>3</sup> texts. ProseVis [Clement et al., 2012] allows interactive exploration and visualisation of sonic features in a text, such as phrase boundaries, parts of speech, phonetic spelling, stress, and rhythm markings, to aid the discovery of phonetic patterns within a text at different levels of granularity. Poemage [McCurdy et al., 2015] is another such tool that supports visualization of the interaction of complex sonic patterns across a poem.

While these tools offer highly detailed meta information through visualizations of poetry, they do not provide support for annotation in the close reading process, which our study reveals to be intrinsic to the sense-making process. We build on the work of these previous systems by supporting the close reading process through the interpretation of annotations followed by their extension to distant reading based queries. We designed a study to specifically look at the moment

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<sup>3</sup><http://www.tei-c.org/index.xml>

of interaction that is required by the work flow in close reading and bridge the gap between individual poems and literary history. The prototype system, MetaTation, was designed based on the findings of the study, and allows the critic to first interact with the text, and then presents context-specific meta information based on implicit interpretations of those interactions with the system. This not only allows the critic to conduct an in-depth close reading of a single text using annotation, but also permits the use of those annotations for extending the search for patterns of interest out to larger corpora and ultimately across literary history.

### **5.3.2 Studies of Annotations**

There is a subset of previous work that specifically investigates ink annotations and has implications for digital design. Marhsall [1997], and later Marshall and Brush [2004], have investigated annotations made by students in textbooks and when reading papers. They provide observations that are largely consistent with our own study of annotation practices in poetry analysis, having noticed the importance of spatial arrangement, the need to support idiosyncratic annotations, and the need to minimize distraction from the reading task [Marshall, 1997]. Moreover, they provide a coding of annotations into anchor-only (e.g., underline, circle, margin bar, etc.), content-only (e.g., notes, marks (such as \*), doodles, etc.) and compound (anchor + content) marks, and evidence that most annotations in their study were anchor-only (20%).

It is important to note that these studies focus on materials where the experience of reading may be less relevant. Our work extends this literature by considering annotations made in the domain of poetics, and attempts to bridge the gap between two well known literary practises. While both of the previous studies have identified the idiosyncratic nature of annotations, none of



them have attempted to infer the annotator's thought process based on these annotations. We make use of the external cognition framework [Preece et al., 2015] to explain the role of annotations in close reading, with the aim of resolving the annotation form-function ambiguity and for employing these annotations as cues for generating context-specific supplementary data.

### **5.3.3 Annotations for Computation**

Most of the work on reading practices has so far focused on moving from paper to digital, and thus many tools have been developed to support paper-like annotations on digital devices [Ovsiannikov et al., 1999, Wolfe, 2002]. There are fewer examples of research that explore the idea of processing physical/digital annotations for the purpose of computation.

XLibris [Schilit et al., 1998], a pen-enabled tablet display with paper-like affordances for supporting active reading, was the first to make an attempt at using annotations made by a reader to generate additional relevant content. Words annotated by a single pen stroke were used as keywords to retrieve research papers relevant to the one being studied. These papers were then presented to the reader as links in the margin close to the pen stroke that invoked this retrieval. Our system, MetaTation, also employs annotations made by a reader during the analysis process as cues to generate real-time context-specific supplementary data to augment close reading. However, our system differs from this work in that we focus on physical pen strokes on paper, and process information specific to the words on the page, rather than higher-level concepts like related literature to the entire document or context.

Shipman et al. [2003] analysed annotations made by students when preparing briefs on legal cases for a moot court session and characterized high-value annotations that can be used to identify

important passages from a document. While their tool is similar to our work in that their system also extracts meaning from annotations made by hand on documents, their tool is intended to automate the process of summary and extraction when reading based on annotation characteristics, rather than augmenting the processes involved in sense-making when reading.

### **5.3.4 Pen-and-Paper vs. Digital Documents in Active Reading**

Active reading is the practice of engaging with the content of a text for the purpose of extracting its meaning. It differs from close reading, practiced in the domain of literary criticism, in that the purpose of close reading is not limited simply to the deduction of the meaning of a text as with active reading but also focuses on how various low-level linguistic features of the text generate meaning. Close reading is concerned with the system that leads to meaning, where active reading is interested in a particular meaning derived from a text, such as a summary. Active reading has been studied by previous literature with the aim of understanding the effects of substitution of pen-and-paper by digital documents on the process of text comprehension.

O'Hara and Sellen [1997] presented a comparison of active reading practices (annotating while reading a text) for performing a text summarization task when using physical and digital documents. It was noted that annotating while reading aids text comprehension by facilitating the development of an internal representation of the text through re-structuring and collation of information, and that annotations also serve as sources for later reference. Physical paper was reported to have better affordances to support active reading practices than digital documents, such as flexibility of free-form in-context ink annotations, ease of switching between annotating and reading, ease of cross-referencing of multiple documents, and bimanual interactions, among

others. While active reading and close reading are certainly related, their respective goals differ slightly. Active reading can be considered any annotating while reading, and close reading is a practise used in literary analysis to understand the poetic elements of a text. Morris et al. [2007] employed a similar study design that used paper or digital documents on tablets, that also compared a stylus-enabled horizontal display to a dual-monitor desktop setup. It was observed that paper and tablets were preferred overall for both reading and annotating, with dual-monitor desktop setups performing the worst. Though experience using tablets and horizontal displays was comparable to that of paper, insufficient margin space and mode switching while inking were noted as challenges. However, no significant difference in terms of the number of annotations made and annotation forms was observed. Similarly, our observations of poetry critics' annotation strategies when performing close reading also reflected the preference for using paper over digital documents and indicated the need for providing support for free-form annotations.

The benefits of coupling physical and digital documents were explored as early Vannever Bush's Memex, which was a re-imagining of analog file systems<sup>4</sup> and Ted Nelson's controversial Xanadu project, which was an example of early hyper-text theory. DigitalDesk [Wellner, 1993], a physical desk that allowed interaction with digital documents via a projected display. Since this work, many systems have explored the augmentation of physical or digital paper in connection with handwriting [Mackay et al., 2002, Stifelman et al., 2001, Yeh et al., 2006]. Many researchers have also specifically investigated the use of predefined pen gestures [Norrie et al., 2006, Liao et al., 2008, Steimle et al., 2009, Tsandilas et al., 2009] to control a digital system, as well as predefined regions [Liao et al., 2008], hotspots [Signer and Norrie, 2007], or document structure [Norrie et al., 2006] to interpret annotations digitally in a variety of domains, including

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<sup>4</sup><http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/>

academic publications [Norrie et al., 2006, Steimle et al., 2009], slide handouts [Signer and Norrie, 2007], and music composition [Tsandilas et al., 2009]. MouseLight [Song et al., 2010], a tool that explores bimanual interaction of a mobile projector and digital pen to augment physical paper with virtual information, is an example of subsequent research focused on closing the feedback loop from digital to physical documents.

These systems are related to our own work, but focus on materials where the experience of reading itself may be less relevant (e.g., scientific publications, lecture slides). While some of our design decisions use known technology (e.g., Anoto, stroke recognition), our observational study highlights the need to support the experience of language in the analysis of literature as primary. Our work differentiates itself through the goal of supporting the experience of close reading, paramount to the sense-making process, and extensions of the findings from close reading to support distant reading of larger corpora, by analysing free-form reader annotations in real time.

## **5.4 Observational Study: Poetry Annotation**

In order to better understand the sense-making process of literary critics when performing a close reading, as well as the role of annotation therein, we designed an observational study. We observed the work flow of literary critics analysing poetry with the intent of answering the following question: can annotations be used as a cue for determining the type of computational support that should be provided to a reader during the analysis process, to augment close reading while also serving as starting points for distant reading based exploration? We were also interested in what, if any, external tools (digital or otherwise) these critics already used and how they were integrated into this work process.

### **5.4.1 Participants**

We recruited 14 participants (11 male and 3 female), comprising 3 PhD students and 11 university professors with varied areas of expertise, who publish on literary criticism and/or teach poetics, from three different universities in Canada.

### **5.4.2 Choice of Poetry**

To ensure that our study data represented a breadth of poetic styles and time periods and that the poems we used were of recognized scholarly importance, we drew on the Norton Anthology of English Poetry [Ferguson et al., 2005] to create our study dataset. Literary critics, as a practise, generally specialize in specific time periods of literature. Thus, someone who is an expert in Modernist literature would not have comparable proficiency in Elizabethan drama. Consequently, ensuring the inclusion of works of diverse poetic styles from different eras was essential to mitigate the effects of expertise bias in our study. Dividing literary history into appropriate epochs is a complex problem and so we deferred to the well-respected anthology to supply the time constraints for our selection process as well as the texts themselves. We randomly selected 14 poems, two from each of the seven different time periods (1510–1620, 1620–1690, 1690–1780, 1780–1830, 1830–1880, 1880–1920 and 1920–). These fourteen poems were then randomly grouped into seven pairs, such that each pair included poems from two different time periods. To avoid expertise bias, such as having a Shakespearean scholar annotate a Shakespearean sonnet, pairs of poems were counterbalanced and randomly assigned to the participants for analysis so that each pair was analysed by two participants, once in each ordering. As a result, none of our participants undertook the study with poems that fell within their area of expertise. Having two

poems per participant and common poems between two participants permitted us to observe how the annotation practises varied based on both the reader as well as the work being analysed.

### **5.4.3 Task & Procedure**

Each participant was asked to perform a close reading (analysis) on one pair of poems. Each poem was provided in an assigned order on a separate sheet of Anoto paper, printed in Times New Roman with 1.5 line spacing. Participants were provided with a Livescribe<sup>5</sup> Anoto pen to use for annotations. The Anoto pen tracks pen position on the Anoto dot pattern permitting us to record pen strokes made by our participants as they annotate the printed sheets of paper.

Observational sessions were conducted in the regular work environment of the participants and were video and audio recorded. The video was recorded from two separate angles: one from directly above the desk to capture how the participant analysed the poem, and another facing the participant to capture facial expressions. We also logged pen strokes from the Anoto pens and paper using the Anoto LiveScribe software and collected the physical paper at the end of the session.

Participants were instructed to perform a close reading on each poem in accordance with their own work practises. The participant was given a printed copy of the poem and instructed to conduct an analysis until they were finished or until 15 minutes had passed. In our pilot studies we discovered that this analysis process was a highly personal experience and the presence of the experimenter was found to be distracting. Therefore, the participants were left alone to work during each of these 15 minute periods.

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<sup>5</sup><http://www.livescribe.com>

Participants were not required to annotate the poem, but if they did, they were requested to use the provided LiveScribe Anoto pen. Participants were also permitted to access any form of available external resources that they would normally use. Following the analysis session, participants were asked to explain the function of the annotations they made through a retrospective think aloud process using the annotated poem as a guide. The same procedure was then repeated for the second poem assigned to a participant.

The observation sessions concluded with a brief recorded interview regarding participants' current annotation practises with respect to close reading.

#### **5.4.4 Data Coding Process**

We used open coding for qualitative analysis of the recorded sessions. We first created an interactive tool to synchronize, replay, and add user-defined codes to the recorded pen stroke log files, scans of the final annotated poem pages, videos of the analysis sessions, and videos of the retrospective think aloud sessions. This tool also allowed us to query the coded data to see, for example, all the codes for annotations in a particular area of the page or for a particular time frame.

Two researchers iteratively worked on randomly selected samples of data to develop a mutually agreeable code set and guidelines for categorisation of the annotations. The final code set comprised of two categories of codes, form and cognitive purpose, each of which consisted of several subcategories of codes (see Table Table 5.1).

The form code category was defined with the aim of supporting an exploration of the forms of annotations. In the initial iteration of the coding process, the form code had 29 subcategories of

**A**

Sonnet 129 - William Shakespeare

Th' expense of spirit in a waste of shame  
 Is lust in action; and till action, lust  
 Is perjured, murderous, bloody, full of blame,  
 Savage, extreme, rude, cruel, not to trust;  
 Enjoyed no sooner but despised straight:  
 Past reason hunted; and no sooner had,  
 Past reason hated, as a swallowed bait,  
 On purpose laid to make the taker mad:  
 Mad in pursuit, and in possession so;

*anaphora: lust is mentioned body not head*  
*Who lays it?*

*series of reversals in sentence structure*

a  
b  
c  
d  
e

*diction harsh + extreme*  
*lust had*  
*but take*  
*outcome*

**B**

Sonnet 129 - William Shakespeare

Th' expense of spirit in a waste of shame  
 Is lust in action; and till action, lust  
 Is perjured, murderous, bloody, full of blame,  
 Savage, extreme, rude, cruel, not to trust;  
 Enjoyed no sooner but despised straight:  
 Past reason hunted; and no sooner had,  
 Past reason hated, as a swallowed bait,  
 On purpose laid to make the taker mad:  
 Mad in pursuit, and in possession so;  
 Had, having, and in quest to have, extreme;  
 A bliss in proof, and proved, a very woe;  
 Before, a joy proposed; behind, a dream.  
 All this the world well knows; yet none knows well  
 To shun the heaven that leads men to this hell.

*anaphora: lust is mentioned body not head*  
*Who lays it?*

*series of reversals in sentence structure*

a  
b  
c  
d  
e  
f  
g

*diction harsh + extreme*  
*lust had*  
*but take*  
*outcome*

*spat*

① before lust becomes action - it's dangerous  
 ② When acted upon - poisonous consequences  
 ③ Not as good as the dream

*we all know this, but we act on lust anyway*

*h sounds = declarative*  
*p/b sounds = negative, harsh*  
*long "a" = almost wailing*  
*'s' = sibilant, sneaky*

*very preachy tone emphasized by stop/pauses within lines*  
*- breaks up the regular iambic pentameter*

**C**

Had, having, and in quest to have, extreme;  
 A bliss in proof, and proved, a very woe;  
 Before, a joy proposed; behind, a dream.

**D**

*h sounds = declarative*  
*p/b sounds = negative, harsh*  
*long "a" = almost wailing*  
*'s' = sibilant, sneaky*

Figure 5.2: Annotations made during close reading of poetry. (A) Shows the raw annotated page as collected in our study. (B) shows **cognitive purpose** codes assigned to annotation units for one of the participants' annotations, as visualized by our coding tool. Orange and blue bounding boxes represent annotation units categorised as CO and EML respectively. (C) is an example of an annotation unit, identifying the repetition of sounds, categorised as CO. (D) shows an example of an annotation unit, noting observations about repetitions of sound across the poem, coded as EML



Table 5.1: Categories of codes in the final code set.

<b>Code Category</b>	<b>Code Subcategory</b>
Form	Ellipses, polygons, connectors, brackets, text, miscellaneous notations
Cognitive Purpose	CO, EML, EML+CO, A

Table 5.2: Subcategories of form codes.

<b>Form Code Category</b>	<b>Form Code Subcategory</b>
Ellipse	Circles, spirals, concentric circles
Polygons	Squares, rectangles, triangles, others
Connectors	Arcs, angular arcs, single-headed arrows, double-headed arrows, cross-headed arrows, arrow-headed wavy arcs, circle-begin and underline-end arcs, circle-headed arcs, lines
Brackets	Regular square, half-square, round, double round, curly, vertical line
Text	Letters, numbers, special characters
Miscellaneous Notations	Squares, rectangles, triangles, others

codes (see Table Table 5.2) that were grouped and refined in subsequent iterations to generate the final form code categories listed in Table Table 5.1.

To identify the cognitive processes involved in close reading, we examined the functions of annotations. We started by categorizing annotations based on the poetic elements they identified in addition to noting participants' reading habits, generating the code categories listed in Table Table 5.3. We realised, however, that while these codes helped us identify the types of linguistic

Table 5.3: Initial code categories for examining annotation function.

<b>Purpose Code Category</b>	<b>Purpose Code Subcategory</b>
Poetic Elements	Connections, grammar, syntax, semantics, diction, sound, rhyme, alliteration, consonance, assonance, repetition, syllable counts, stress, rhetoric, allusions, bibliographical information
Reading Habits	Reading the poem out loud, reading the poem silently, pausing to look up information, idiosyncratic habits while reading

features and thus supplementary data of possible interest to poetry critics, they were inadequate at indicating the higher-level cognitive processes involved. We then reviewed frameworks that explain the role of external representations in supporting cognition. The switch to an external cognition based code set was driven by the fact that while participants were consistent in terms of what linguistic features they were identifying, the annotation forms used to mark these features were idiosyncratic, leading to annotation form-function ambiguity. Categorization of the annotations based on the external cognition framework permitted the intent of the annotations to be discerned despite this ambiguity.

Codes based on the **cognitive purpose**, served by the process of annotation in text comprehension, included: computational offloading (CO), externalizing to reduce memory load (EML), both computational offloading and externalizing to reduce memory load (EML+CO) and ambiguous (A). CO and EML codes have been derived, in the context of annotations and close reading, based on the main cognitive benefits of using external representations identified by Preece et al. [2015]. CO represents the act of thinking through the content by annotating whereas EML refers to the act of tracking intermediate conclusions through the use of annotation. EML+CO is used to denote those annotations for which both CO and EML are being performed as a contiguous unit while A marks those annotations whose purpose is unclear. Descriptions of the purpose of annotations, elicited through the retrospective think aloud sessions, were referenced to guide this **cognitive purpose** based categorisation. Figure Figure 5.2 shows an example of the result of the coding process, based on **cognitive purpose**, when applied to the final annotated poem sheet for participant P11.

Annotations were also noted as being located either on the text itself (word space), between the lines and stanzas of the poem (white space) or in the margins (margin space). At the outset, we manually coded annotations based on the space they occupied. However, our inability to achieve

coder agreement due to frequent cross-overs of annotations across the different spaces on the page led to our decision to use automatic categorisation of annotations based on their location. Annotations with more than 50% of the area of their bounding box falling under one or more bounding boxes of the lines of the poem were categorised as being in the word space. Similarly, annotations with more than 50% of the area of their bounding box falling under one or more bounding boxes of the spaces between the lines and stanzas of the poem, were said to occupy the white space. All other annotations were categorised as belonging to the margin space.

Finally, all annotations were manually grouped into sets that represented a semantic unit, for example, three consecutive underlines of rhyming words. The start and end times of annotation events were also recorded.

Following the code set development, two researchers independently coded four randomly chosen sessions out of the 28 analysis sessions and Cohen's  $\kappa$  was calculated to measure inter-rater reliability. The measure revealed good agreement on coders' judgements for both annotation form,  $\kappa = 0.75$ , and annotation function,  $\kappa = 0.66$ . The remaining 12 analysis sessions were then independently coded by each of the two researchers.

## **5.5 Results & Discussion**

The results of our study highlighted several themes common to many of our participants. The first is that free form annotation is an important part of the close reading process in literary criticism (subsection 5.5.1). We observed that annotation use was highly idiosyncratic and polymorphic (subsection 5.5.2). The function of annotations can be disambiguated through patterns in space,

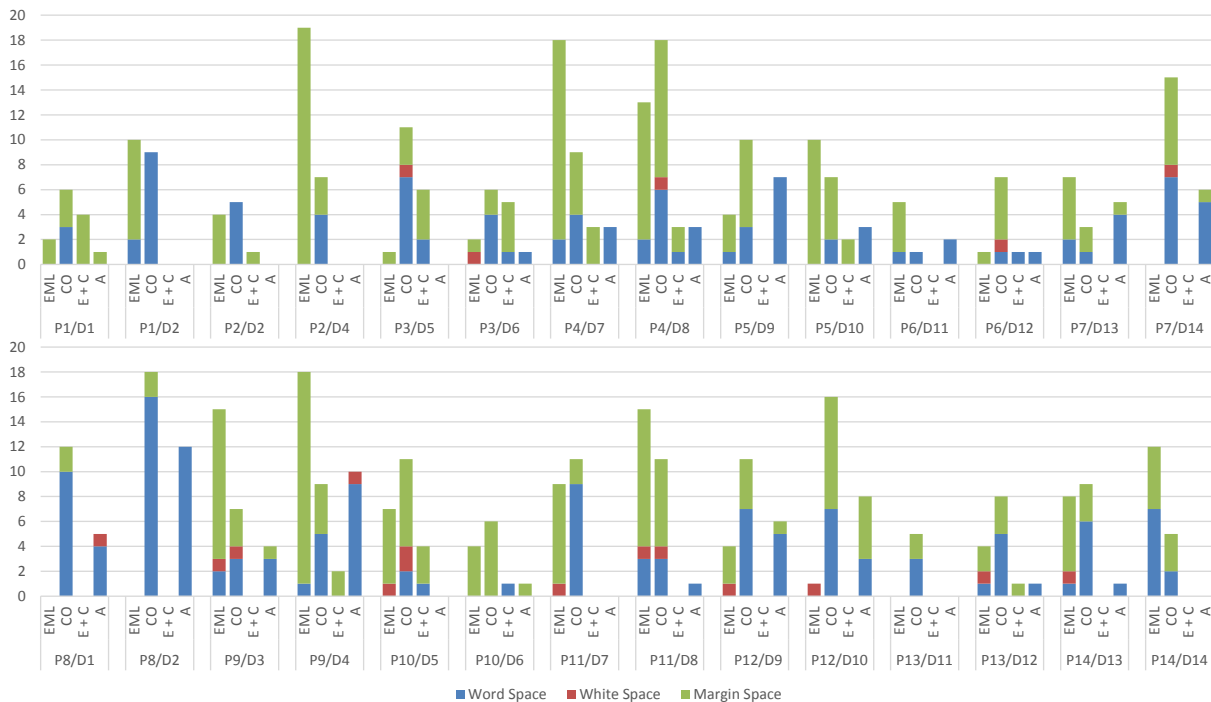


Figure 5.3: Cognitive purpose codes by participant (P1–P14) and poem (D1–D14) and space (colours). Poems are aligned in columns.

time and forms used and the cognitive purpose served by annotation (subsection 5.5.3). Sometimes annotation serves as a placeholder for intuition, and annotation becomes a form of experiential cognition [Norman, 1994] (subsection 5.5.4). Participants made use of external resources to aid their analysis, and usually deferred their use of tools until they had finished a complete reading, reducing interruptions (subsection 5.5.5).

These themes will be explored in depth in the following subsections, and inform the design of our subsequent system, MetaTation.

### **5.5.1 Role of Free-form Annotations in Sense-making**

The practise of annotating while analysing poetry was reported as being intrinsic to the current work practises of 9 of our 14 participants. For the remaining 5 participants, this practise was noted to be more prevalent when working on poems that they were planning to teach, but was nonetheless an important part of their routine. All of our participants reported that they usually use a pen/pencil to annotate printed sheets of paper when performing a close reading to analyse poetry. Only two of the participants stated that they have previously used a stylus/touch-enabled tablet for the same purpose. Two of the participants stated that they occasionally use coloured pens to visually separate annotations made on the current reading of a poem from those made on previous readings of the same poem or to visually separate different themes emerging from the poem.

A majority of participants reported using physical tools (pen/pencil) over digital tools (stylus, computer) for annotation in close reading. The reason for this preference could be that paper supports free-form annotations well [O'Hara and Sellen, 1997]. Free-form ink annotations are highly suited to the close reading process since they afford the flexibility needed for the idiosyncratic manner of annotating with minimal attentional overload, in contrast with digital ink annotations that require explicit switching between the available markup tools. Paper also provides additional affordances such as quick navigation, portability, rotation and physical manipulation of pages, and the ease of cross-referencing multiple documents side-by-side, among others, to support the close reading task [O'Hara and Sellen, 1997].

On the basis of our observational study, it is clear that the experience of language contributes to the understanding of poetry and is reflected through the practise of annotation. That is, people

who chose his epitaph?—himself alone  
 Could thus have dared the grave to agitate,  
 And claim, among the dead, this awful crown;  
 Nor doubt that He marked also for his own  
 Close to these cloistral steps a burial-place,  
 That every foot might fall with heavier tread,

*volition* [bracketed around the first two lines]  
*paradox: 'miserimus = hubris'*  
*alliteration, internal rhyme*

**A** Th' expense of spirit in a waste of shame  
 Is lust in action; and till action, lust  
 Is perjured, murderous, bloody, full of blame,  
 Savage, extreme, rude, cruel, not to trust;  
 Enjoyed no sooner but despised straight:  
**B** Past reason hunted; and no sooner had,  
 Past reason hated, as a swallowed bait,  
 On purpose laid to make the taker mad;  
 Mad in pursuit, and in possession so;  
 Had, having, and in quest to have, extreme;  
 A bliss in proof, and proved, a very woe;  
 Before, a joy proposed, behind, a dream.

*States of*  
*by nature*  
*indecipherable*  
*ars-n*  
*CO*  
*and, s*  
*before*  
*:-tut.*  
*another*  
*you*

**C** not one a fighter; It is like a plane  
 dusting apple orchards or Arabs or  
 one of the mighty ... one of the hel

**D** Perhaps you consider yourself an oracle,  
 Mouthpiece of the dead, or of some god or  
 Thirty years now I have labored  
 To dredge the silt from your throat—  
 I am none the wiser.  
 Scaling little ladders with gluepots and pa  
 I crawl like an ant in mourning  
 Over the weedy acres of your brow  
 To mend the immense skull plates and cle  
 The bald, white tumuli of your eyes.  
 A blue sky out of the Oresteia  
 Arches above us, O father, all by yourself  
 You are either an oracle or the De

*biography*  
*know its*  
*biographical?*  
*what a autobiogr?*

**E** On thy withered lips and dry,  
 Which like barren furrows lie,  
 Brooding kisses I will pour  
 Shall thy youthful (heat) restore  
 (Such kind showers in autumn fall,  
 And a second spring recall)  
 Nor from thee will ever part,  
 Ancient person of my heart.  
 Thy nobler part, which but to name  
 In our sex would be counted shame  
 By age's frozen grasp possessed,  
 From [his] lice shall be released,  
 And soothed by my reviving hand  
 In former warmth and vigor stand.  
 All a lover's trick can reach

Figure 5.4: Snippets of participants' final annotated sheets exhibiting annotation polymorphism. Annotation form and function do not hold a one-to-one relation as can be seen in the examples.

**A**

On thy withered lips and dry,  
Which like barren furrows lie,  
Brooding kisses I will pour  
Shall thy youthful heart restore.  
(Such kind showers in autumn fall,  
And a second spring recall.)  
Nor from thee will I ever part,  
Ancient person of my heart.

On thy withered lips and dry,  
Which like barren furrows lie,  
Brooding kisses I will pour  
Shall thy youthful heart restore.  
(Such kind showers in autumn fall,  
And a second spring recall.)  
Nor from thee will I ever part,  
Ancient person of my heart.

Thy nobler part, which but to name  
In our sex would be counted shame,  
By age's frozen grasp possessed,  
From this ice shall be released,  
And soothed by my devoting hand,  
In former warmth and vigor stand.  
All a lover's wish can reach,  
For thy joy my love shall teach,  
And for thy pleasure shall improve  
All that a husband can bestow.

Thy nobler part, which but to name  
In our sex would be counted shame,  
By age's frozen grasp possessed,  
From this ice shall be released,  
And soothed by my devoting hand,  
In former warmth and vigor stand.  
All a lover's wish can reach,  
For thy joy my love shall teach,  
And for thy pleasure shall improve  
All that a husband can bestow.

**B**

And marching single in an endless file  
Bring diadems and fagots in their hands,  
To each they offer gifts after his will,  
Bread, kingdom, stars, and sky that holds them all,  
I, in my pleached garden, watched the pomp,  
Forgot my morning wishes, hastily  
Took a few baskets and departed.

And marching single in an endless file  
Bring diadems and fagots in their hands,  
To each they offer gifts after his will,  
Bread, kingdom, stars, and sky that holds them all,  
I, in my pleached garden, watched the pomp,  
Forgot my morning wishes, hastily  
Took a few baskets and departed.

**C**

Turned and departed silent, I, too late,  
Under her solemn fillet saw the scorn,  
Under her solemn fillet saw the scorn.

Turned and departed silent, I, too late,  
Under her solemn fillet saw the scorn,  
Under her solemn fillet saw the scorn.

**D**

Like shadows in love's frenzied, stifled throes  
And yet I am, and live like vapors tossed  
Into the nothingness of scorn and noise,  
Into the living sea of waking dreams.

Like shadows in love's frenzied, stifled throes  
And yet I am, and live like vapors tossed  
Into the nothingness of scorn and noise,  
Into the living sea of waking dreams.

**E**

Could thus have dared the  
And claim, among the dead  
That every foot might fall  
Trampling upon his viler  
Softly, to save the cont

Could thus have dared the  
And claim, among the dead  
That every foot might fall  
Trampling upon his viler  
Softly, to save the cont

**F**

The Painter - John Ashberry

So there was never any paint on his canvas  
As a painter he was not a painter  
Put him to work by trying to paint  
The painter's model or perhaps, to a scene

The Painter - John Ashberry

So there was never any paint on his canvas  
As a painter he was not a painter  
Put him to work by trying to paint  
The painter's model or perhaps, to a scene

Figure 5.5: Examples of consistency in the types of activities that participants analysing the same pairs of poems engage in.

‘think’ by ‘doing’ through annotation in poetics. For example, P7, whose annotations comprised pictograms and other common annotation forms, explained that through the use of annotations he was “working through the progress in parts [of the poem] visually; it’s an abstraction of what is being seen in the poem”. The practise of annotation in the domain of literary criticism isn’t simply a means for note-taking but rather forms the basis for sense-making. Free-form annotations are thus a required part of the analysis process of literary critics. Whether or not substituting physical paper with a stylus-enabled tablet is appropriate, is still unclear.

### **5.5.2 Polymorphism of Annotations**

All of our participants reported that they do not follow a formalized personal system of annotations. From our analysis and observations of the annotation process it was clear that annotations made by participants were highly idiosyncratic (specific to their process alone) and polymorphic (annotation form did not consistently serve the same function for different participants, or even throughout the annotation process of a single poem for an individual participant leading to form-function ambiguity). Figure Figure 5.4 (A) shows an example of how underlines are being used by P14 for highlighting both words that are indicative of volition as well as words that exhibit alliteration and internal rhyme. In Figure Figure 5.4 (B), P4 has overloaded the use of circles to indicate repetition of sound patterns, peculiarity of punctuation use, and words employed as qualifiers. Similarly, Figure Figure 5.4 (C) shows how circles and connectors have been used to convey synonymy as well as phonetic relations between words in P1’s work. Figure Figure 5.4 (D) is another example of how the meaning associated with an annotation form (square) changes from stanza to stanza for P9. Lastly, in Figure Figure 5.4 (E), P8 has identified both the change in part-of-speech of



‘part’ and a set of metaphorical words through the use of the same annotation form, circle.

However, we noticed that all of our participants were engaging in similar activities, although the places on the page and the times in the process varied across participants. For example, both P1 and P8 have identified the use of metaphors in their analysis of D1 (see Figure Figure 5.5 (A)). Figure Figure 5.5 (B) and (C) show notes, on poem structure and pertaining to the meaning of ‘fillet’ as well as the tone of the line, made by P4 and P11 for D8. P6 and P13 both indicating enjambment between stanzas of D12 as shown in Figure Figure 5.5 (D) is another example of inter-participant consistency. P14 and P7 have used different means for indicating the role of the words ‘dared’ and ‘claim’ in D13 as can be seen in Figure Figure 5.5 (E). Similarly, word repetitions in D9 have been tracked and recorded in different ways by P5 and P12 (see Figure Figure 5.5 (F)).

Annotation polymorphism is indicative of the constant shift in the meaning associated with the different annotation forms during the analysis and this suggests a need for avoiding constraints on the location or function of readers’ annotations in a digital literary analysis tool. What this means for design is that the tool needs to be robust enough to work with incomplete information since the attribution of meanings to different annotation forms can greatly vary depending on a plethora of factors.

### **5.5.3 Annotation Function Disambiguation**

We observed that our participants were actively grouping written thoughts and ideas into three main areas of the page: on the text itself (word space), in between the lines of text (white space), and in the margins. Looking into what function individual annotations served on each area of

- A** making a short, unhealthy life, the shorter.  
I kill it, and another instant's added  
to the horrifying mortmain of  
ephemera: keys, drift, sea-urchin shells,  
you packrat off with joy ... a dead fly swept
- B** A repeating fly, blueback, thumb thick—so gross,  
it seems apocalyptic in our house—  
whams back and forth across the nursery bed  
manned by a madhouse of stuffed animals,
- C** We stood by a pond that winter day,  
And the sun was white, as though chidden of God,  
And a few leaves lay on the starving sod;  
— They had fallen from an ash, and were gray.  
  
Your eyes on me were as eyes that rove  
Over tedious riddles of years ago;  
And some words played between us to and fro  
On which lost the more by our love.  
  
The smile on your mouth was the deadest thing
- D** thought but that word assigned  
That solitary word—to separate
- E** To each they offer gifts after his will, <sup>so left</sup>  
Bread, kingdom, stars, and sky that holds them all  
I, in my pleached garden, watched the pomp, <sup>of it</sup>  
Forgot my morning wishes, hastily <sup>of it</sup>  
<sub>... PRAYERS?</sub>

Figure 5.6: CO annotation snippets of participants' final annotated sheets. As can be seen in the examples, CO annotations tend to occupy the word space and are characterized through the use of common forms in spatial and temporal proximity (implicit connection) as well as explicit connectors for linking words of interest.

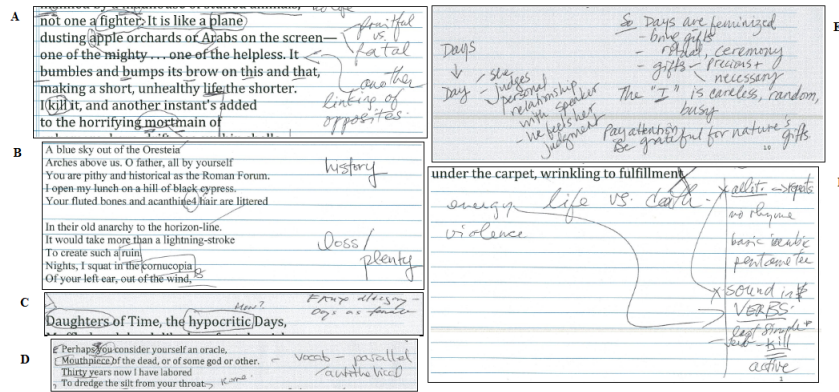


Figure 5.7: EML annotation snippets of participants' final annotated sheets. As can be seen in the examples, EML annotations tend to occupy the margin space and generally comprise of notes regarding observed patterns of interest or general commentary about the poem.

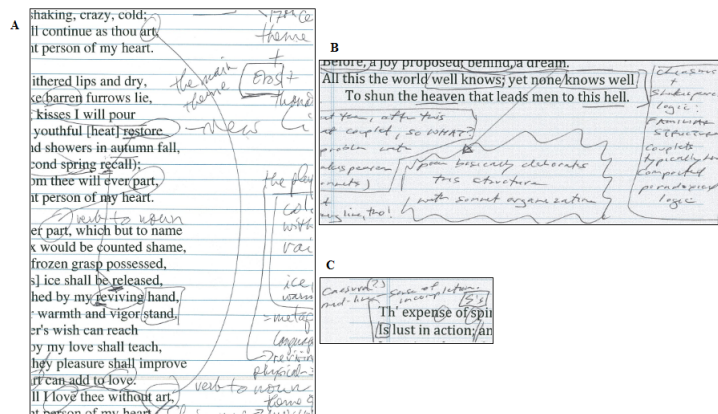


Figure 5.8: EML+CO annotation snippets of participants' final annotated sheets. As can be seen in the examples, EML+CO annotations comprise of consequent occurrence of CO and EML annotations.

the page, a clear pattern began to emerge. Annotations that served as a means of computational offloading (CO) were observed to operate mainly in the word space and the white space, whereas those that served as a means of externalizing to reduce memory load (EML) were noted to occupy mainly the margin space (see Figure Figure 5.3).

Implicit connections of points of interest through the use of similar forms (especially ellipses and underlines) in spatial and temporal proximity, in addition to explicit connection through the use of connectors, were prevalent with CO annotations. Figure Figure 5.6 constitutes of examples of CO annotations made by the participants. In Figure Figure 5.6 (A), P1 has implicitly linked the repetitions of ‘m’ in ‘mortmain’ and ‘ephemera’ through the use of underlines whereas synonymy between ‘kill’ and ‘mort’ has been implied via circles. He has also explicitly connected ‘mort’ and ‘dead’ and ‘dead’ and ‘life’ to point out the synonymy and antonymy relation respectively between the word pairs. Similarly, Figure Figure 5.6 (B) shows how the repetitions of ‘b’, ‘th’, ‘s’, and ‘m’ and those of ‘—’ have been implicitly linked using underlines and check-marks respectively in addition to an emphasis on diction through the use of circles by P8. Figure Figure 5.6 (C) is a snippet from P7’s sheet showing how he explicitly connected the occurrences of the pronouns ‘we’, ‘your’, and ‘me,’ whereas Figure Figure 5.6 (D) is an example of implicit connection of words of interest through the use of common forms in proximity from P7/D13. Similarly, Figure Figure 5.6 (E) presents an example of implicit linking of the sound in ‘pleached’ and ‘pomp’ and explicit connection of synonyms ‘will’ and ‘wishes’ in the work of P4.

EML annotations mainly comprised notes about the participants’ interpretations of patterns and themes observed in the poem as well as reminders to look up supplementary information, such as word usage or alluded works. These were linked to the source text through the use of explicit connectors or through spatial proximity to relevant parts of the text. Notes providing

general commentary about the poem usually occupied the space towards the bottom of the page. Figure Figure 5.7 (A), (C), and (D) are examples of EML annotations that are notes about patterns observed in the poem, whereas Figure Figure 5.7 (B) shows EML annotations commenting about the themes of the stanzas. Notes synthesizing the poem content, placed in the margins at the end of the poem text, are shown in Figure Figure 5.7 (E) and (F).

EML+CO annotations are characterised by the occurrence of an EML annotation, commenting upon the intermediate conclusion about an observed pattern, immediately following a CO annotation, identifying and working through a pattern of interest in the text, and a linking of the two types of annotations through the use of explicit connectors or spatial proximity. For example, Figure Figure 5.8 (A) shows how P1 identified the change in part-of-speech of the words ‘art’ and ‘part’ across stanza breaks and accompanied this with a note explaining that the two words have assumed noun form following their usage as verbs. Similarly, in Figure Figure 5.8 (B), P4 has marked the occurrence of chiasmus in ‘well knows’ and ‘knows well,’ along with a note detailing the effect of its usage in the last couplet. Figure Figure 5.8 (C) is another example of EML+CO annotations where the use of caesura has been highlighted in the word space and discussed in a note placed in the margin.

Both CO and EML annotations were consistently interleaved throughout an analysis session for all of our participants whereas EML+CO annotations were relatively rare.

Thus, even though annotations made by the participants are polymorphic in nature, the use of common annotation forms in spatial and/or temporal proximity often indicated related points of interest in the poem pertaining to the current thought process of the reader. The form of annotations, coupled with the spatial and temporal distance between them as well as the cognitive

purpose they serve, could be used to infer the type of computational support that could augment a reader's analysis process at a given moment in time during close reading. Determining a universal threshold for grouping strokes based on spatial and temporal proximity, however, is difficult due to inter-participant diversity; further research is warranted.

Relations between the sets of words identified as points of interest by the reader through the use of CO annotations that serve as a visible trace of a reader's contemplation can be used for deducing the type of supplementary data to be generated. CO annotations can be identified through the space on the page that the reader is annotating in as well as through the presence of similar forms in spatial and/or temporal proximity. The type of supplementary data to be generated that could augment the analysis process could be inferred based on the relations between the sets of words identified as points of interest by the reader through the use of CO annotations.

We believe that this form of user-initiated data generation would work well in the domain of literary criticism. A follow up with our participants suggests that they would be amenable to being informed of things that they might have overlooked or simply did not know could be used for identifying alternative connections between their words of interest. In addition, the use of reader annotations as a means of implicit interaction for requesting supplementary data could minimize the disengagement from the analysis process and interruption to the flow of reading that usually results from a switch to the process of retrieval of additional material from external resources.

The requirements of annotation may be a limitation of physical paper and pen, and the physical space available for EML, but nonetheless there is a pattern to cognitive sense-making in terms of where it happens within the space given. Current tools created for this domain disrupt both time (in terms of interaction) and space (in terms of available annotation space), constricting the analyst's

ability to think through the text. For example, a program like PoemViewer does an excellent job of presenting information about linguistic features for a given text. But we have found that a necessary part of the process for our participants is uncovering this information themselves. If all of the meta information is presented first and annotation is not supported, then the work flow and sense-making is not allowed to happen over time. Several of our participants describe the ‘experience’ of the poem changing over time as they build up more and more connections to a single thought. This is not to say that existing tools do not provide opportunities for analysis, they simply create a different workflow than the one we have observed in our participants’ close reading practises.

#### **5.5.4 Annotations as a Reflection of Experience**

Some of our participants stated that there were times when they were unsure as to why certain words of the poem seemed important to them, but these words were nevertheless marked and, at a later time, associated with other relevant points of interest once this understanding was solidified. We frequently observed that the expert readers would have some intuition and identify something as being important, before they knew how or why. For example, both P1 and P8 had initially annotated the adjective “repeating” (D2) for its peculiarity with later realisation that the adjective was used by the poet as a literal indicator of the repeating sound patterns in the poem.

This behaviour is important to consider when it comes to designing an interaction with a system, because it implies that analysts must be allowed the ability to think and interact with their own intuition. Current tools for poetics, which bulk process poems and present results all at once, do not allow for this thoughtful exploration. Slowing down the provision of analytic assistance

through just-in-time support would integrate better with the work flow we observed.

### **5.5.5 Use of external Resources and Minimal Interruption**

Three of our participants accessed external resources (both digital and physical documents) to look up metadata such as word definitions, usage histories, poetic forms, and terminology. In addition, information about the poet, such as era, their other works, and that of their contemporaries, was referenced during the analysis process. For example, both P4 and P11 looked up senses of the word “pleached” (D8) in a physical dictionary. Similarly, P6 referenced an on-line illustration of a spinning wheel when analysing D11. One of our participants had a tablet with him throughout the analysis sessions for quick web look-up. It is also important to note that external resources were usually accessed at the end of a single reading of the poem, with the exception of those times when supplementary information had to be promptly retrieved in order to proceed further with the analysis process e.g., when coming across archaic usage of words in the poem.

This behavior indicates that the metadata must be available on demand and in relation to what has been annotated by the participants during the close reading process. Because the analysis is time dependent, and may be started again once a given reading is completed, a robust system will allow for analyst-initiated metadata and the ability to access that data when needed in a non-intrusive manner.



## 5.6 Design of MetaTation

Our observations of poetry critics' sense-making process when performing close reading revealed the importance of supporting free-form annotations to sustain the experience of interacting with poetic language that is essential to the process of interpretation. We also noted the need to permit critics to reflect upon the content on their own and thus the necessity of slowing down the provision of assistance in the design of a literary analysis tool. We also needed to consider how to connect what we have learned by observing close readings with the computationally driven distant reading based analysis. Based on these design guidelines, we developed a tool, MetaTation, that couples a desktop-based literary support application with physical paper (augmented by the Anoto dot pattern) that is accessed through the Anoto pen [T1]. The Anoto pen is a digital pen that records its position on a physical sheet of paper, augmented with the Anoto dot pattern, by processing digital snapshots of the pattern generated by an optical lens embedded beneath the pen-tip. Annotations made by a critic while reading initiate interaction with the system. The annotations are processed in real time, taking into account the space they occupy as well as their form and function, as implicit interactions for requesting context-specific supplementary metadata [T2, T3, T4]. Specifically, MetaTation interprets CO annotations to deduce reader intent and generates apt assistance based on this interpretation to better support the critic's current thought process. Our system is thus subtle in that critics are not required to create specific pen gestures, such as "rhyme" or "alliteration" annotations, to access analytical support. MetaTation also extends the close reading annotations to generate distant reading based metadata.

Based on the observations of our study, we realize the need to minimize interruptions to the critic's reading process that could arise as a result of presentation of the generated supplementary

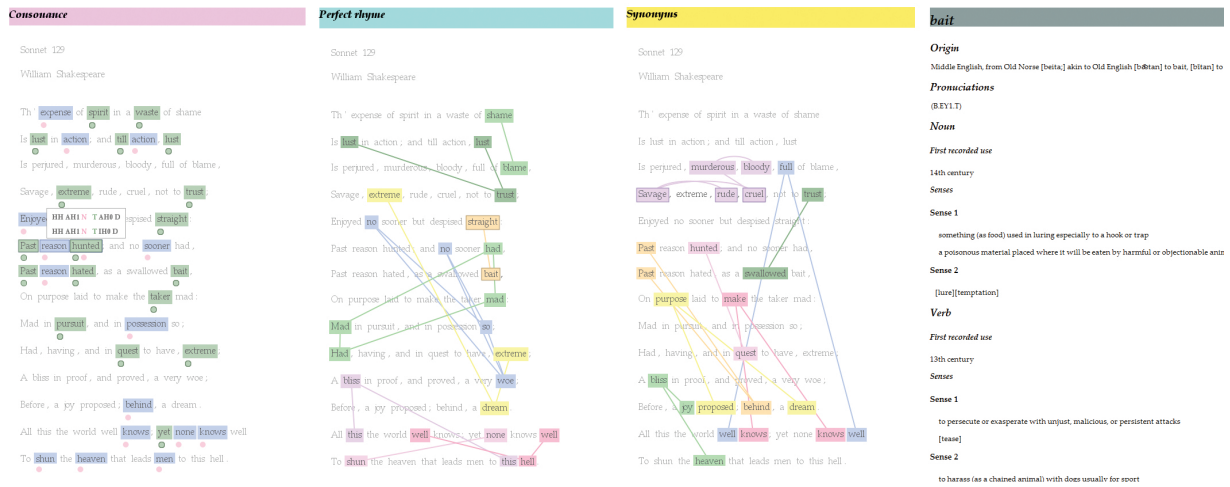


Figure 5.9: Four representative MetaTation tile types. Phonetic relation tiles, such as consonance, are interactive. Here, “hunted” participates in two relations, as indicated by green and pink dots. Upon hovering on the green dot, the pronunciation is shown in the tooltip to reveal which phonemes are relevant, and all related words in that set are highlighted. Synonyms and rhyme groups are connected by colours and lines. Word detail tiles are titled with the focus word and detailed information is provided in a structured layout.

reference materials. Video recordings of the analysis sessions from our study also indicated that critics, when performing close reading of a poem, tend to focus on the document on their desk with their head bent down. MetaTation thus presents the analytic assistance on a peripheral display to minimize but not eliminate interruptions to the flow of reading, as the data is outside of the critic’s field of view and the critic has the choice to decide when to look at the computational support provided [T5, T6]. We considered alternatives where the generated data is projected onto the desk or on the document itself, but decided against them to avoid distraction from even simple visual cues in the reader’s field of view.

In the following sections, we describe the design and implementation of our system in detail.

### **5.6.1 Example Use & System Description**

Once a reader specifies a poem to work with, the desktop application generates a printable image file that is a composite of the Anoto dot pattern and the poem. As the reader annotates the poem using an Anoto pen, the pen captures and communicates the pen position on the paper in real time, via bluetooth, to our application running on a nearby computer. The application groups the received pen points into pen strokes and then clusters these pen strokes based on spatial and temporal proximity. Pen strokes are categorised as ellipses, underlines or connectors by a geometric recognizer. Words associated with pen strokes are then extracted from the poem.

The query framework then processes the sets of annotated words, either implicitly grouped by pen strokes having a common form in a cluster, or explicitly grouped through connector strokes to identify possible semantic and phonetic relations. On finding a relation, the query framework looks not only for other words in the poem that are similarly related to the annotated words, but also for all other sets of words in the poem that share the same relation. The semantic relations considered are: synonymy, antonymy, and word repetitions. The phonetic relations considered are alliteration, consonance, assonance, and rhyme. The query framework also fetches word definitions, usage history, usage examples, and etymology. Acts of annotation thus become implicit queries. For example, through circling two words that rhyme, our system detects the rhyme and propagates a rhyming query across the entire poem. The results generated by the query framework are then formatted into a structured presentation or visualization called a ‘query tile’ and provided to the reader in a non-interruptive manner. The reader can then choose when to pause the process of annotation and reference the fetched metadata, which is provided on a nearby screen for easy glancing. Each query tile can also be investigated further by accessing information

on how the critic's observations in a single poem relate to larger corpora throughout different times in literary history.

It is this ability to take annotations made on a single poem (close reading) and extending them out to larger corpora (distant reading) that bridges these common approaches to literary criticism. The system leverages computational power to identify relevant connections of possible interest in large corpora that would otherwise be hard to track manually. For example, if a participant annotates two antonyms in a poem but misses a third, the system will not only highlight the third antonym in that poem but also trigger a search for pairs of antonyms in the provided corpora that exhibit similar characteristics. The similarity of antonym pairs in the corpora could be computed based on different measures such as token distance and/or semantic distance. Thus, annotations made while close reading could be used to spur distant-reading-based exploration of relevant text corpora and both approaches to literary criticism could be seamlessly supported. The architecture of MetaTation is illustrated in Figure Figure A.1.

### **5.6.2 Query Framework**

Firstly, the query framework retrieves definitions, usage history, usage examples, and etymology for each of the words in an issued query and sends the results to be displayed. It then inspects the query words to identify the presence of semantic and phonetic relations between them. If the query framework identifies some relation between the annotated words, it searches for other words in the poem that share the same relation with the annotated words, as well as all other sets of words in the poem that also hold this relation. The query framework also extends this search to available relevant corpora to find all sets of words in the poems of the corpora that exhibit this

relation and permits filtering of the results based on the similarity of these sets with those of the poem being analysed.

Detection of semantic relations between query words is supported by the synonyms and antonyms of the words retrieved from the Merriam-Webster Thesaurus [Dictionary, 2006] and WordNet. The CMU phoneme dictionary [Bartlett et al., 2009] is referenced for accessing phonemes of the query words for an investigation of phonetic relations. To check for full rhyme, the framework first looks for the presence of common vowel phonemes in the stressed syllables of the query words. On finding one or more such phonemes, the framework then checks to see whether all phonemes following the matched ones are identical in both the words and those before the matched phonemes are different. Alliteration in the annotated words is detected through the presence of common consonant phonemes in the stressed syllables of the words. Assonance is identified by the presence of common vowel phonemes in the query words whereas consonance is indicated by the presence of common consonant phonemes. The results generated by the query framework are then communicated to the desktop application for display.

### **5.6.3 MetaTation Interface**

The desktop application interface is comprised of two panels, namely the worksheet viewer panel and the metadata tile stream panel, as shown in Figure Figure 5.1. Interface components are described in detail in the following sections.

### **Worksheet Viewer Panel**

The worksheet viewer panel displays the poem being analysed and conveys the availability of relevant metadata for reference. Before a reader starts annotating the physical sheet of paper, the poem content is grayed out. As the reader annotates, the system processes the pen strokes and highlights the words annotated by these pen strokes creating pen stroke words. As metadata generated by the query framework are received by the application, color-coded dots representing the different types of available query results appear below the respective pen stroke words. Both pen stroke words and query result dots can be selected to filter the metadata tile stream.

### **Metadata Tile Stream Panel**

The metadata tile stream panel displays the query results as they are generated by the query framework, so the most recent results are visible at a glance. Query results are displayed in interactive tiles which have a layout and visual design appropriate to the query type, as shown in Figure Figure 5.9. As new query words get generated throughout the reading of a poem, the query tiles also allow the same queries to be posed to larger corpora of poems and support exploration of these distant reading based query results. This connection between a single poem and a corpora allows the analyst to expand literary critical questions out into literary history bridging the gap between close and distant reading.

### **Assonance, Consonance & Alliteration Tiles**

Pen stroke words received by the query framework are examined to detect the presence of assonance, consonance, or alliteration relation between pairs of words. Successful detection of

one such relation for a given pair of words triggers a search for other word pairs in the poem that also exhibit the detected relation.

Query tiles for assonance, consonance and alliteration share the same visual and interaction design. For example, an assonance tile highlights words having one or more of the same vowel phonemes as those identified by the system to be common between the pen stroke words. Pen stroke words, contributing to tile generation, are differentiated from the extrapolated words through the use of a faint border around their highlights. Each of the common vowel phonemes, if present in a highlighted word, is represented by colored dots placed below the word. Hovering over a highlighted word reveals its phonetic transcription with the phonemes of interest highlighted. Clicking on one of the phoneme dots brings forth only those of the highlighted words that contain the selected phoneme.

### **Synonyms & Antonyms Tile**

For a pair of pen stroke words, the query framework looks for the presence of one of the constituent words in the set of synonyms or antonyms of the other word. On finding one such relation for a given pair of words, a search for other word pairs in the poem depicting the detected relation is triggered.

The synonyms tile highlights sets of words that are synonymous. Word pairs identified as being synonyms by the query framework are each assigned a unique color unless one of the words in the pair has been previously encountered. If a word pair comprises of one of the words from a previously processed pair, the current word pair is assigned the same color as that previous pair to generate sets of synonymous words. One-to-one synonymy relation between a pair of words

is indicated by connecting the constituent words by arcs. Pen stroke words, contributing to tile generation, are differentiated from the extrapolated words through the use of a faint border around their highlights. Visual design is consistent across query tiles depicting sets of synonyms and those depicting sets of antonyms.

### **Full Rhyme Tile**

Phonetic transcriptions of pen stroke words received by the query framework are examined to detect the presence of perfect rhyme between pairs of words. On detection of a rhyming relation for a given pair of words, a search for all other word pairs in the poem that rhyme is triggered.

The perfect rhyme tile highlights sets of words that rhyme. Word pairs identified as exhibiting perfect rhyme relation by the query framework are each assigned a unique color unless one of the constituent words in the pair have been previously processed. If a word pair includes one of the words from a previously seen pair, the current word pair also receives the same color as that pair to visually group sets of rhyming words. In addition to this, rhyming word pairs are explicitly linked through the use of connecting arcs to convey the pattern of sounds across the poem.

### **Word Detail Tile**

A request for word details is triggered for each of the pen stroke words received by the query framework. The word detail tile displays the etymology, senses, definitions, usage history and usage examples of an annotated word. Initially, this tile was set to display detailed information corresponding only to a word's part-of-speech (POS) in the poem but was later changed to show



details about all possible senses of the word irrespective of the word's POS as the meaning of a word and its POS have been noted to not always coincide in the case of poetic language.

## **5.7 Expert Review**

Following the development of our prototype system, MetaTation, we designed a preliminary cooperative evaluation study for an initial investigation into the effectiveness of the tool in leveraging free-form annotations for augmenting the process of close reading for literary criticism. We recruited two of the literary scholars who had previously participated in our observational study for gathering qualitative feedback on the design of the MetaTation system. Our selection criteria was based on proximity and availability. Both of our participants have been teaching poetics for the past 10 (P6) and 20 (P9) years respectively.

Each participant was given a description of how MetaTation was created using the results of the study that they had previously participated in. They were then given a demonstration of how the system works, followed by a session where each participant was allowed to explore the tool while discussing their experience as well as concerns out loud with the researcher as they performed a reading of an assigned poem. We decided to assign the poem "Sonnet 129" by William Shakespeare (D7), from the poetry dataset created for the observational study, to both of our participants, since the poem exhibits all the semantic and phonetic relations that our system is capable of identifying and providing support for. In addition, neither of the participants had previously analysed this poem during the observational study.

After the participants had a chance to sufficiently interact with the various components of the

system, they were requested to elaborate upon their general impressions about the tool in a brief interview guided by the following questions:

1. What are your general impressions of the tool?
2. Did the addition of technology interfere with your process in any way?
3. Could you envision using a tool such as this in your daily work? What are some of the problems that you think would crop up when using this tool?
4. Can you think of any other modules that could be helpful in supporting the kind of work that you do?
5. Do you have any other suggestions for improving the tool?

The cooperative evaluation of the tool revealed helpful insights about the current design and directions for future work.

### **5.7.1 Qualitative Results & Discussion**

P6 had a very telling interaction with the tool as he chose to focus on and analyze the following lines in the sestet:

A bliss in proof, and proved, a very woe;  
Before, a joy proposed; behind, a dream.  
All this the world well knows; yet none knows well  
To shun the heaven that leads to this hell.

The participant underlined the words “bliss”, “dream”, “heaven”, and “hell” and referenced the metadata tiles generated by the tool. He noticed that MetaTation had added “joy” from line 12 to the set of {bliss,heaven} in the synonyms tile and “woe” from line 11 to the set of {bliss,joy} in the antonyms tile. The participant appeared pleasantly surprised to see the additions that MetaTation had provided. He realised that he had missed the connotation of the word “joy”, highlighted by the tiles, which when taken together with the other annotated words lead the lines to convey a sense of parallelism. He was genuinely excited about the possibility of using a tool such as this in his daily work that would help him catch insights that he might possibly have overlooked. He added that while he would have generally performed a single pass of reading first followed by a look up of supplementary information, he wouldn't mind concurrently using our system while analysing and was receptive of the results altering or enhancing his thoughts.

This is exactly the type of interaction for which the system was intended for. Understanding how these domain experts experience a text, the addition of one extra connection to a set that has been initiated by the user can have far reaching consequences for sense making within the text. We have observed our participants conducting similar actions during the study and have noticed how the addition of a single term to a cluster of annotated connections multiplicatively affects all of the other connections in the poem related to the new set. In this way, even simple additions, like an extra synonym or antonym, can end up having a profound effect on interpretation and thus, this reaction by P6 was very crucial.

The other participant (P9) started by underlining the words ‘waste’, ‘shame’ and ‘blame’ followed by marking the words ‘perjured’, ‘murderous’ and ‘bloody’. She was particularly impressed by how well the visual design of the tiles, while being very simple, effortlessly revealed and made apparent the patterns of semantic and phonetic relations in the poem. P9's reaction was

more focused on a particular use case as she was highly interested in the possibility of using our tool, in its current form, within a teaching context, “especially in a first year course, like intro to literary genres”. This was an unintended, but exciting reaction. She went on to discuss how the visual groupings of word meanings would add greatly to the process of describing the complex functions of words when working within a poem and was very excited about the possibilities the tool held for teaching. She commented that the results generated by the tool seemed serendipitous in a sense since her own annotations were being used to guide metadata generation and added that “if this was meant to be a proof of concept, consider it proved”.

When asked if the use of MetaTation would interfere with their workflow, P9 said that it would “not interfere” and P6 “liked how you could simply keep the machine with the tool separate from the workspace and reference it after a single pass”. Further discussion in regards to these responses highlighted for us that there are two different modes of use that can be employed with MetaTation. P6 wanted to play with the poem, looking up to see what the tool could tell him during the process, whereas P9 wanted to do her work and then reference the tool. Both use states are already possible within our design and the ability to engage within a user-defined time frame ensures that interruptions to workflow can be minimized.

In regards to general impressions, both participants were pleasantly surprised. P9 said that she would consider using the tool for teaching undergraduates. Although this use case was unintended it was a welcome addition for the possible interactions with the tool. P6 expressed his approval for the process and reiterated his excitement at the tool for filling in a set that he has already been thinking about with the word “joy” and continued to discuss the importance of how even a single addition to his thought process could have immediate consequences on his work.

## 5.8 Limitations

As noted in the results of the observational study, a variety of annotation forms were being employed by the readers when annotating while analysing poetry. The shape recognizer of our system, however, is currently able to process only a limited set of shapes, namely, ellipse, underline and connectors. The reason for picking such a small subset was that these forms were not only consistently prevalent across all of our participants but were also simple enough to be reliably recognised by the system. It is essential to further expand the geometric recognizer to be able to process other annotation forms so as to not constrain the readers and negatively influence their analysis process. Misrecognition or failed recognition of an annotation by the geometric recognizer is simply conveyed to the reader by the system but no means for addressing these are currently available.

Our system currently generates a limited set of basic metadata tiles that can be extended out into larger corpora; development of additional metadata query tiles for research-based analysis is required.

Technological shortcomings such as the pen points, corresponding to reader annotations, being not picked up at all by the Anoto pen and the necessity of the use of distinct Anoto dot patterns for distinguishing between pages, are also problematic for the adoption of this tool as a part of a literary critic's daily routine.

There is a great potential for the development of new meta information tiles for supporting research-based analysis of poetry. We have considered the addition of tiles to enable comparisons of semantic as well as syntactic context of usage of annotated words across all works of a poet as well as with works of other contemporaries of the poet in addition to poems of the same genre

across literary time periods. Metadata tiles hinting at the possible poetic forms exhibited by a poem based on the rhyming patterns and structure observed in the poem as suggested by one of our participants (P6) would also be a useful addition to the system. Identification of alluded works or poets in a poem has also been recommended as one of the required tiles for supporting research-based analysis (P9). We are also interested in expanding the limited set of query types with support for identification of forms of rhetoric, such as metaphor and irony, in the poem. Relating the themes of a poem to major historical events during the time of writing the poem is another interesting avenue to explore.

We made a decision to augment only CO annotations with digital metadata for our proof-of-concept prototype. The reason for not doing so with EML annotations was that they comprised mainly of handwritten notes and while many current handwriting recognition systems provide fairly accurate digitization of the input text, further exploration of how the content of these notes could be used to infer the type of relevant metadata is warranted. Augmenting both CO and EML annotations would help better integrate the tool with the existing analysis process of literary critics by allowing the system to be more robust in terms of the range of computational support it provides. An exploration of the possibility of taking into account the semantic context of the annotated words in addition to the spatial and temporal distance between the respective annotations and their forms could also help refine the metadata being generated by the system. We have also considered the possibility of overloading idiosyncratic reading habits, such as tapping on the desk for counting syllables or when figuring out the stress and sound patterns in a line, as implicit interactions for requesting analytic support.

We would also like to further evaluate our system through a longitudinal study involving all 14 participants to investigate how well the system integrates with their existing workflow. We

are also interested in exploring the possibility of substituting pen-and-paper with stylus-enabled digital tools to further investigate how crucial a role paper plays in the close reading process and to determine whether and how the annotation process gets affected by this change in medium. The transition from Anoto pen and physical paper to stylus-enabled digital tools would not pose any challenges for our system since the system has been developed to function with TUIO events.

While our system was informed by the specific domain of poetry analysis, other domains could easily benefit from its use, including the analysis of legal documents to connect cases and provide background on parties, the analysis of patient data in health care, and in newer forms of pedagogical practise, such as computational rhetoric, where the focus is on exploring artistic writing through computer-supported exploration. The software architecture allows for easy addition of query types and metadata tiles based on user needs. The tiles generated for literary critics may not be applicable to the analysis of legal documents, but if the annotation process is similar, new tiles could be quickly designed. In this way MetaTation is robust and customizable while maintaining the flexibility to address the annotation needs of multiple disciplines.

## **5.9 Conclusion**

In this chapter I have presented a study and a subsequent tool design that addresses the connection between close and distant reading. If chapter 4 was an attempt to define a new work flow that has the potential to produce literary insights, chapter 5 approaches the problem from the existing work flow of literary critics. Both of the previous projects have tried to add a dimension of the antropological into an existing instrumental framework. I used these projects to try and better understand where exactly the anthropological fits within this paradigm and how to recognize when

this space should be created for humans to interact with. In the next chapter I address the final piece of this puzzle and turn to a more detailed look into how people interact with language.



## **Chapter 6**

# **Gendered or Neutral? Considering the Language of HCI**

“ We are talking about a society in which there will be no roles other than those chosen or those earned. We are really talking about humanism. ”

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Gloria Steinem, *Address to the Women of America*

“ The limits of my language means the limits of my world. ”

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Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*

## 6.1 Introduction

<sup>1</sup>In the previous chapters I have shown three different ways of approaching a technological literary criticism: algorithmic (chapter 3), using visualization (chapter 4), and by studying literary critics (chapter 5). The field of Human Computer Interaction (HCI) routinely test their hypotheses and publish those findings as a matter of course. This is a necessary step in tool design. The collecting of information in regards to work flow or specific task orientation is a first step in building digital applications to aid work. For the humanities this step is problematic for one specific reason: the way the humanities gathers information is through writing and rhetorical argumentation. This is in direct conflict to the demands of tool design, which are empirical by nature. Because of this, there need to be methods laid out that are compatible with both the collection of evidence (such as user studies) and rhetorical argumentation. The previous chapters in this thesis used established methods of collecting evidence to guide the design of tools and methods. Chapter 3 used programming methods, Chapter 4 applied mathematics and visualization to map out language systems, and Chapter 5 was guided by a study of literary critics performing close readings. What is presented here is a first attempt at laying out a method to better understand how people use language. To accomplish this, we have created a user study that tests a humanistic theory. The specific theory that we have chosen is not the most relevant factor of this demonstration. The idea is to start to build a framework so that we can generate rhetorical evidence from empirical studies that use humanistic research questions as their motivation. While these frameworks are well established in the field of HCI for HCI work, this chapter is an initial offering of such a

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<sup>1</sup>This chapter was a collaborative project between Cayley MacArthur, Mark Hancock, Sheelagh Carpendale, and Myself. Portions of this chapter have also appeared in MacArthur's M.A. thesis. Any use of the first person plural indicates collaborative work

technique for humanities questions and ultimately digital humanities tool design. As the previous tools in the thesis have all in some way dealt with digital approaches to language, we designed a study that could address a small but important aspect of language usage. Admittedly, many more studies like the one that follows are needed to produce a usable tool, but each small piece of information that we can produce from studies like this one, can aid greatly in our knowledge of how to develop digital tools for humanistic work. What follows is a demonstration of how to test a humanistic theory using evidence-based techniques.

We designed our study with the specific hypothesis that gendered language exists in places where words are thought to be gender neutral. It is a demonstration of the power of interdisciplinary work where idea generation comes from humanistic inquiry (feminist language theories) and the testing procedures come from HCI. This chapter is the culmination of this hybrid approach and considers feminist perspectives on gendered language as the starting point for the development of a study framework.

At a first glance it would appear that the HCI community is carefully gender neutral in that it fairly consistently chooses gender non-specific words when referring to humans: e.g. “user”, “participant”, “person”, “designer” and “researcher” (CHI 2014 people words). However, like so many professions, it still faces gender inequalities in its ranks, which is leading to research that considers questions of gender equality in HCI [Bardzell et al., 2011a, Bardzell et al., 2011b, Bardzell and Bardzell, 2011, Bardzell, 2010, Beckwith and Burnett, 2004, Burnett et al., 2011, Buttrick et al., 2014, Margolis and Fisher, 2002, Kannabiran et al., 2012, Light, 2011]. We conduct a study that explores whether the language used in our papers to describe people is actually perceived as gender neutral. Our Mechanical Turk study asked participants to think about one of the HCI people words (a user/participant/person/designer/researcher) for ten seconds and

then to draw a picture of it. We found that while we may intend the language that we use within our community to be neutral, it is largely perceived as gendered.

Discussions of equality within HCI are becoming more prevalent [Bardzell et al., 2011a, Bardzell and Bardzell, 2011, Bardzell, 2010, Kannabiran et al., 2012, Light, 2011, Hemphill et al., 2014, Muller, 2011, Vasilescu et al., 2014, Padilla et al., 2014, Dray et al., 2013, Forte et al., 2012]. Indeed, one of the core principles in human-centred design (HCD) is the consideration of the variety of needs and differences between people [Dillon and Watson, 1996]. For example, the use of personas [Grudin and Pruitt, 2002] in design intentionally includes descriptions of people's gender, age, background, and a story to describe their unique situation, with the intention that designers visualize and base design decisions around a variety of demographics. In some instances, these stories and scenarios find their way into academic literature in HCI, but more frequently the language used in our papers centres on the use of nouns such as “users,” “designers,” and “participants,” with the intention that these avoid specifying a gender, and can be thought of as a generic “person.”

However, it is not clear whether this use of non-gendered terms in our academic literature actually leads to non-gendered impressions. Since we, as a community, are interested in promoting gender equality [Bardzell et al., 2011b, Muller, 2011, Dray et al., 2013, Forte et al., 2012, Wajcman, 1991], in encouraging young women into technological career paths in general and HCI in particular [Margolis and Fisher, 2002], we decided to apply common HCI empirical methodology to our own use of vocabulary to discover whether our choice of non-gendered terms is effective in providing gender inclusiveness.

Our study reveals that the common HCI people words are not always gender neutral. We have

found that the language we use to describe people within the community carries gendered, and in some cases other demographic implications. We suggest that we, as authors, should begin to consider the implications of our word usage in publications, and we, as a community, should begin to develop strategies to deal with this likely unintentional bias.

In this chapter we provide evidence that words generally considered within the HCI community to be non-gendered, or at least gender-neutral, are instead perceived as having specific qualities by Mechanical Turkers. We recognize that Mechanical Turk has limitations, such as the tendency towards those who are aware of its existence; however, this method provides a larger and more diverse sample than, for instance, a lab study with university students. The impression of non-experts about our language use is important for a variety of reasons, including the recruitment of future women to the discipline of HCI, the tendency for people to adopt our terms (e.g., “user” is quite commonly understood as a person who uses technology), and the need for our research papers to reflect the diversity and inclusivity we aim to encourage in the use and design of technology. Our work is a first step toward understanding what these words connote, and can act as a baseline for future studies that can compare their use in various contexts. In terms of the whole of this thesis, this chapter presents a step towards understand how people interact with language, which is a requirement for a theory of technological criticism.

## **6.2 Related Work**

There has already been significant work in HCI discussing issues of gender, including discussions of bias in design [Bardzell and Bardzell, 2011, Winograd, 1986], encouragement of participation of women in computer science and HCI [Margolis and Fisher, 2002], and feminism in HCI [Bardzell

et al., 2011b, Bardzell and Bardzell, 2011, Hemphill et al., 2014, Muller, 2011]. Through our study, we add to this literature by providing quantitative evidence that further work is necessary if we want to achieve a more gender neutral balance in interpretation of the language we are using. The feminist perspective on research and design in HCI has been gaining momentum within the HCI community, inviting methodologies to be developed [Bardzell, 2010], workshops to be held [Dray et al., 2013], and reflections to be documented [Muller, 2011]. However, a trend map [Padilla et al., 2014] showing topics of discussion over the past 5 years of CHI demonstrates that discussions around women were more often linked to public or community life, and reached a peak about three years ago, before starting to decline. There have, however, been several recent memorable papers on feminism in HCI [Bardzell et al., 2011b, Bardzell, 2010, Boynton, 1998, Butler, 1988, Fisher and Margolis, 2002, Grudin and Pruitt, 2002].

Few papers attempt to bridge theory with the quantitative style of reasoning more commonly accepted in the CHI community. Notable studies include Burnett et al. [2011] and Vasilescu et al. [2014]. Burnett et al. [2011] conducted studies showing that, in problem solving software, there are significant gender issues in several factors, including which features are used, people's willingness to tinker, and general confidence. They then use this information to inform the design of problem solving software. Vasilescu et al. [2014] studied women's representation in on-line communities and suggested moving away from the gender binary, speculating that this could be causing some problems in itself. In this vein, our study takes another step towards bridging the gap between theory and practice, substantiating theories rooted in the humanities with empirical research.

Gender issues have also been explored in design of artifacts, for example, Significant Screwdriver [Bardzell et al., 2011b] is an exploration of how "designs can perpetuate and even create

gender roles and divisions” focused on meaning attributed to a physical object, but, as Winograd indicates, digital design choices can have the same effect [1986]. The decisions involved in interface design are grounded in a series of observed interactions from which models have been abstract-ed and applied in practice: “theories about the nature of biological existence, about language, and about the nature of human action have a profound influence on the shape of what we build and how we use it”. Czerwinski et al. [2002] studied navigation in 3D environments and showed that by providing wider fields of view and larger displays, the gender gap in performance when navigating virtual environments can be reduced without negatively impacting males.

Wajcman [1991] argues that “as with science, the very language of technology, its symbolism, is masculine.” This language adheres to neutral-sounding terms, standardized by a society that values this rationality (masculinity) over the emotional (feminine). This empiricist view of science as “(gender) neutral” has been critiqued and dismantled extensively by feminist authors throughout the 20th century [Wajcman, 1991]. In feminist theory, a “false universal” is a word that suggests a norm through unspoken connotations, even though it is supposed to encompass everyone (e.g. “mankind”) [Butler, 2004]. Bardzell writes “the interaction design process takes place independent of gender considerations, and even today the central concept of the whole field—the user—remains genderless” [2011]. The theory of the false universal has not been formally explored in HCI, and we wish to identify the possible norms within our own field while exploring whether words like “user” have become false universals. Buttrick et al. [2014] and Light [2011] have brought attention to a problematic relationship between humans and technology through exploration of unconventional themes that call some norms into question. We have chosen to do this through drawing, based in part on the idea from Sontag [2001], that our language contains more hidden stereotypes than the things we draw, so examining images can help us uncover meanings that



would not necessarily be conveyed through words.

The collection and analysis of drawings is a popular and well-documented methodology in psychology (e.g., [Brafman, 2012]). Drawings can help us understand mental processes, showing us representations of perspectives imbued with history and culture [Türkcan, 2013]. One of the goals in soliciting drawings is to understand the “relationships that the artists have with the object of their representations” as well as any “gendered productions” or the discourses that would account for these drawings [Wright, 2014]. The collection of drawings to find out specifically about stereotypes was pioneered by Chambers’ influential Draw-A-Scientist Test (DAST) [Chambers, 1983]. We build on this work by using this drawing method to investigate whether common “people” words used in HCI literature are gendered.

### **6.3 Use of Language in HCI Literature**

The word most often used in the ACM Conference on Human Factors in Computing Systems (CHI) literature to describe people is “user” (17663 instances in 2014). This number was arrived at by creating a concordance of all papers published at CHI in 2014 and ranking them by frequency. In our study, we looked at how the general public perceives the word “user” as well as other popular word choices to describe people. Feminist HCI [Bardzell et al., 2011b] and the neuro-diversity movement [Dalton, 2013] have challenged the use of “user”, but no one has provided empirical evidence for what kinds of biases are associated with the terms. Coleman [2011] suggests that the word “user” could imply “dependency, addiction, and, ultimately, objectification where one is conscripted into the logic of whatever is being used, be it a technology, drug, etc.”

Carnegie [2009] deals with interface design and how in the past it has been treated as if it does not influence our interactions. Dourish and Bell [2001] call on the community to “acknowledge the ways in which technologies both exploit and reproduce a range of power concentrations and relationships”. As Czerwinski et al. [2002] demonstrate in their study of 3D navigation that showed that wider fields of view and larger displays reduced the gender gap in performance without negatively impacting males, technologies can indeed exacerbate the gender gap.

In our work, we investigate whether using conventional “people” words from HCI literature could be contributing to a gender gap by studying whether these words have gendered connotations.

### **6.3.1 Vocabulary usage motivation**

Psychological research has already set a precedent for linguistic awareness and change within the HCI community that can be found in the discussion about the word “subject” and the word “participant”. In 1995, The British Psychological society recommended that the term “subject” be abandoned and replaced by “participant” [Chalmers, 1999] “[a]fter noting that psychologists owe a debt to those who agree to take part in their studies. . . deserve to be treated with the highest standards of consideration and respect”, the society. Boynton [1998] published an article in the British Medical Journal entitled “People should participate in, not be subjects of, research” in which he called for terminology reform in psychological research studies to shift from the generally accepted word “subject” to that of “participant”. This action was spawned by a belief that the words that psychologists used held power and had an influence over how they were conducting their research studies. Figure 6.1 shows an *n*-gram analysis of the use of the words “subject” and “participant” in CHI papers published since the first SIGCHI conference in 1982. It is

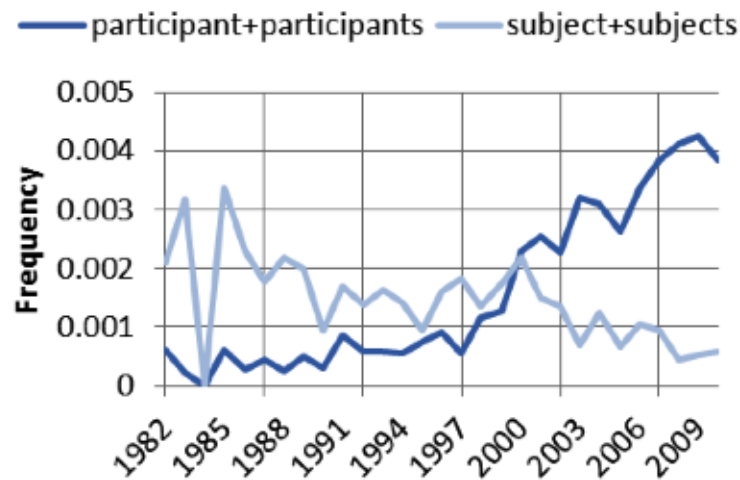


Figure 6.1: Frequency of word usage for the words “participant” and “subject” from the dataset of all 1982-2011 CHI papers.

clear that in or around 1998 the use of the word “subject” was replaced by the word “participant”.

What the psychologists were in fact doing was realizing that by labeling their “participants” as “subjects”, the pragmatics of the word “subjects” was negatively impacting their work. It goes without saying that psychology is a large part of HCI, and our community has already shown that they support this kind of thinking by changing their terminology to match that used in psychology. Following Boynton’s suggestion, we have also chosen to refer to our Mechanical Turk workers as “participants” throughout this paper. What we suggest is that there are other words in our lexicon, specifically the word “user”, which act in negative ways like the word “subject”. By considering how these words operate and how their history has affected their meaning, we can gain a larger picture of exactly how their use may be affecting our work.

## 6.4 Study: Drawing People Words

We designed a study to specifically investigate whether words we use in our research papers are perceived as gendered. We were particularly interested in the gender, age, race, and other demographic information people associate with these words, and whether this relates to one's own demographic information (e.g., do men think of men, and women think of women?). We therefore designed a study in which we asked participants to draw what they imagined for people-themed words from CHI 2014 literature.

Our study design was modelled after work by McMaster [2012], who explored the feasibility of similar image-based research using Mechanical Turk. In this work, he suggests that a globalizing effect on imagery may be taking place, accounting for consistency in visual themes collected despite the diversity of respondents [McMaster, 2012]. As Cohn points out [1987], the images people draw cannot directly be translated into specific motivations, but can provide higher-level themes showing how the imagery originates from a cultural and temporal context. In collecting images we do not intend to identify individuals with biases, but to uncover broader themes.

We also took inspiration from Schmettow [2013], who sought to illustrate individual differences in what people associate with computers by using priming to understand implicit associations; in our study, participants are making associations with the people words. Rather than asking for word associations after seeing a picture, we wanted to inspire visual representations of common words to see whether participants identified with the universal terms used in HCI. Given the prevalence and success of drawing studies in psychology and the work done by McMaster, we were interested in applying this approach to HCI people words.

## **6.4.1 Participants**

Participants were recruited from the Mechanical Turk marketplace. We posted 5 unique Human Intelligence Tasks (HITs), one per word with 150 workers per HIT, for a total of 750 instances; however, some participants completed multiple HITs leaving only 433 unique respondents (58 completed all 5, 9 completed 4, 12 completed 3, and 34 completed 2). We received 766 responses, which is greater than the number of requested HITs, perhaps due to participants restarting the study or revisiting the URL after problems such as system failure. Thus, in our data cleaning process, we used only complete responses, with an image and corresponding questionnaire data. This gave us 757 unique responses. Therefore, our analysis is based on the unit of responses, rather than participants, affecting sample size, degrees of freedom, etc.

As to English proficiency, 328 participants indicated English as their primary language, and, of the 316 that indicated another language as primary, 226 (72%) indicated being fluent, 73 (23%) indicated functional knowledge, and 17 (5%) indicated limited or no knowledge of how to communicate in English. Demographic information, such as gender, ethnicity, and age are primary factors in our analysis, and so are discussed in the Results section.

## **6.4.2 Task & Conditions**

Each Turker was directed to our server via Mechanical Turk and asked to think for 10 seconds about one of five words: “user”, “participant”, “person”, “designer”, and “researcher” using the exact phrase “for the next 10 seconds think about a . . .”. Our software prevented them from continuing the survey until this 10 seconds had elapsed. They were then asked to draw that word with the phrase: “in this box, draw a . . . sitting down”. We specifically recommended that

participants switch to a device that provided touch or pen input, if they had one available. Once they uploaded a screenshot of this drawing, they were given a survey designed to gather data about the drawing (its gender, age, ethnicity, etc.), and then asked to describe themselves (again, gender, age, ethnicity, etc.) via a set of predefined questions.

Because our study was specifically targeted at collecting data about gender issues, we took some care in how we asked participants about gender. Specifically, we asked:

*“Does the subject of your drawing have a gender, and if so, what is it?”*

With the options: Male/Female/Other, and a follow up question:

*“If you answered ‘other’, you may elaborate here”.*

Similarly, for ethnicity, we asked:

*“What is the race/ethnicity of the person in your drawing? (i.e., people’s ethnicity describes their feeling of belonging and attachment to a distinct group of a larger population that shares their ancestry, skin colour, language or religion)”.*

The drop down box had the options: Caucasian, Latino/Hispanic, Middle Eastern, African, Caribbean, South Asian, East Asian, Mixed, Other (clarify). The study was implemented through Mechanical Turk, but participants were directed to a local web server that hosted a web-based application that allowed participants to draw in an HTML5 canvas, and then respond to survey questions.

### 6.4.3 Word Selection

The list of five words was derived by gathering all of the papers published in the CHI 2014 proceedings, performing a frequency analysis of individual words, and making a list of the top five words used to reference people within this dataset. To come up with this final list we combined words that had the same lemmas. For example we combined the words “participant” and “participants” into a single list item, as well as “person”, “persons”, and “people”. In this literature there were 17663 instances of “user”, 14523 of “participant”, 2337 of “person”, 1092 of “designer”, and 1044 of “researcher”. Note that the word “individual” was some-times used to refer to people and actually has 1795 instances in CHI 2014 literature. We discussed including this word in our list; however, many of these instances were not referring to people (e.g., the phrase “each individual (object)” was often used to described artifacts, instances of data, etc.), and so we did not consider this to be in the top five of words referring to people.

### 6.4.4 Hypothesis

We began thinking about this work because we thought that there was a possibility that the word “user” was a false universal representing a norm, and would be predominantly thought of as male. We also expected that this bias would exist for participants of all genders. We thus hypothesized:

*H1. Participants would draw ‘a user’ and describe the drawing more frequently as ‘male’.*

After an initial pilot, with the conditions “user” and “person”, we observed the trend that both were thought of as male, and decided to include the five conditions described above. We thought

that this might indicate that all of the words we use to describe or identify people within CHI papers are thought of as male. We thus can describe these same hypotheses for any of the words as follows:

*H1 (revised). Participants would draw any of these words and describe the drawing more frequently as 'male'.*

We expected a similar bias about ethnicity descriptions, and thus had the following hypothesis:

*H2. Participants would draw any of these words and describe the drawing more frequently as 'Caucasian'.*

## **6.5 Results**

Participants drew a wide variety of images, which ranged significantly in detail and showed a clear attention to thoughtful interpretations of the words. While we hypothesized that any gender effects in the data would be population wide, what we found was that they were divided by the gender of the participants. For this reason we have divided our analysis into separate conditions based on gender of the participants. Figure 6.2 shows a sample of images collected in each condition. Unless stated otherwise, all the data reported in this chapter is as reported by the participants in the survey accompanying their drawings and has not been coded.



## 6.5.1 Gender

Across all five conditions, only 14 responses described the participant's gender or the gender of the image as "other", and so statistical analyses on data about this group was not conducted (Figure 4). There were also 134 instances when the gender of the drawing or participant is unknown. This occurred when participants described the drawing as not being human, or when participants opted not to provide data about the image's or their own gender.

We therefore used a Pearson's Chi Square test on the remaining drawings, which were described as being male or female by participants who described themselves as either male or female. We used the null hypothesis that the drawings would be equally distributed across these two genders; that is, that the word was interpreted as being non-gendered, and so would be uniformly distributed independent of participant gender. Figure 3 shows the frequency distributions for all five words by the different genders.

For all five words, images drawn by males were more frequently of males than of females.

This suggests that when men read these commonly used words, they tend to perceive these people to be men. Similarly, images drawn by females were more frequently of males than of females for the words "user" and "researcher". This finding suggests that, when women read these two words, they tend to perceive these people to be men. Promisingly, images drawn by females for the words "person", "participant", and "designer" were not more frequently of either men or women.

While it is not appropriate to accept the null hypothesis (i.e., that this frequency is actually equal to 50%), this finding suggests that this gender bias, if it does exist, is far less pronounced for women for these words than it is for men.

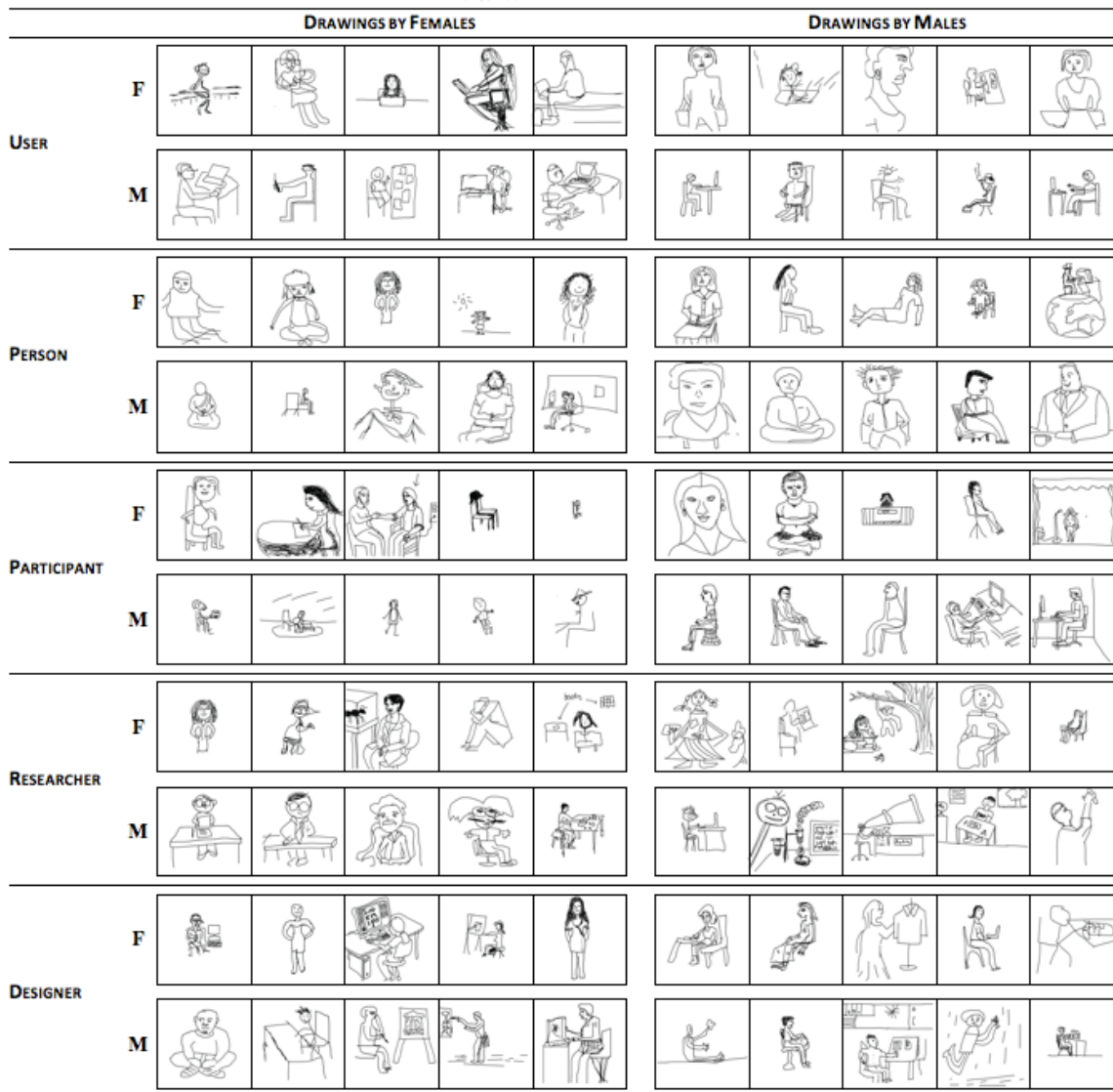


Figure 6.2: Sample drawings of the top five words used to describe people in CHI 2014 papers. Drawings done by female participants are on the left, and drawings by male participants on the right. Within each word condition, drawings on the top row were identified as being of females, and drawings on the bottom row were identified as being of males.

	<i>Drawn by males</i>	<i>Drawn by females</i>
<i>“user”</i>	$X^2(1, N = 71) = 39.6$ $\varphi = 0.71$ $p < .001^{***}$	$X^2(1, N = 49) = 4.6$ $\varphi = 0.29$ $p = .03^*$
<i>“person”</i>	$X^2(1, N = 86) = 31.4$ $\varphi = 0.59$ $p < .001^{***}$	$X^2(1, N = 50) = 1.3$ $\varphi = 0.15$ $p = .26^*$
<i>“participant”</i>	$X^2(1, N = 75) = 37.5$ $\varphi = 0.70$ $p < .001^{***}$	$X^2(1, N = 47) = 0.2$ $\varphi = 0.06$ $p = .66$
<i>“researcher”</i>	$X^2(1, N = 64) = 42.2$ $\varphi = 0.76$ $p < .001^{***}$	$X^2(1, N = 52) = 15.1$ $\varphi = 0.51$ $p < .001^{***}$
<i>“designer”</i>	$X^2(1, N = 61) = 15.8$ $\varphi = 0.48$ $p < .001^{***}$	$X^2(1, N = 53) = 2.3$ $\varphi = 0.20$ $p = .13^*$

Table 6.1: Chi-square statistics for words drawn by participants in our study. Each comparison uses the null hypothesis that the number of drawings of men and women is equal in proportion.

Based on this data, we can confirm H1 for drawings by male participants and all words, but can only confirm H1 for drawings by female participants for the words “user” and “researcher”.

## Gender Markers

In our analysis of the images, we observed many images with what could be considered gender markers (Figure 6.4), such as facial hair and ties for men, and dresses and bows for women. We recognize that these markers are not exclusive of gender (women can wear ties and men dresses), but participants identified these images as being male or female as well. In our counts we exclusively used declarations of participants and merely note here that drawings often, but not always, also included gendered markings.



Figure 6.3: A selection of images labeled with genders as “other”, colour-coded to indicate the gender of the drawer.

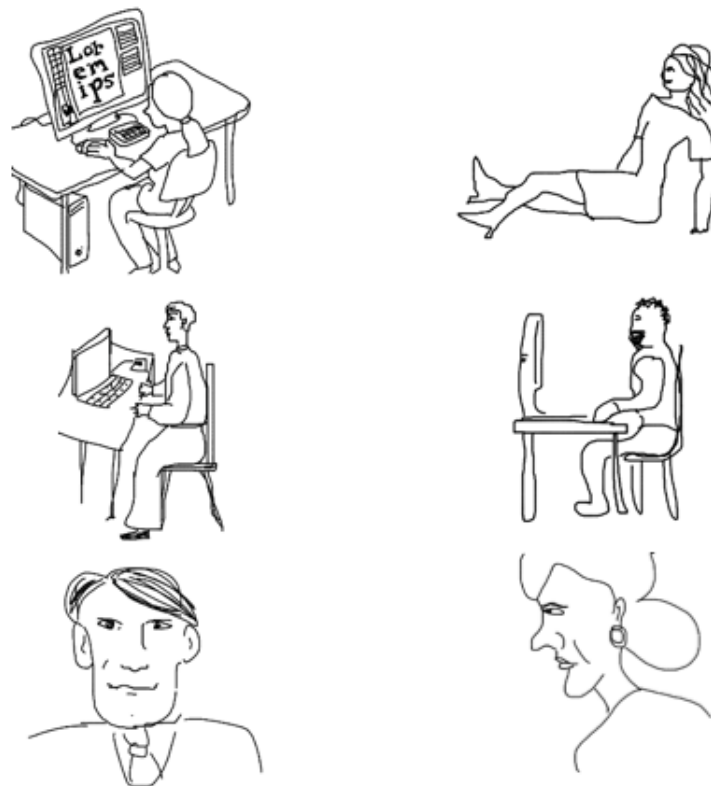


Figure 6.4: (top) A female “designer” and an image of a “person” wearing a dress and high heels. (middle) Two male “users” and a drawing with the “male” gender marker of a goatee. (bottom) a male and female “person”.

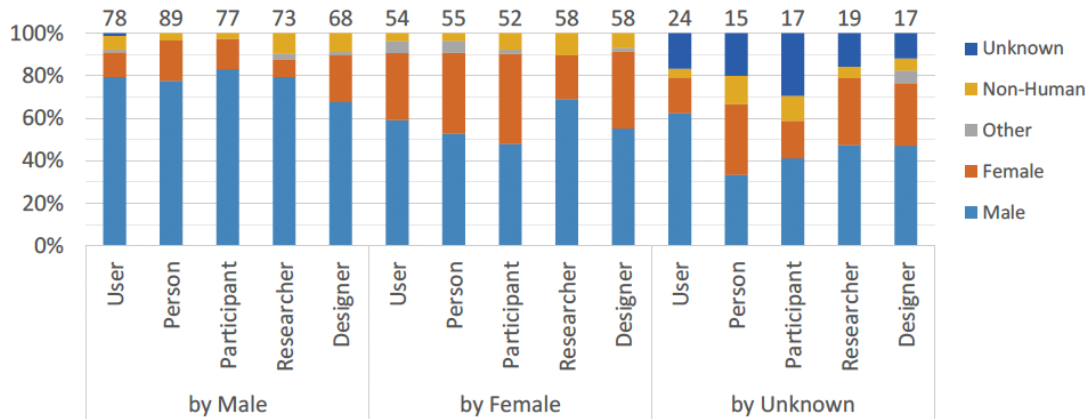


Figure 6.5: Percentage of drawings described by participants as being of a particular gender. Numbers at the top describe the number of valid responses in that condition. The subject of drawings by males were of males for all words, but the subject of drawings by females were of males only for “user”, and “researcher”. Only data where gender was specified was analyzed.

### Ethnicity

The sample in our dataset was not spread sufficiently across all ethnicities to be able to conduct formal analyses of this data (223 Caucasian, 313 South Asian, and 104 not specified, with the remaining 126 spread across conditions such that each ethnicity-condition total was less than 10 data points). However, as shown in Figure 6, there was a tendency for Caucasian and South Asian participants to draw people of their own ethnicity in all conditions. It appears as though participants of other ethnicities tend to draw Caucasians in addition to their own ethnicities, though the samples of these populations are perhaps too small to draw conclusions about this data. Thus, we cannot confirm H2.

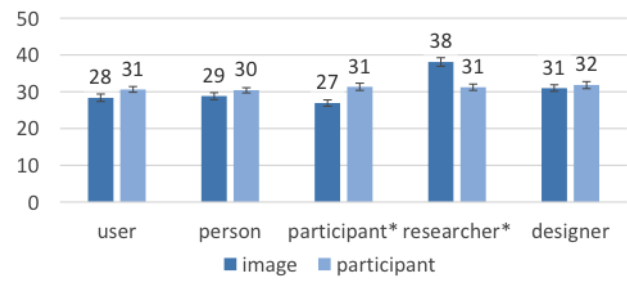


Figure 6.6: Mean age of drawings and mean age of participants for each word condition.

## Age

We compared the age of participants to the age of the person drawn using paired t-tests. As shown in (Figure 6.6), drawings were of people younger than themselves when they drew “participants” ( $t(97)=3.9$ ,  $d = 0.39$ ,  $p<.001$ ) and older than themselves when they drew “researchers” ( $t(106)=4.7$ ,  $d = 0.46$ ,  $p<.001$ ). For the remaining three words, the age of the drawings was not significantly different than the age of the participant (user:  $t(96)=1.8$ ,  $d = 0.19$ ,  $p<.07$ ; person:  $t(122)=1.4$ ,  $d = 0.13$ ,  $p<.16$ ; designer:  $t(101)=0.7$ ,  $d = 0.07$ ,  $p<.49$ ). This finding suggests that our participants perceive researchers to be older, participants to be younger, and the remaining words (user, person, and designer) to be of similar age.

## 6.5.2 Use of Artifacts

Since we asked participants to draw their condition sitting down, we saw many versions of chairs. We were also able to distinguish additional artifacts in the drawings as participants were prompted to identify them in words. We therefore noted some interesting artifacts such as lab equipment for the “researcher” condition and art easels for the “designer” condition (Figure 8).



Figure 6.7: (left) A “user” sitting at a computer and (right) a simplistic but still recognizable picture of a computer.

### **Computers**

Many drawings in the user condition were of a person sitting down typing at a computer (Figure 6.7). Interestingly only 6 drawings (3.8%) included images where the participants indicated in their responses to the questionnaire that they had drawn phones or tablets, suggesting that “user” is thought of not only predominantly as male, but also as a desktop computer user.

### **Drug Use Equipment**

One of the interesting aspects of the “user” condition was that 9 drawings (5.8%) were images of drug users (Figure 6.8). Usually these images were described by our participants as either having needles or drug smoking paraphernalia present within the image. This finding suggests that the word “user”, despite being so ubiquitously used when referencing people who use technology, is still thought of in the context of drug use by a more general population. Thirty years after the term “user” was first appropriated in 1935 to describe drug takers, it was then used as the go-to noun for the emerging computer revolution. Our data suggests that the earlier definition is still alive, and at times will be imagined by readers. Even though it was a small percentage that drew drug users



Figure 6.8: Drawings of drug users from the “user” condition.

(5.8%), our study provides evidence that this meaning is still implicated by the use of this word.

Moving forward, we need to be aware as a community that all of the terminology we use has the potential to not only be misinterpreted due to multiple meanings, but also has the potential to affect how we operate within our own community. One difficulty is that conscious awareness of this process is not a necessary condition for having it occur. We are not suggesting that researchers in any way mean to imply alternate meanings, only that it is a part of using words and we should be aware that it may have these negative implications.

## 6.6 Discussion

Our study produced the following results: (1) For all five words, drawings by male participants were significantly more of men than women. (2) For “user” and “researcher”, drawings by female participants were significantly more of men than women. (3) For “person”, “participant”, and “designer”, drawings by female participants were about 50/50. (4) The gender “other” was used to describe only 14 images or participants. (5) Drawings from ethnic groups tended to be of a person from their own ethnic group. (6) Drawings of “participants” were younger than themselves, and



“researchers” older than themselves.

### **6.6.1 Gender**

For all five conditions, drawings by male participants were significantly more of men than women. This finding suggests that men, when reading the words that most represent people in our literature, have a tendency to think of these words as being representative of males. Biases are present in all work we do. Significant effort is made to minimize these effects, but we suggest that the imagery implicated by individual people words is not fully known but can be remedied with some careful attention. Although this is a preliminary investigation into this phenomenon with a general population, we find the effect interesting enough to warrant discussion and future investigation in more context-driven environments with domain experts.

For the “user” and “researcher” conditions, drawings by females were significantly more of men than women. That this did not occur for the other three conditions suggests more inherent gender bias in the reception of these two words. There is also a cultural undertone that suggests that the people using technology and that researchers in general are thought of by both genders as being predominantly male. For the “person”, “participant”, and “designer” conditions, female participants drew images that were not significantly different than a 50% split between genders, meaning that, for women, these words may be more gender-balanced.

Our finding of gender imbalances may be reflective of an actual state of gender imbalance within the larger cultural context. Even though we have domain expertise, we are still part of the larger cultural landscape. We hypothesize that adding context may negate some of these effects, but suggest that being aware of our word use and the implications of the words we choose to

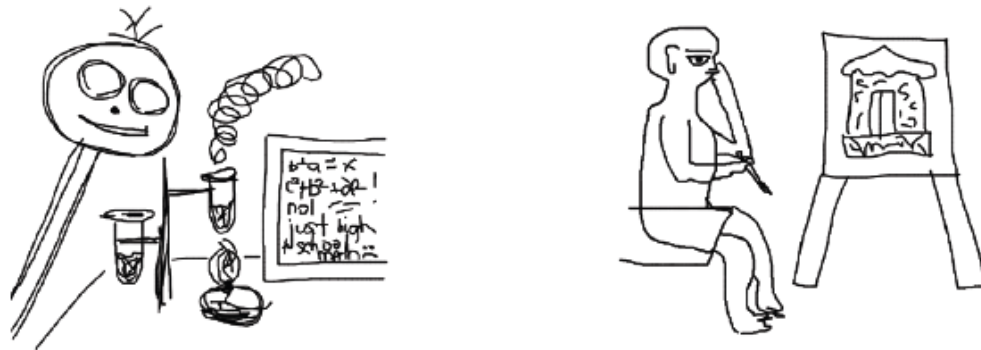


Figure 6.9: (left) A drawing of a researcher with lab equipment and (right) a designer sitting and painting at an easel.

describe people could have a direct impact on making the discourse of the HCI community more inclusive. It may be that consideration of the variety of complex personas from many different demographics results in more inclusive impressions of people.

It should also be noted that although only 14 data points (0.3%) used “other” to describe the participant’s or the image’s gender, the considerations for this gendered language description cannot and should not only be inclusive of males and females. Moreover, the categories provided in our questionnaire of “male”, “female”, and “other”, may be insufficient to describe gender, and perhaps both language in CHI papers and our methods of gender data collection should aim to be more sensitive to implying a binary.

Our hypothesis for this work was that words we use in HCI research to describe people were inherently gendered. Our data shows that, in words that we intend to be universal, there exists a gender bias in a general population of participants. “User” is our most common word for describing people in CHI papers and we should be aware that words like these can bring with them unintended implications. Future work should test these phenomena in context-driven situations to observe whether the effects hold.

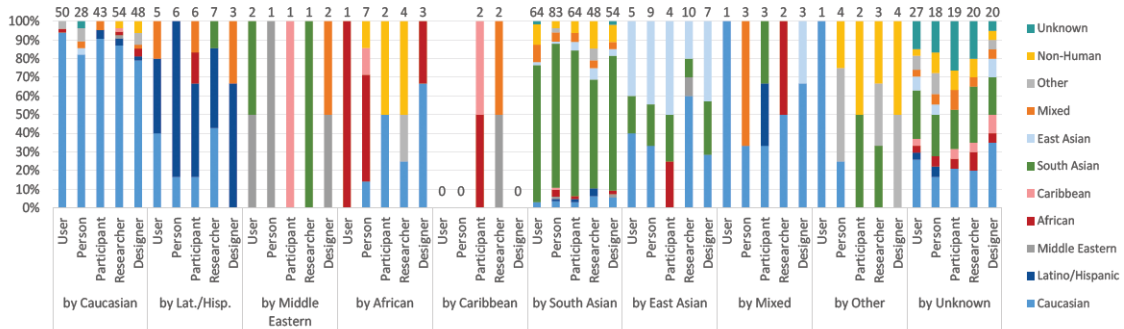


Figure 6.10: Ethnicity of participants vs. ethnicity of drawn images.

## Ethnicity

The majority of our drawings had participants that self-identified as Caucasian and South Asian, and the ethnicity of the drawing was typically the same as the participant’s. The data itself was not spread sufficiently across all ethnicities to draw conclusions, but future work could investigate whether people words are thought of as being more of one ethnicity than another. This would be a surprising result because of the diversity of the HCI community, but our data provides some (very weak) evidence that some non-Caucasian ethnicities would more frequently draw Caucasians.

## Age

In the “researcher” condition, drawings were of someone older than participants, suggesting that this word not only holds a gender bias, but has age connotations as well. Moreover, in the “participant” condition, drawings were of people younger than participants, indicating a different kind of interpretation, which perhaps indicates a belief that this group is less mature than one’s self. Further study would help elucidate the meaning of these findings.

## 6.7 Study Limitations

A limitation of our study is that we only tested the reception of the words by Mechanical Turkers in a context free environment. We recognize that the Mechanical Turk platform has several limitations; the integrity of our data is not guaranteed, and our sample is limited to Mechanical Turk workers (i.e., those that know of its existence). However, in past work collecting drawings from Mechanical Turk it has been found that “despite cultural, age, and geographic differences, the representations had some striking similarities in the way they conveyed the meanings of the words” [McMaster, 2012], which indicates potential in providing an overall baseline.

Also, since we investigated words without context, we want to be clear that these perceptions may not reflect those of a particular word in the context of a paper. For example, the word might even be used in the context of a gender discussion. To address possibilities of ambiguity around the drawings’ contents, we follow the suggestion to collect “more in-depth survey data to complement and support the image data captured” [McMaster, 2012]. We think our approach provides interesting evidence that we hope will trigger considerable future work to further explore these issues. We are particularly interested in the contextual issue in our own future work.

In the early stages of this work, we predicted that the word “user” in particular was more inherently biased and began the practice of replacing it with words like “person” or “human”, but our data suggests that this will not completely avoid the bias in question, so it is a partial solution at best. While the practice of substituting words such as “user” for the words “person” or “people” will still bring with it some male bias for a general population, it is perceived by females as being more equally distributed, and may therefore have the effect of being more inclusive. We thus suggest that substituting “person” for the word “user”, and (when appropriate) “designer”

for the word “researcher” can begin to address these problems of gender imbalance at the point of reception. We believe the HCI community has always been forward thinking, and an active discussion of language choice in our literature, in light of this new evidence, can lead to greater equality. As a community, we need to increase our awareness of this issue to fuel creative solutions to this problem going forward.

While our study addresses how individual words used to describe people in CHI papers are received by non-experts, we did not connect actual CHI papers and researchers to these phenomena nor do we suggest that there is malicious intent present within the HCI community in using these words. Future work will focus on whether use of these words within the community follows similar patterns to our data, and will try to investigate the other side of this issue, unintentional gender biases in research. There are methodological questions that make these next steps challenging:

*How do you choose a paper that is representative of the community as a whole?*

*How do you then choose a single paragraph?*

*With all of the varied work within the community does this phenomenon exist across the entire spectrum of work?*

These are difficult questions and we ask the community to engage in ongoing debate with regards to equality and gender issues within HCI research. In our future work, we would also like to connect language to other work in the community that is more technological, such as how large screens level the gender playing field [Carnegie, 2009].

We wish to identify what the gender norms may be within our own field. This motivation aligns with feminist HCI, assisting with revealing unspoken values within our research methods. While some authors [Bardzell and Bardzell, 2011, Buttrick et al., 2014, Light, 2011] have already brought attention to a problematic relationship between humans and technology through exploration of unconventional themes, we hope to support their illustrative work with our rich set of images and data.

Our Mechanical Turk study shows that non-gendered words used in CHIs papers to describe people are received by general readers with a gender bias. In HCI, the idea of thinking about humans is already a central tenet of our work and; we have highlighted how the terminology we use to describe people does not always reflect these design goals. We suggest that community members be aware that their work has the potential to be received in this way and that they should substitute the words “user” and “researcher”, with the words “person” and “designer” respectively when appropriate. Although this does not address the whole problem, which we think is culturally present outside of our work, it does take a positive step forward in trying to make the HCI community an inclusive one, sensitive to the needs and wants of all of our people.

## **6.8 Conclusion**

The preceding study is an example of how we can use the methods of HCI to better understand how humans interact with language and reciprocally how we can develop research questions in HCI using humanistic theories. In terms of developing tools for a technological literary criticism it is imperative that we understand how people interact with language to be able to design proper interfaces for those interactions. Admittedly, the study in this chapter is very specific, but as a

team we chose a theory that we thought was relevant to the current discourse surrounding language and demonstrated the possibilities of an interdisciplinary approach. I would classify this study as a way to access the anthropological outlined in chapter 2. By studying people in these ways we can start to confirm humanistic theories, such as the idea of false universals that we addressed in this chapter, and start to round out a theory of technological criticism.

## **Chapter 7**

# **Conclusion and Future Work: Avoiding the Big Duck**



“ Philosophers might really learn something from the literary critics, who after all have to jump into language at the deep end. What they might learn is that between telling people things (simple assertion), and playing on their emotions, there is a third possibility, namely “presenting” or “showing”. This latter has long been recognized in practice by those concerned with a serious discussion of poems and poetic prose. ”

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Andrew Harrison, *Poetic Ambiguity*

“ Perception begins with what is experienced, rather than beginning with what is expected; the model is to “see and understand” rather than “understand and see. ”

---

Paul Dourish, *Where the action is*

## 7.1 Conclusion

The digital humanities as a discipline love big ducks. I will explain. In architecture there is a balance between function and ornament in design and the big duck is used as a metaphor for when this balance has moved too far towards ornament. Venturi et al write:

When Modern architects righteously abandoned ornament on buildings, they unconsciously designed buildings that *were* ornament. In promoting Space and Articulation over symbolism and ornament, they distorted the whole building into a duck. They substituted for the innocent and inexpensive practice of applied decoration on a conventional shed the rather cynical and expensive distortion of program and structure to promote a duck. . . It is now time to reevaluate the once-horrifying statement of John Ruskin that architecture is the decoration of construction, but we should append the warning of Pugin: It is all right to decorate construction, but never construct decoration.

In the digital humanities the ornament of method has taken over for the substance of what those methods can produce. Ultimately this is a result of the learning curve of incorporating technology into existing methods. A fully realized technological criticism is not a simple endeavour. Within the two disciplines that I have chosen in this thesis to be the humanistic and scientific approaches to this problem, there are significant hurdles to overcome. The first is that the discipline of English studies and the discipline of System Design Engineering operate under two different but equally important epistemologies. At its base level the two disciplines create knowledge with different approaches: one being rhetorical, and the other being experimental and based on the evidence



Figure 7.1: A building in Las Vegas that has become total ornament

found in those experiments. In his thesis I have tried to navigate the middle ground between these two disciplines to demonstrate how both can be used to produce literary criticism. I sympathize with scholars from both camps, because the skills needed to incorporate each other's work are difficult to learn while still remaining rooted in a particular discipline. I have had to learn not only two different ways to argue, but two different approaches to knowledge, two different sets of terminologies and jargon, and technical skills that have taken the bulk of my doctoral work to begin to understand. That being said, it is possible to be trained in both disciplines for the purposes of working in this middle ground.

In chapter one I presented a framework for looking into how DH has tried to sanitize the poetic out of language and has tried to assert and not show that technology can be incorporated into literary studies. An understanding of the the instrumental and the anthropological as it relates to technology is what is needed to navigate this divide. For a truly technological criticism there needs to be not only an understanding of the differences between what the machine can do, but an understanding of how we interact, learn, and experience as humans through technology as well.

Chapter two describes the ideas of using the machine to instrumentalize literature, which is to force a false assertion, to remove its ambiguous nature. It is this removal that is problematic and is when digital projects start turning into big ducks. Technological interventions must approach the problem with the understanding that there are certain things, like ambiguity, that cannot be removed from texts that have been processed if they are to remain useful for literary criticism. In chapter one and two I have laid out a theoretical framework for how to approach the problem of a technological criticism, and how literary studies and engineering can work in concert to achieve this goal. To accomplish this there needs to be a balance between the processing power of the machine and the space and time for people to experience that power.

Chapter three is an attempt to stay within the realm of literary criticism and use statistics and computation to answer a specific research question about literature. I wanted to demonstrate how applying the instrumentality of the machine after engaging with a text or set of texts could produce useful insights. In this chapter I have tried to realign and address the order that these processes are carried out in and to stress that the work of literary criticism needs to be performed first, before we ask questions of the machine.

Chapter four is an attempt to design a system that allows for the instrumentality of the machine but does not remove the potential for the experience of language. The stacked n-dimension nature of the system allows for multiple meanings and associations to be encoded within each mapping. The ability to reconstitute the text from the visualization allows for a type of close reading of the visualization itself. It makes the original text into an embedded dimension. This allows language to be displaced, so that research questions can be pursued within a mathematical realm, but also firmly roots the outputs in the original source material.

Chapter five is a demonstration of how to allow for human interaction to define what kind of showing the language is doing and demonstrates an augmented approach to using the instrumentality of the machine to aid in the feedback loop. The main insight taken from the study is that literary critics think by doing; it is detrimental to the process to provide too much information to the user in ways that are not needed by the process.

Chapter six investigates how language is constantly displaying its own multiple meanings and how we interpret those meanings. We question the assertion of supposedly non-gendered pronouns and show that the semantic reality of these words is that they "show" very different things to different people.

In general, assertion is a scientific idea, and the showing is a cultural/literary one. Poets show, episteme asserts, and technology can be used instrumentally for assertions and anthropologically for presentations. DH and HCI are not dissimilar in their approaches to these problems, in fact HCI is held up as an exemplar for how DH works should be done (especially by me). This thesis investigated new design guidelines for dealing with language and technology that presents and does not assert or presents and then asserts based on those presentations. By incorporating these processes into our design for digital tools we can begin to approach a place where literary critics can experience texts in ways not possible without machine intervention. And, hopefully, will allow critics to produce technological criticism, and not big ducks.

## **7.2 Future Work**

While this thesis makes a contribution both to the Digital Humanities and to HCI research there are still questions that are not within the scope of this document that remain unanswered and ready for future work. While chapter 3 was a self-contained study, the application of the technique to the close reading of Eliot's text with the new knowledge gained from the technological intervention is an obvious next step. Extending the findings into close readings of Eliot's complete works could produce novel criticism in relation to Eliot's diction. The LDNA visualization mapping builds with it a space for organizing symbol systems into visual dimensions. But, the mathematics of those systems could be explored in many different ways. Part of the motivation for the type of approach presented in chapter 4 was to allow for mathematical investigations into systems of language and the LDNA mapping makes this possible. In terms of the Metatation interface, the system used preliminary tiles to demonstrate what was possible by incorporating the work flow of actual

literary critics into tool design and building a tool based on the theoretical grounding in chapter 1 and chapter 2. There is still work to be done designing tiles that leverage the instrumentality of the computer to interpret analysts annotations and produce novel suggestions as to how those interpretations can be incorporated into the display. The gendered language study that was presented in chapter 6 was a demonstration of how to approach the study and confirmation of humanistic theories in an HCI context. There are two areas that are ripe for continued research in relation to this chapter. The first is the design of studies to test other theories from the humanities. There are significant theories in English studies that could benefit from confirmation or denial and the study framework presented here can be a guide for how to approach that work. Secondly, the study we conducted was with non-experts outside of the specific context of HCI work. It was the general public's view of semantics carried within the five most used people words in HCI literature. To extend this work a study within the context of HCI with domain experts is needed to understand better whether the context of a scholarly publication negates any of the effects witnessed.

# References

- [Abdul-Rahman et al., 2013] Abdul-Rahman, A., Lein, J., Coles, K., Maguire, E., Meyer, M., Wynne, M., Johnson, C. R., Trefethen, A., and Chen, M. (2013). Rule-based visual mappings – with a case study on poetry visualization. *Computer Graphics Forum*, 32(3):381–390.
- [Alexander, 2012] Alexander, M. (2012). Patchworks and field-boundaries: visualizing the history of english. In *Digital Humanities 2012*, Hamburg Germany.
- [Arriaga et al., 2013] Arriaga, E. A., Sancho-Caparrini, F., and Suárez, J.-L. (2013). Modeling afro-latin american artistic representations in topic maps: Cuba’s prominence in latin american discourse. *Digital Humanities Quarterly*, 7.
- [Bardzell, 2010] Bardzell, S. (2010). Feminist HCI: taking stock and outlining an agenda for design. In *SIGCHI Conference on Human Factors in Computing Systems*, 1301–1310.
- [Bardzell and Bardzell, 2011] Bardzell, S. and Bardzell, J. (2011). Towards a feminist HCI methodology: social science, feminism, and HCI. In *SIGCHI Conference on Human Factors in Computing Systems*, 675–684.



- [Bardzell et al., 2011a] Bardzell, S., Churchill, E., Bardzell, J., Forlizzi, J., Grinter, and Tatar, R. (2011a). Feminism and interaction design. In *Extended Abstracts on Human Factors in Computing Systems*, 1–4. ACM Press.
- [Bardzell et al., 2011b] Bardzell, S., Gross, S., Wain, J., Toombs, A., and Bardzell, J. (2011b). The significant screwdriver: care, domestic masculinity, and interaction design. In *25th BCS Conference on Human-Computer Interaction*, 371–377.
- [Bartlett et al., 2009] Bartlett, S., Kondrak, G., and Cherry, C. (2009). On the syllabification of phonemes. In *Proceedings of Human Language Technologies*, 308–316. Association for Computational Linguistics.
- [Beckwith and Burnett, 2004] Beckwith, L. and Burnett, M. (2004). Gender: An important factor in end-user programming environments? In *IEEE Symposium on Visual Languages and Human Centric Computing*, 107–114.
- [Binder and Jennings, 2014] Binder, J. M. and Jennings, C. (2014). Visibility and meaning in topic models and 18th-century subject indexes. *Literary and Linguistic Computing*, 29(3):405–411.
- [Bingenheimer et al., 2009] Bingenheimer, M., Hung, J., and Wiles, S. (2009). Markup meets gis – visualizing the ‘biographies of eminent buddhist monks. In *Proceedings of Information Visualization IV*, 550–554, Piscataway/NJ. IEEE Computer Society.
- [Bingenheimer and Xishihu, 2006] Bingenheimer, M. and Xishihu, J. (2006). Social network visualization from tei data. *Literary and Linguistic Computing*, 26(3):271–278.

- [Black, 2015] Black, M. L. (2015). A textual history of mozilla: Using topic modeling to trace sociocultural influences on software development. *Digital Humanities Quarterly*, 9(3).
- [Boynton, 1998] Boynton, P. M. (1998). People should participate in, not be subjects of, research. *BMJ*, 317(7171):1521.
- [Brafman, 2012] Brafman, A. H. (2012). *The Language of Drawings: A New Finding in Psycho-dynamic Work*. Karnac Books, London.
- [Burke, 1945] Burke, K. (1945). *A Grammar of Motives*. Prentice Hall, New York.
- [Burnett et al., 2011] Burnett, M. M., Beckwith, L., Wiedenbeck, S., Fleming, S. D., Cao, J., Park, T. H., Grigoreanu, V., and Rector, K. (2011). Gender pluralism in problem-solving software. *International Journal of Human-Computer Interaction*, 23(5):450–460.
- [Butler, 1988] Butler, J. (1988). Performative acts and gender constitution: An essay in phenomenology and feminist theory. *Theatre Journal*, 519–531.
- [Butler, 2004] Butler, J. (2004). *Undoing Gender*. Routledge, New York.
- [Buttrick et al., 2014] Buttrick, L., Linehan, C., Kirman, B., and O’Hara, D. (2014). Fifty shades of chi: the perverse and humiliating human-computer relationship. In *Fifty shades of CHI: the perverse and humiliating human-computer relationship*, 825–834.
- [Buxton and Sniderman, 1980] Buxton, W. and Sniderman, R. (1980). Iteration in the design of the human-computer interface.
- [Carnegie, 2009] Carnegie, T. A. M. (2009). Interface as exordium: The rhetoric of interactivity. *Computational Composition*, 26(3):164–173.

- [Cecire, 2015] Cecire, N. (2015). Ways of not reading gertrude stein. *ELH*, 82(1):281–312.
- [Chalmers, 1999] Chalmers, I. (1999). People are ‘participants’ in research. further suggestions for other terms to describe ‘participants’ are needed. *BMJ*, 318(7191):1141.
- [Chambers, 1983] Chambers, D. W. (1983). Stereotypic images of the scientist: The draw-a-scientist test. *Science Education*, 67(2):255–265.
- [Chaturvedi et al., 2012] Chaturvedi, M., Gannod, G., Mandell, L., Armstrong, H., and Hodgson, E. (2012). Myopia: A visualization tool in support of close reading. *Digital Humanities*, 2.
- [Chen, 2006] Chen, C. (2006). Citespace ii: Detecting and visualizing emerging trends and transient patterns in scientific literature. *JIS&T* 57, 359–377.
- [Chiu and Wilcox, 1998] Chiu, P. and Wilcox, L. (1998). A dynamic grouping technique for ink and audio notes. In *User Interface Software and Technology Symposium*, 195–202. ACM.
- [Clement et al., 2012] Clement, T., Auvil, L., Tcheng, D., Capitanu, B., Monroe, M., and Goel, A. (2012). Sounding for meaning: Analyzing aural patterns across large digital collections. *Digital Humanities*, 2.
- [Clement, 2008] Clement, T. E. (2008). A thing not beginning and not ending: Using digital tools to distant-read gertrude stein’s the making of americans. *Literary and Linguistic Computing*, 23(3):361–381.
- [Cohn, 1987] Cohn, C. (1987). Sex and death in the rational world of defense intellectuals. *Signs*, 687–718.

- [Coleman, 2011] Coleman, B. (2011). *Hello avatar: rise of the networked generation*. MIT Press, Cambridge, Mass.
- [Coleridge and Wordsworth, 2008] Coleridge, S. T. and Wordsworth, W. (2008). *Lyrical Ballads 1798 and 1800*. Broadview, New York.
- [Collins et al., 2009a] Collins, C., Carpendale, S., , and Penn., G. (2009a). Docuburst: Visualizing document content using language structure. *Computer Graphics Forum*, 28(3).
- [Collins et al., 2009b] Collins, C., Viegas, F., and Wattenberg., M. (2009b). Parallel tag clouds to explore and analyze faceted text corpora. In *Visual Analytics Science and Technology*. IEEE.
- [Czerwinski et al., 2002] Czerwinski, M., Tan, D. S., and Robertson, G. G. (2002). Women take a wider view. In *Proceedings of the SIGCHI Conference on Human factors in Computing Systems*, 195–202.
- [Dalton, 2013] Dalton, N. S. (2013). Neurodiversity & HCI. In *Extended Abstracts on Human Factors in Computing Systems*, 2295–2304.
- [Dalvean, 2013] Dalvean, M. (2013). Ranking contemporary american poems. *Digital Scholarship in the Humanities Apr 2015*, 30(1):6–19.
- [DeCamp et al., 2005] DeCamp, P., Frid-Jimenez, A., Guinness, J., and Roy, D. (2005). Gist icons: Seeing meaning in large bodies of literature. In *Proceedings of IEEE Symposium on Information Visualization*.
- [Dictionary, 2006] Dictionary, M.-W. (2006). *The Merriam-Webster Dictionary*. Merriam-Webster, Incorporated.

- [Dillon and Watson, 1996] Dillon, A. and Watson, C. (1996). User analysis in HCI—the historical lessons from individual differences research. *International Journal of Human Computer Interaction*, 45(6):619–637.
- [Dourish, 2011] Dourish, P. (2011). *Divining a digital future: mess and mythology in ubiquitous computing*. MIT Press, Cambridge, Mass.
- [Dray et al., 2013] Dray, S. M., Peters, A. N., Brock, A. M., Peer, A., A. Druin, S. Gitau, J. K., and Murray, D. (2013). Leveraging the progress of women in the HCI field to address the diversity chasm. In *Extended Abstracts on Human Factors in Computing Systems*, 2399–2406, New York.
- [Eliot, 1933] Eliot, T. S. (1933). *The Use of Poetry and the Use of Criticism: Studies in the Relation of Criticism to Poetry in England*. Faber, London.
- [Eliot, 2014a] Eliot, T. S. (2014a). *The Complete Prose of T.S. Eliot: The Critical Edition, vol. 1*. Johns Hopkins UP, Baltimore.
- [Eliot, 2014b] Eliot, T. S. (2014b). *The Complete Prose of T.S. Eliot: The Critical Edition, vol. 2*. Johns Hopkins University Press, Baltimore.
- [Ellul, 1964] Ellul, J. (1964). *The Technological Society*. Random House, New York. Translation: John Wilkinson.
- [Fekete and Dufournaud, 2000] Fekete, J.-D. and Dufournaud, N. (2000). Compus: Visualization and analysis of structured documents for understanding social life in the 16th century. In *Proceedings ACM Conference on Digital Libraries*, pages 47–55.

- [Ferguson et al., 2005] Ferguson, M., Salter, M. J., and Stallworthy, J. (2005). *The Norton Anthology of Poetry*. WW Norton & Company.
- [Fish, 2012] Fish, S. (2012). Mind your p's and b's: The digital humanities and interpretation. nytimes.com. [Online; posted 27-August-2012].
- [Fisher and Margolis, 2002] Fisher, A. and Margolis, J. (2002). *Unlocking the Clubhouse: Women in Computing*. MIT Press, Cambridge, Mass.
- [Forte et al., 2012] Forte, A., Antin, J., Bardzell, S., Honeywell, L., Riedl, J., and Stierch, S. (2012). Some of all human knowledge: Gender and participation in peer production. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work Companion*, pages 33–36, New York.
- [Frye, 1949] Frye, N. (1949). The function of criticism at the present time. *University of Toronto Quarterly*, 19(1):11–16.
- [Frye, 1970] Frye, N. (1970). *The Stubborn Structure: Essays on Criticism and Society*. Cornell University Press, Ithaca, NY.
- [Frye, 2000] Frye, N. (2000). *Anatomy of Criticism*. Princeton UP, Princeton, NJ.
- [Gardner et al., 2010] Gardner, M. J., Lutes, J., Lund, J., Hansen, J., Walker, D., Ringger, E., , and Seppi, K. (2010). The topic browser: An interactive tool for browsing topic models. In *NIPS (Workshop on Challenges of Data Vis)*.
- [Glaser, 1992] Glaser, B. G. (1992). *Emergence vs. Forcing: Basics of Grounded Theory Analysis*. Sociology Press, Mill Valley, CA.

- [Glaser and Strauss, 1967] Glaser, B. G. and Strauss, A. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine Publishing Co, Chicago.
- [Gould, 2003] Gould, R. V. (2003). Uses of network tools in comparative historical research. In Mahoney, J. and Rueschemeyer, D., editors, *Comparative Historical Analysis in the Social Sciences.*, pages 241–269. Cambridge UP, Cambridge.
- [Graves, 1967] Graves, R. (1967). *Poetic Craft and Principle*. Littlehampton Book Services Ltd, Faraday Close.
- [Gretarsson et al., 2011] Gretarsson, B., O’Donovan, J., Bostandjiev, S., Llerer, T. H., Asuncion, A., Newman, D., and Smyth, P. (2011). Topicnets: Visual analysis of large text corpora with topic modeling. *Transactions on Intelligent System and Technology*, 3(2).
- [Gruber, 2009] Gruber, T. (2009). The encyclopedia of database systems. In Liu, L. and Özsu, M. T., editors, *The Encyclopedia of Database Systems*. Springer, New York.
- [Grudin and Pruitt, 2002] Grudin, J. and Pruitt, J. (2002). Personas, participatory design and product development: An infrastructure for engagement. In *PDC*, pages 144–152, Malmo, Sweden.
- [Hall et al., 2008] Hall, D., Jurafsky, D., and Manning, C. D. (2008). Studying the history of ideas using topic models. In *EMNLP*, pages 363–371.
- [Harpham, 2013] Harpham, G. G. (2013). Finding ourselves: The humanities as a discipline. *American Literary History*, 25(3):509–534.
- [Harrison, 1963] Harrison, A. (1963). Poetic ambiguity. *Analysis*, 23(3):54–57.

- [Hearst, 1995] Hearst, M. A. (1995). Tilebars: visualization of term distribution information in full text information access. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM Press/Addison-Wesley Publishing Co.
- [Heidegger, 1982] Heidegger, M. (1982). *The Question Concerning Technology, and Other Essays*. Harper Collins, New York. Translation: William Lovitt.
- [Heller, 2015] Heller, M. (2015). <http://www.itsokaytobesmart.com/post/26993944713/word-colliderparticiple-physics> [Accessed April 19 2015].
- [Hemphill et al., 2014] Hemphill, L., Erickson, I., Ribes, D., and Mergel, I. (2014). Feminism and social media research. *Conference on Human Factors in Computing Systems*, pages 319–322.
- [Hetzler et al., 1998] Hetzler, B., Whitney, P., Martucci, L., and Thomas, J. (1998). Multi-aceted insight through interoperable visual information analysis paradigms. In *Proceedings of IEEE Symposium on Information Visualization*.
- [Hope and Witmore, 2010] Hope, J. and Witmore, M. (2010). The hundredth psalm to the tune of "green sleeves": Digital approaches to shakespeare's language of genre. *Shakespeare Quarterly*, 61(3):357–390.
- [Jänicke et al., 2015] Jänicke, S., Franzini, G., Cheema, M. F., and Scheuermann, G. (2015). On close and distant reading in digital humanities: A survey and future challenges. *Eurographics*.
- [Jessop, 2006] Jessop, M. (2006). Dynamic maps in humanities computing. *Human IT*, 8(3):68–82.



- [Jessop, 2008] Jessop, M. (2008). The inhibition of geographical information in digital humanities scholarship. *Literary and Linguistic Computing*, 23(1):39–50.
- [Jockers, 2013] Jockers, M. L. (2013). *Macroanalysis: Digital Methods and Literary History*. University of Illinois Press, Chicago.
- [Jones, 2012] Jones, S. (2012). When computers read: Literary analysis and digital technology. *Bulletin of the American Society for Information Science and Technology*, 38(4):27–30.
- [Kannabiran et al., 2012] Kannabiran, G., Bardzell, S., and Bardzell, J. (2012). Designing (for) desire: a critical study of technosexuality in HCI. In *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design*, 655–664.
- [Kara et al., 2008] Kara, L. B., Gennari, L., and Stahovich, T. F. (2008). A sketch-based tool for analyzing vibratory mechanical systems. *Journal of Mechanical Design*, 130(10):101.
- [Kirsh, 2014] Kirsh, A. (2014). Technology is taking over english departments: The false promise of the digital humanities. <http://www.newrepublic.com/article/117428/limits-digital-humanities-adam-kirsch>.
- [Lee et al., 2010] Lee, B., Riche, N. H., Karlson, A. K., and Carpendale, S. (2010). Sparkclouds: Visualizing trends in tag clouds. In *IEEE Transactions on Visualization and Computer Graphics*, 1182–1189.
- [Liao et al., 2008] Liao, C., Guimbretière, F., Hinckley, K., and Hollan, J. (2008). Papiercraft: A gesture-based command system for interactive paper. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 14(4):18.

- [Light, 2011] Light, A. (2011). HCI as heterodoxy: Technologies of identity and the queering of interaction with computers. *International Journal of Human–Computer Interaction*, 23(5):430–438.
- [Lin, 1992] Lin, X. (1992). Visualization for the document space. *In Vis*, 274–281.
- [Livingston, 1991] Livingston, P. (1991). *Literature and Rationality: Ideas of Agency in Theory and Fiction*. Cambridge UP, Cambridge.
- [Mackay et al., 2002] Mackay, W. E., Pothier, G., Letondal, C., Bøegh, K., and Sørensen, H. E. (2002). The missing link: Augmenting biology laboratory notebooks. *In User Interface Software and Technology Symposium*, 41–50.
- [Marcuse, 1998] Marcuse, H. (1998). *Technology, War and Fascism: Collected Papers of Herbert Marcuse Volume 1*, 49. Routledge, New York.
- [Margolis and Fisher, 2002] Margolis, J. and Fisher, A. (2002). *Unlocking the clubhouse: women in computing*. MIT Press, Cambridge, Mass.
- [Marsh, 1912] Marsh, E., editor (1912). *Georgian Poetry 1911 – 12*. Poetry Bookshop, London.
- [Marshall, 1997] Marshall, C. C. (1997). Annotation: From paper books to the digital library. *In Proc. of the ACM/IEEE Joint Conference on Digital Libraries*, 131–140.
- [Marshall and Brush, 2004] Marshall, C. C. and Brush, B. A. J. (2004). Exploring the relationship between personal and public annotations. *In JCDL*, 349–357.

- [Marshall et al., 2001] Marshall, C. C., Price, M. N., Golovchinsky, G., and Schilit, B. N. (2001). Designing e-books for legal research. In *Proc. of the ACM/IEEE Joint Conference on Digital Libraries*, 41–48.
- [McCarty, 2002] McCarty, W. (2002). Humanities computing : essential problems, experimental practice. *Literary and Linguistic Computing*, 17(1):103–125.
- [McCurdy et al., 2015] McCurdy, N., Lein, J., Coles, K., and Meyer, M. (2015). Poemage: Visualizing the sonic topology of a poem. *IEEE Trans. on Visualization and Computer Graphics*, 21(12).
- [McMaster, 2012] McMaster, S. (2012). New approaches to image-based research and visual literacy: A pilot project report. *New Horizons in Visual Literacy Selected Readings of the International Visual Literacy Association*, 122–132.
- [Mitcham and Mackey, 1983] Mitcham, C. and Mackey, R. (1983). *Philosophy and Technology*. MacMillan, New York.
- [Monroe, 1920] Monroe, H. (1920). King george’s poets. *Poetry*, 16, 108–109.
- [Moretti, 2005] Moretti, F. (2005). *Graphs, Maps, Trees: Abstract Models for a Literary History*. Verso.
- [Moretti, 2013] Moretti, F. (2013). *Distant Reading*. Verso.
- [Morris et al., 2007] Morris, M. R., Brush, A. J. B., and Meyers, B. R. (2007). Reading revisited: Evaluating the usability of digital display surfaces for active reading tasks. In *Proceedings of*

- the IEEE Workshop on Horizontal Interactive Human-Computer Systems (TABLETOP)*, 79–86.
- [Muller, 2011] Muller, M. (2011). Feminism asks the ‘who’ questions in HCI. *International Journal of Human–Computer Interaction*, 23(5):447–449.
- [Muralidharan et al., 2013] Muralidharan, A., Hearst, M. A., and Fan, C. (2013). Wordseer: A knowledge synthesis environment for textual data. In *Proceedings of the ACM Conference on Information & Knowledge Management (CIKM)*, 2533–2536.
- [Newbolt, 1932] Newbolt, S. H. (1932). *My World as in My Time*. Faber and Faber, London.
- [Nielsen, 1993] Nielsen, J. (1993). Iterative user-interface design. *Computer*, 26(11).
- [Norman, 1994] Norman, D. A. (1994). *Things That Make Us Smart: Defending Human Attributes In The Age Of The Machine*. Basic Books.
- [Norman, 1999] Norman, D. A. (1999). Affordance, conventions, and design. *interactions*, 6(3):38–43.
- [Norrie et al., 2006] Norrie, M. C., Signer, B., and Weibel, N. (2006). Print-n-link: Weaving the paper web. In *Proceedings of the ACM Symposium on Document Engineering*, 34–43.
- [O’Hara and Sellen, 1997] O’Hara, K. and Sellen, A. (1997). A comparison of reading paper and on-line documents. In *Conference on Human Factors in Computing Systems*, 335–342. ACM.
- [Olson, 1950] Olson, E. (1950). William empson, contemporary criticism and poetic diction. *Modern Philology*, 47(4):222–252.

- [Ovsiannikov et al., 1999] Ovsiannikov, I. A., Arbib, M. A., and McNeill, T. H. (1999). Annotation technology. *International Journal of Human-Computer Studies*, 50(4):329–362.
- [Padilla et al., 2014] Padilla, S., Methven, T. S., Corne, D. W., , and Chantler, M. J. (2014). Hot topics in chi: trend maps for visualising research. *Extended Abstracts on Human Factors in Computing Systems*, pages 815–824.
- [Paley, 2002] Paley, W. B. (2002). Textarc: Showing word frequency and distribution in text. *IEEE Symposium on Information Visualization*. <http://www.textarc.org/>.
- [Paulson et al., 2008] Paulson, B., Rajan, P., Davalos, P., Gutierrez-Osuna, R., and Hammond, T. (2008). What!?! no rubine features?: using geometric-based features to produce normalized confidence values for sketch recognition. In *HCC Workshop: Sketch Tools for Diagramming*, pages 57–63.
- [Perloff and Dworkin, 2009] Perloff, M. and Dworkin, C., editors (2009). *The Sound of Poetry / The Poetry of Sound*. University of Chicago Press, Chicago.
- [Posavec, 2015] Posavec, S. (2015). <http://www.stefanieposavec.co.uk/-everything-in-between/#/writing-without-words/> [Accessed April 19 2015].
- [Potter, 1988] Potter, R. G. (1988). Literary criticism and literary computing: The difficulties of a synthesis. *Computers and the Humanities*, 22(2):91–97.
- [Pound, 1913] Pound, E. (1913). A few don'ts by an imagiste. *Poetry*, 1(6):200–206.
- [Preece et al., 2015] Preece, J., Sharp, H., and Rogers, Y. (2015). *Interaction Design: Beyond Human-Computer Interaction*. John Wiley & Sons.

- [Quinn, 1996] Quinn, P. J. (1996). *Reader's Guide to Literature in English*. Fitzroy Dearborn Publishers, London.
- [Ramsay, 2011] Ramsay, S. (2011). *Reading Machines: Towards an Algorithmic Criticism*. University of Illinois Press, Chicago.
- [Richardson, 1997] Richardson, B. (1997). *Unlikely Stories: Causality and the Nature of Modern Narrative*. University of Delaware Press, Newark.
- [Rockwell, 2003] Rockwell, G. (2003). What is text analysis, really? *Literary and Linguistic Computing*, 18(2):209–219.
- [Rockwell, 2015a] Rockwell, G. (2015a). portal.tapor.ca [Accessed April 19 2015].
- [Rockwell, 2015b] Rockwell, S. S. . G. (2015b). <http://voyant-tools.org/> [Accessed April 19 2015].
- [Ross, 2015] Ross, S. (2015). Cfp reading modernism with machines. <https://www.hastac.org/opportunities/cfp-reading-modernism-machines>. Accessed: 2016-06-28.
- [Schilit et al., 1998] Schilit, B. N., Golovchinsky, G., and Price, M. N. (1998). Beyond paper: Supporting active reading with free form digital ink annotations. In *Conference on Human Factors in Computing Systems*, 249–256.
- [Schmettow et al., 2013] Schmettow, M., Noordzij, M. L., and Mundt, M. (2013). An implicit test of ux: individuals differ in what they associate with computers. In *Extended Abstracts on Human Factors in Computing Systems*, 2039–2048.

- [Shipman et al., 2003] Shipman, F., Price, M., Marshall, C. C., and Golovchinsky, G. (2003). Identifying useful passages in documents based on annotation patterns. In *Research and Advanced Technology for Digital Libraries*, 101–112. Springer.
- [Siemens, 2002] Siemens, R. G. (2002). A new computer-assisted literary criticism? *Computers and the Humanities*, 36(3):259–267.
- [Signer and Norrie, 2007] Signer, B. and Norrie, M. C. (2007). Paperpoint: A paper-based presentation and interactive paper prototyping tool. In *Proceedings of the ACM Conference on Tangible and Embedded Interaction (TEI)*, 57–64.
- [Signer and Norrie, 2010] Signer, B. and Norrie, M. C. (2010). Interactive paper: Past, present and future. In *Proceedings of the International Workshop on Paper Computing (PaperComp)*.
- [Simon, 1988] Simon, H. A. (1988). The science of design: creating the artificial. *Design Issues*, pages 67–82.
- [Smalheiser et al., 2009] Smalheiser, N. R., Torvik, V. I., and Zhou, W. (2009). Arrowsmith two-node search interface: a tutorial on finding meaningful links between two disparate sets of articles in medline. *Computer M&P in Biomedicine* 94, 2., 190–197.
- [Small, 2013] Small, H. (2013). *The Value of the Humanities*. Oxford UP, Oxford UK.
- [Snow, 2001] Snow, C. (2001). *The Two Cultures*. Cambridge UP, Cambridge.
- [Song et al., 2010] Song, H., Guimbretière, F., Grossman, T., and Fitzmaurice, G. (2010). Mouse-light: Bimanual interactions on digital paper using a pen and a spatially-aware mobile projector.

- In *Proc. of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI)*, 2451–2460.
- [Sontag, 2001] Sontag, S. (2001). *On photography*. Farrar, Straus and Giroux, New York.
- [Stead, 1979] Stead, C. (1979). *The New Poetics*. AMS Press Inc., New York.
- [Steimle et al., 2009] Steimle, J., Brdiczka, O., and Mühlhäuser, M. (2009). Coscribe: Integrating paper and digital documents for collaborative knowledge work. *IEEE Trans. on Learning Technologies*, 2(3):174–188.
- [Stifelman et al., 2001] Stifelman, L., Arons, B., and Schmandt, C. (2001). The audio notebook: Paper and pen interaction with structured speech. In *Proc. of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI)*, 182–189.
- [Strauss and Corbin, 1990] Strauss, A. and Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications, Newbury Park, CA.
- [Symon, 1969] Symon, M. (1969). The georgian poetic. *The Bulletin of the Midwest Modern Language Association*, Vol. 2, 121.
- [Tsandilas et al., 2009] Tsandilas, T., Letondal, C., and Mackay, W. E. (2009). Mus ink: Composing music through augmented drawing. In *Proc. of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI)*, 819–828.
- [Türkcan, 2013] Türkcan, B. (2013). Semiotic approach to the analysis of children’s drawings. *Advances in Health Sciences Education: Theory and Practice*, 13(1):600–607.



- [Utterback, 2015] Utterback, C. (2015). <http://camilleutterback.com/projects/text-rain/>[Accessed April 19 2015].
- [van Ham et al., 2009] van Ham, F., Wattenberg, M., and Viegas, F. (2009). Mapping text with phrase nets. In *InfoVis*, 1169–1176.
- [Vasilescu et al., 2014] Vasilescu, B., Capiluppi, A., and Serebrenik, A. (2014). Gender, representation and online participation: A quantitative study. *International Journal of Human–Computer Interaction*, 26(5):488–511.
- [Viegas and Wattenberg, 2008] Viegas, F. and Wattenberg, M. (2008). Tag clouds and the case for vernacular visualization interactions. *TIMELINES 15*, 49–52.
- [Viegas et al., 2009] Viegas, F. B., Wattenberg, M., and Feinberg, J. (2009). Participatory visualization with wordle. In *IEEE Transactions on Visualization and Computer Graphics*, pages 1137–1144.
- [Wajcman, 1991] Wajcman, J. (1991). *Feminism confronts technology*. Pennsylvania State University Press, University Park, Pa.
- [Wattenberg and Viegas, 2008] Wattenberg, M. and Viegas, F. B. (2008). The word tree, an interactive visual concordance. *IEEE Transactions on Visualization and Computer Graphics*, 14.6, 1221–1228.
- [Wear, 1999] Wear, D. N. (1999). Challenges to interdisciplinary research. *Ecosystems*, 2(4):299–301.

- [Wellner, 1993] Wellner, P. (1993). Interacting with paper on the digitaldesk. *Communications of the ACM*, 36(7):87–96.
- [Winograd, 1986] Winograd, T. (1986). *Understanding computers and cognition: a new foundation for design*. Ablex Pub. Corp, Norwood, N.J.
- [Wise et al., 1995] Wise, J., Thomas, J. J., Pennock, K., David Lantrip, M. P., Schur, A., and Crow, V. (1995). Visualizing the non visual: spatial analysis and interaction with information from text documents. In *InfoVis*, 51–58.
- [Witmore, 2016] Witmore, M. (2016). *The Oxford Handbook of Shakespearean Tragedy*, chapter Digital approaches to Shakespeare and Drama. Oxford UP, Oxford. with Johnathon Hope and Michael Gleicher.
- [Wolfe, 2002] Wolfe, J. (2002). Annotation technologies: A software and research review. *Computers and Composition*, 19(4):471–497.
- [Wood, 1992] Wood, D. (1992). *The Power of Maps*. Guilford Press, New York.
- [Wright, 2014] Wright, S. (2014). I mean, the queen’s fierce and the king’s not: Gendered embodiment in children’s drawings. *International Journal of Early Childhood Education*, 46(3):391–406.
- [Yatani et al., 2011] Yatani, K., Novati, M., Trusty, A., and Truong, K. N. (2011). Review spotlight: a user interface for summarizing user-generated reviews using adjective- noun word pairs. In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems*, 1541–1550.

[Yeh et al., 2006] Yeh, R., Liao, C., Klemmer, S., Guimbretière, F., Lee, B., Kakaradov, B., Stamberger, J., and Paepcke, A. (2006). Butterflynet: A mobile capture and access system for field biology research. In *Conference on Human Factors in Computing Systems*, 571–580.

# Appendix A

## Metation Technical Details

### A.1 Preprocessing

An initial calibration of the Anoto pen with respect to the display device being used is essential to ensure reception of accurate position information from the pen by the system. Extents of the Anoto dot patterns used by the system are manually recorded and stored to facilitate a mapping of the raw pen points captured by the pen to locations on a composite of a poem and the dot pattern. Raw text file of a poem to be analysed using the system should be formatted such that the poem title and name of the poet is followed by the content of the poem stanzas with each of the stanzas separated by a new line. An input poem file specified by the user is processed by the system and the poem content is rendered over the Anoto dot pattern image file to generate a printable composite of the dot pattern and the poem, as shown in Figure A.2.

The system also stores the following information in a JSON file for quick access by the query

framework, as shown in Figures A.1 and A.2:

- the relative position of a word in the poem (stanza, line and word index)
- extents of the word's bounding box printed on the physical sheet of paper
- the part-of-speech (POS) tag assigned to the word by the POS tagger from the Stanford NLP Toolkit
- word pronunciations from the syllabified CMU phoneme dictionary [Bartlett et al., 2009]
- synonyms and antonyms from Merriam-Webster Thesaurus [Dictionary, 2006]
- WordNet and word etymology, senses, definitions, usage history and usage examples from Merriam-Webster Dictionary [Dictionary, 2006]

The system also stores information about the relative position of a word in the poem (stanza, line and word index), extents of the word's bounding box printed on the physical sheet of paper, the part-of-speech (POS) tag assigned to the word by the POS tagger from the Stanford NLP Toolkit, word pronunciations from the syllabified CMU phoneme dictionary [Bartlett et al., 2009], synonyms and antonyms from Merriam-Webster Thesaurus [Dictionary, 2006] and WordNet and word etymology, senses, definitions, usage history and usage examples from Merriam-Webster Dictionary [Dictionary, 2006] into a jsonfile for quick access by the query framework, as shown in Figures A.1 and A.2.

### **A.1.1 Stroke Clustering and Shape Recognition**

As a reader writes on physical paper augmented with the Anoto dot pattern, the Anoto pen generates TUIO events that are received by the desktop client. We group pen points between consecutive pen down and pen up events as pen strokes. These pen strokes are then clustered using

hierarchical agglomerative clustering as presented by Chiu and Wilcox [Chiu and Wilcox, 1998]. We empirically observed that the single-linkage criterion outperformed both complete-linkage and mean-linkage criteria in terms of clustering accuracy when tested using participant data gathered during the observation study. Thus, we defined the linkage criterion that determines the distance between clusters as the minimum of the pairwise distances between the pen strokes in the clusters. The distance between two pen strokes is defined as a weighted function of the spatial and temporal distance between them. The temporal distance between two pen strokes  $s_1$  and  $s_2$ , is defined as,

$$time = \begin{cases} 1 & , \text{ if } t_{start}(s_2) - t_{end}(s_1) > 60\text{s} \\ \frac{t_{start}(s_2) - t_{end}(s_1)}{60} & , \text{ else} \end{cases}$$

where  $t_{start}(s_2)$  is the start time of a pen stroke and  $t_{end}(s_1)$  is the end time of another pen stroke, assuming that  $s_1$  precedes  $s_2$ . The time metric has an empirically determined upper bound of 60 seconds to facilitate its normalization across all pen stroke pairs.

The spatial distance,  $space$ , between two pen strokes is defined as the minimum distance between the two bounding boxes for  $s_1$  and  $s_2$ . The  $x$  and  $y$  values of bounding box locations are normalized by the extents of the dot pattern printed on the paper prior to their use in the spatial distance calculation. The spatiotemporal distance between two pen strokes is then given by,

$$d = \sqrt{space^2 + time^2}$$

On every iteration, the distance between clusters increases. The clustering process stops at an

iteration  $i$  for which the ratio  $r_{i+1} < r_i$  where  $r$  is given by,

$$r = \frac{(d_{i+1} - d_i)^2}{d_i - d_{i-1}}$$

as proposed by Kara et al. [Kara et al., 2008].

Prior to stroke type recognition, pen strokes for which more than 50% of the area of their bounding box falls under the margin space are eliminated from further processing since we decided to focus solely on CO annotations [T3] (5.5.3). The shape recognizer of our prototype system has been designed to support categorisation of pen strokes into a small set of predetermined geometric primitives, namely, ellipse, underline and connectors, as these forms were the most common and frequent amongst our participants' CO annotations. The recognizer estimates the fit of the pen points of a pen stroke to an ideal version of the predetermined geometric primitives through geometric tests and formulas. We recognize ellipses by comparing them to an expected shape and pattern, underlines by testing whether the stroke is primarily horizontal and fits between lines of the poem, and connectors by testing whether the stroke follows an arc pattern.

Following pen stroke clustering and shape recognition, words annotated by each of the pen strokes are extracted. Words annotated by pen strokes having a common form (ellipse or underline) in the same cluster are then grouped together as a single query to be issued to the query framework. Similarly, words annotated by pen strokes explicitly connected through the use of a connector are sent to the query framework as a single unit.

## A.2 Architecture diagrams

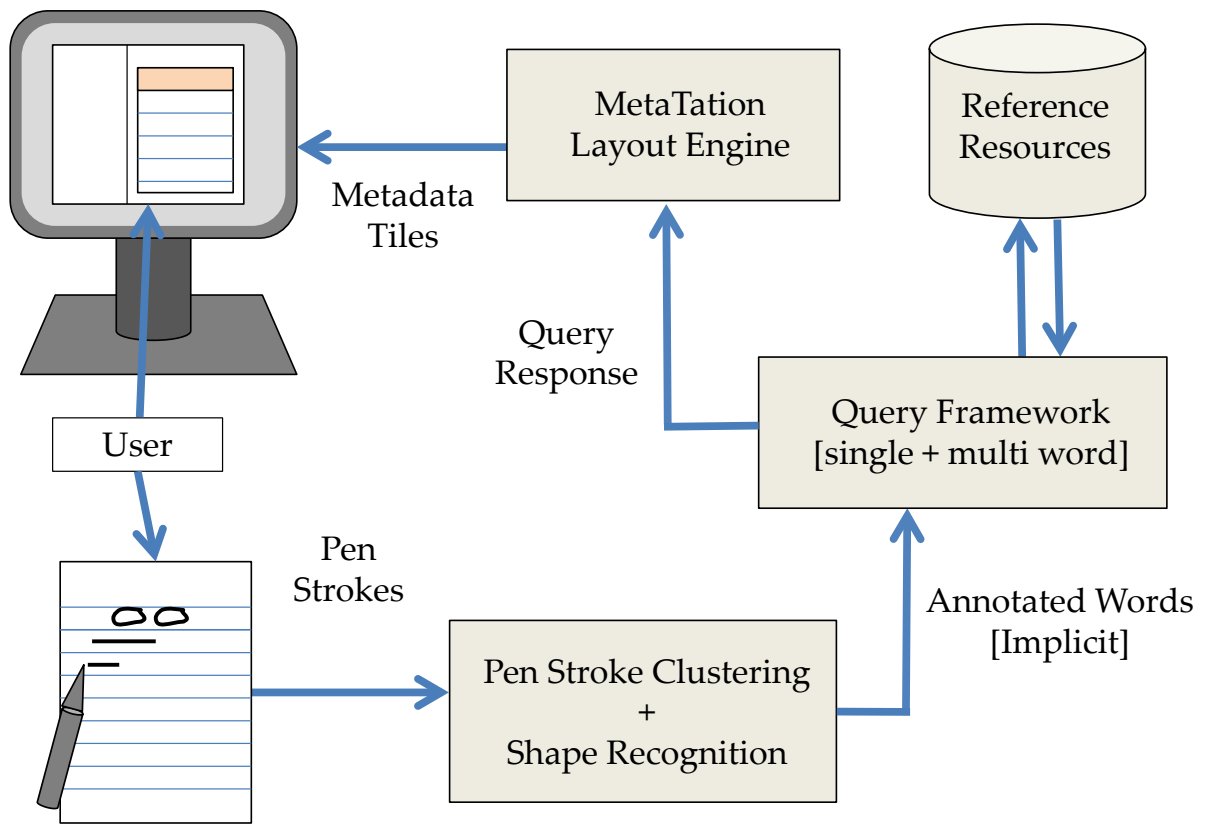


Figure A.1: MetaTation system architecture.



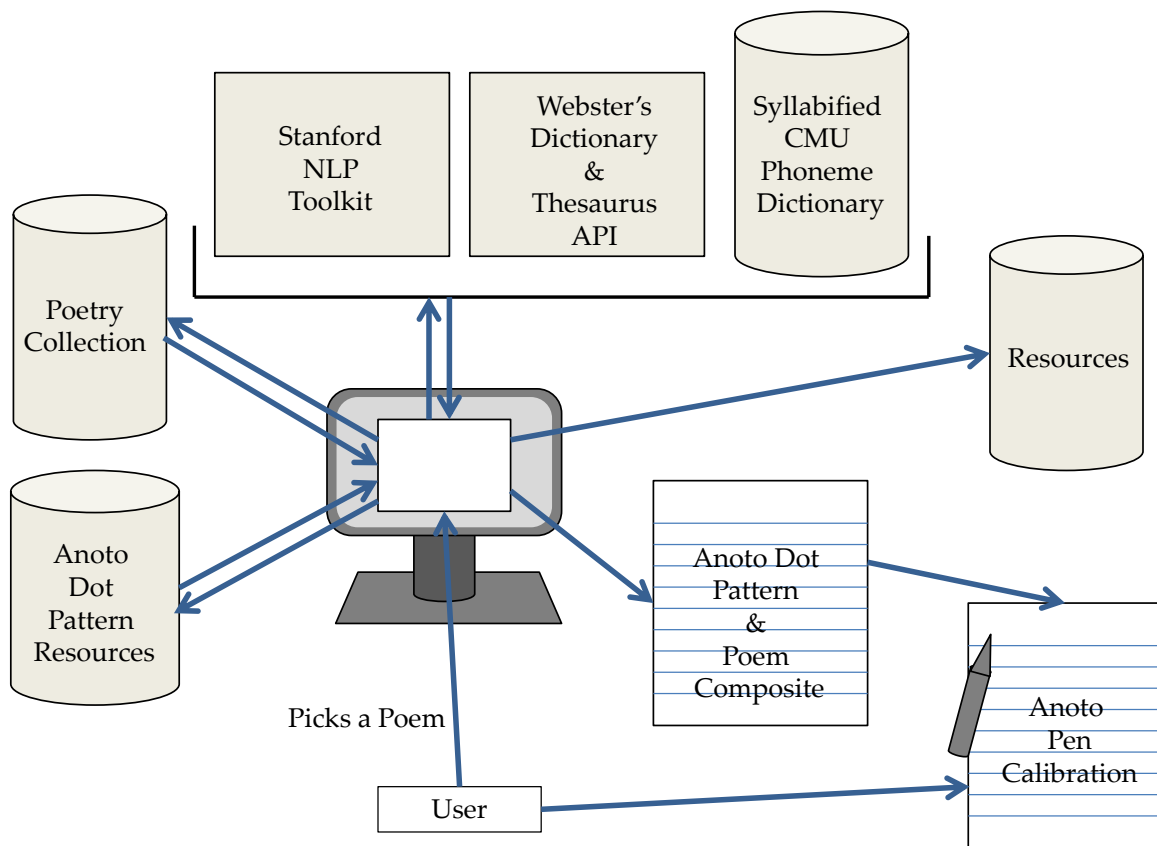


Figure A.2: MetaTation preprocessing pipeline.

# **Appendix B**

## **Code Repository Details**

The code for each individual project in this thesis can be found in this repository:

<https://github.com/pony-boy/AdamBradleyThesis>

# **Appendix C**

## **Ethics Forms**

What follows is the ethics materials used in each of the different projects in this thesis.

Dr. Mark Hancock – Gendered User Study  
Questions for Questionnaire

1. What is your age?
2. What is your Gender? M\_\_\_, F\_\_\_ , Other \_\_\_\_\_
3. Did you draw a human?
4. If you answered yes to number 4, what gender was your drawing?
5. Were there any objects in your drawing?
6. If you answered yes to number 5, what objects did you draw?
7. What country were you born in?
8. In what country do you currently reside?

## **The Gendered User**

Dr. Mark Hancock, Cayley MacArthur, Adam Bradley  
Management Sciences Department, University of Waterloo, Canada

### **Task Completed**

Thank you for participating in this ongoing study. If you are interested in reviewing the results of this research, please email me (adam.bradley@uwaterloo.ca), and I will be sure to contact you when the study has been completed.

The purpose of this study is to learn how people gender certain words.

Once again, I remind you the data collected as part of this study, with the exception of your Mechanical Turk User ID (MTurk ID), will be made publicly available.

If you have concerns about this study, you may also contact the Director of the Office of Research Ethics at the University of Waterloo at (519) 888-4567 ext. 36005. This project was reviewed by, and received clearance through a University of Waterloo Research Ethics Committee.

Sincerely,

Cayley MacArthur and Adam Bradley

If you have any comments regarding this HIT, or found the instructions hard to understand, we would love to hear from you. Please enter such details in the box below. We will use your feedback to improve this, and other HITs, in the future.

Back

Finish

## Information Letter and Electronic Consent Form

Dr. Mark Hancock, Dr. Sheelagh Carpendale, Adam Bradley, Cayley MacArthur

You are invited to participate in a research study conducted by Cayley MacArthur and Adam Bradley, under the supervision of Dr. Mark Hancock, Management Sciences Department of the University of Waterloo, Canada. The objectives of the research study are to better understand people's conceptions of "Users". The study is part of a Master's thesis and ongoing graduate work.

If you decide to volunteer, you will be asked to draw a picture and then fill out a short online survey that is completed anonymously. Survey questions focus on the picture that you have drawn and some demographic information. Participation in this study is voluntary. You may decline to answer any questions that you do not wish to answer and you can withdraw your participation at any time by not submitting your responses. There are no known or anticipated risks from participating in this study.

This survey uses a UWaterloo system saved on Canadian servers. It is important for you to know that any information that you provide will be confidential. All of the data will be summarized and no individual could be identified from these summarized results. Furthermore, the web site is programmed to collect responses alone and will not collect any information that could potentially identify you (such as machine identifiers).

You may decline to answer any questions that you do not wish to answer and you can withdraw your participation at any time by ceasing to answer questions, without penalty or loss of remuneration. To receive remuneration please proceed to the end of the questionnaire, obtain the unique code for this HIT, and submit it.

This HIT is expected to take on average 20 mins and you will be paid \$0.15.

The data, with no personal identifiers, collected from this study will be maintained on a password-protected computer database in a restricted access area of the university. As well, the data will be electronically archived after completion of the study and maintained for two years and then erased.

Should you have any questions about the study, please contact either Cayley MacArthur (csimacar@uwaterloo.ca) or Mark Hancock (mark.hancock@uwaterloo.ca). Further, if you would like to receive a copy of the results of this study, please contact either investigator.

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please feel

free to contact Dr. Maureen Nummelin in the Office of Research Ethics at 1-519-888-4567, Ext. 36005 or [maureen.nummelin@uwaterloo.ca](mailto:maureen.nummelin@uwaterloo.ca).

Thank you for considering participation in this study.

### **Consent to Participant**

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

- I agree to participate
- I do not wish to participate (please close your web browser now).

**Next**



---

**Name of Researcher, Faculty, Department, Telephone & Email:**

Dr. Sheelagh Carpendale, Professor - Department of Computer Science, University of Calgary  
403-220-6055, [sheelagh@ucalgary.ca](mailto:sheelagh@ucalgary.ca)

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Dr. Mark Hancock, Assistant Professor – Department of Management Sciences, University of Waterloo  
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**Title of Project:**

Study of a Cartesian Visualization of Language

**Sponsor:**

NSERC / Alberta Innovates Technology Futures / SMART Industrial Research Chair; SurfNet

---

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

**Purpose of the Study:**

We have developed a visualization technique for translating language (written words) into n- dimensional numerical space. This technique was created as a domain- specific approach to visualizing literature and as a space possible of experimenting with literary theory. It has three important characteristics: mathematical consistency throughout the space guaranteeing reversibility, infinite points from a null string to a string of infinite length, and the algorithm works in n- dimensions allowing for the development of complex spaces.

The purpose of this study is to validate:

- 1) Our understanding of a domain-specific problem (i.e. the visualization of language)
- 2) Our design decisions with regards to visual language (i.e. graphic design)

**What Will I Be Asked To Do?**

You will be asked to complete a questionnaire about our current research, and to participate in a semi-structured interview about your opinions. The questionnaire/interview session will take approximately 30-45 minutes.

Your participation is entirely voluntary. You may refuse to participate altogether, or may withdraw from the study at any time without penalty by stating your wish to withdraw to the researchers.



## What Type of Personal Information Will Be Collected?

Should you agree to participate, you will be asked to provide your field of study, research interest or occupation in a questionnaire. Providing this information is optional.

There are several options for you to consider if you decide to take part in this research. You can choose all, some or none of them.

Please put a check mark on the corresponding line(s) that grants us your permission to:

I agree to let video clips or stills from my workshop session and interview to be used, for data analysis only.	YES ___	NO ___
I agree to let video clips or stills from my workshop session and interview to be used for presentation of the research results.	YES ___	NO ___
I agree to let my conversation during the study be directly quoted, anonymously, in presentation of the research results.	YES ___	NO ___
I grant permission to be contacted for a follow-up interview. If 'yes', please provide an email address at which you can be contacted: <b>email:</b> <input type="checkbox"/>	YES ___	NO ___

The main purpose for collecting the video is for reviewing ad-hoc interview questions and responses. The interview will be video recorded for the purpose of dictation and post-study analysis. With your permission, we may use clips or stills of the video in presentations and publications, but this can only happen with your consent. Please, indicate above if you grant us permission to use video clips or still pictures recorded as part of this study. Any clips or stills of the video will not be associated with your name or contact information. If consent is given to present video clips and/or photographs, then no anonymity can be guaranteed and you will be clearly recognizable as a participant in this study.

Please note that once photographed or videotaped images are displayed in any public forum, the researchers will have no control over any future use by others who may copy these images and repost them in other formats or contexts, including possibly on the internet.

## Are there Risks or Benefits if I Participate?

There are no known harms associated with your participation in this research.

## What Happens to the Information I Provide?

You are free to withdraw from this study at any point. If this occurs, we will immediately stop collecting data from you, ensuring that only data for which you have given consent is used.

All data received from this study will be kept indefinitely in a secure place. Only the investigators indicated on this form will have access to the raw data.

In any written reports created based on this study, you will be represented anonymously, using a pseudonym or participant number (e.g. Participant 4). With your permission (as indicated in the table above) we may use quotes from your interview or video stills of your session in our published results; these will not be associated with your name, contact information, pseudonym, or participant number. If you request, we will also edit out or otherwise mask any sensitive portions (such as faces) from video clips. Please note that once videotaped images are displayed in any public forum, the researchers will have no control over any future use by others who may copy these images and repost them in other formats or contexts, including possibly on the internet.

Potential venues for the dissemination of results are: Graduate student projects, IEEE InfoVis, ACM CHI, and similar venues.

### **Signatures (written consent)**

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print) \_\_\_\_\_

Participant's Signature \_\_\_\_\_ Date: \_\_\_\_\_

Researcher's Name: (please print) \_\_\_\_\_

Researcher's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

### **Questions/Concerns**

If you have any further questions or want clarification regarding this research and/or your participation, please contact:

Dr. Sheelagh Carpendale,  
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If you have any concerns about the way you've been treated as a participant, please contact the Senior Ethics Resource Officer, Research Services Office, University of Calgary at (403) 220-3782; email [rburrows@ucalgary.ca](mailto:rburrows@ucalgary.ca).

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

## Questionnaire – Study of a Cartesian Visualization of Language

Here is a set of sample questions for our questionnaire.

1) What are your initial interpretations of this visualization?

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2) After the visualization has been explained, is the structure of the visualization more clear / readable / understandable?

unclear    **1**       **2**       **3**       **4**       **5**       completely clear

Please explain:

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3) We have attempted to preserve the structure of language in this visualization, based on the structure of individual words. As a result, there remains a significant amount of white space in this visualization.

a) Does this space carry any perceivable / potential meaning?

**Yes / No**

Please explain:

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b) Is this space necessary for representing the structure of language?

**Yes / No**

Please explain:

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c) Can you imagine a more suitable or readable structure?

**Yes / No**

Please explain:

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4) Languages are represented by color, and words by individual points. Does this approach work well?

poorly      1      2      3      4      5      very well

Please explain:

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5) Did this visualization inspire new ideas or cause you to think of creative possibilities for the practice of exploring the structure of language through spatial representation?

**Yes / No**

Please explain:

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6) Please provide any criticism you have about this visualization.

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We are seeking participants for a study that aims to investigate the current annotation practises of literary critics. If you are interested in participating, please contact Dr. Mark Hancock, [mark.hancock@uwaterloo.ca](mailto:mark.hancock@uwaterloo.ca), or Adam Bradley, [adam.bradley@uwaterloo.ca](mailto:adam.bradley@uwaterloo.ca).

This project was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee.

### **Study Information**

“Orthography and Poetry” is part of a study being conducted by Dr. Mark Hancock and PhD candidate Adam Bradley at the Touchlab, University of Waterloo, Canada. The purpose of this study is to observe the orthographical techniques currently used by literary critics when working on poetry. The data collected during the study will contribute to the development of a pen-based interaction technique for literary critics.

We will be using dot-matrix paper and a Livescribe smartpen to investigate how literary critics write directly on poetry. If you choose to participate in this study, you will be given a poem printed out on dot-matrix paper and asked to annotate it as you would in your day-to-day work. The information will be collected by interviewing you and videotaping the interview (with your permission), as well as by using smartpen technology, which is a tool that records orthographical strokes on the special paper that will be provided.

Participants should be 18 years of age or older. Participation in the study is voluntary. The study should take 1 hour. The study will be conducted at the University of Waterloo’s Touchlab CPH 3643. You may not benefit personally from your participation in this study. However, by participating, you will help researchers to improve their technology making interaction techniques for literary critics.

Data collected during this study, including the video recordings, will be retained indefinitely in a locked office in the CPH Engineering building on the University of Waterloo campus. Electronic data will be kept on password-protected computers. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study. With your permission, anonymous quotations may be used in publications. By participating, you agree, with full knowledge of all foregoing, of your own free will to participate in this study.

If you have any questions about participation in this study, please contact Dr. Hancock at (519) 888-4567 ext. 36587 or by email at [mark.hancock@uwaterloo.ca](mailto:mark.hancock@uwaterloo.ca).

This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have any questions or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or [maureen.nummelin@uwaterloo.ca](mailto:maureen.nummelin@uwaterloo.ca).

Yours Sincerely,



## CONSENT FORM

I have read the information presented in the information letter about a study being conducted by Dr. Mark Hancock of the Department of Management Sciences at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio and video recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in any publications to come from this research with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. If you have any questions or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or [maureen.nummelin@uwaterloo.ca](mailto:maureen.nummelin@uwaterloo.ca)

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

YES  NO

I agree to have my interview video recorded.

YES  NO

I agree to the use of anonymous quotations in any publication or presentation that comes of this research.

YES  NO

Participant Name: \_\_\_\_\_ (Please print)

Participant Signature: \_\_\_\_\_

Witness Name: \_\_\_\_\_ (Please print)

Witness Signature: \_\_\_\_\_

Date: \_\_\_\_\_