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Making Machines Learn. Applications of Cultural Analytics to the Humanities

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A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Hispanic Studies

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Abstract

The digitization of several million books by Google in 2011 meant the popularization of a new kind of humanities research powered by the treatment of cultural objects as data. Culturomics, as it is called, was born, and other initiatives resonated with such a methodological approach, as is the case with the recently formed Digital Humanities or Cultural Analytics. Intrinsicly, these new quantitative approaches to culture all borrow from techniques and methods developed under the wing of the exact sciences, such as computer science, machine learning or statistics. There are numerous examples of studies that take advantage of the possibilities that treating objects as data has to offer for the understanding of the human. This new data science that is now applied to the current trends in culture can also be replicated to study more traditional humanities. Led by proper intellectual inquiry, an adequate use of technology may bring answers to questions intractable by other means, or add evidence to long held assumptions based on a canon built from few examples. This dissertation argues in favor of such approach. Three different case studies are considered. First, in the more general sense of the big and smart data, we collected and analyzed more than 120,000 pictures of paintings from all periods of art history, to gain a clear insight on how the beauty of depicted faces, in the framework of neuroscience and evolutionary theory, has changed over time. A second study covers the nuances of modes of emotions employed by the Spanish Golden Age playwright Calderón de la Barca to empathize with his audience. By means of sentiment analysis, a technique strongly supported by machine learning, we shed some light into the different fictional characters, and how they interact and convey messages otherwise invisible to the public. The last case is a study of non-traditional authorship attribution techniques applied to the forefather of the modern novel, the *Lazarillo de Tormes*. In the end, we conclude that the successful application of cultural analytics and computer science techniques to traditional humanistic endeavours has been enriching and validating.

Keywords

Digital Humanities, Cultural Analytics, Machine Learning, Art History, Face Recognition, Beauty, Calderón de la Barca, Sentiment Analysis, Authorship Attribution, Lazarillo de Tormes.

Co-Authorship Statement

Chapter 2 is an article that has been already published in a peer-reviewed journal.

Chapter 3 is in-print for a specialized volume in extreme emotions. Chapter 4 is an article manuscript that will be shortened and submitted to a peer-reviewed journal. The contribution of each author is stated below.

Chapter 2: A Quantitative Approach to Beauty. Perceived Attractiveness of Human Faces in World Painting

Authors: Javier de la Rosa, Juan Luis Suárez, Adriana Soto-Corominas

Status: Published in the *International Journal for Digital Art History*

Experimental work, data analysis and writing were performed by Javier de la Rosa. Juan Luis Suárez provided the theoretical background as well as copy editing and consultation regarding interpretation of results. The manuscript was revised by Nandita Dutta and Adriana Soto-Corominas.

Chapter 3: It's All a Sham! The Role of Emotions in the Characters of Calderón de la Barca's Autos Sacramentales

Authors: Javier de la Rosa, Juan Luis Suárez, Adriana Soto-Corominas

Status: In-print in a volume called *Baroque to Neo-baroque: Emotion and Seduction of the Senses*

Experimental work, data analysis and writing were performed by Javier de la Rosa. Juan Luis Suárez provided consultation regarding experimental work, interpretation of results, and the general background and methodological framework. Adriana Soto-Corominas provided us with consultation and help with the privacy and ethics issues related to the collection of the data, as well as the revision of the manuscript.

Chapter 4: The Life of Lazarillo de Tormes and of His Machine Learning Adversities
Non-traditional authorship attribution techniques in the context of the Lazarillo

Authors: Javier de la Rosa, Juan Luis Suárez

Status: To be shortened and submitted to the *PMLA: Publications of the Modern Language Association of America*

Experimental work, data analysis and writing were performed by Javier de la Rosa. Juan Luis Suárez provided general consultation and advice. The manuscript was revised by Adriana Soto-Corominas and Ben McArthur.

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Chapter 1

1 Introduction

In the late 1940's Roberto Busa initiated the collection and digitization of all works of Saint Thomas Aquinas. His *Index Thomisticus* (Busa, "Index") needed the investment of almost 30 years in order to be considered complete, and it is probably the first example of synergy between the humanities and computer science. In retrospect, we owe the existence of the computational humanities to a project privately sponsored by IBM and its founder himself, Thomas J. Watson (Busa, "Annals" 83-90). In a time when computers were huge mainframes conceived to ingest and process data for governments, big companies, and research in the STEM disciplines (science, technology, engineering, and mathematics), the achievement of Father Busa ushered in a new and unexplored world of possibilities for humanists. Despite the criticism that accompanied –and still does– this new methodology (see *e.g.*, Kirsch), over the next decades the mixing of technology with traditional scholarship would develop silently and in parallel with the advances in computing. The appearance of affordable personal computers and their popularization in homes fostered the notion of the machine as a universal computing center. Day-to-day activities started to be replaced or carried out by computers, and more digitized resources began to be a necessity in the humanities for both their study and preservation. The explosion in the communications that the Internet and smartphones brought about, led humanities scholars to demand their own customized pieces of software. Databases and encyclopedias of all kinds were developed, initiatives and standardization efforts such as the "Poughkeepsie Principles" –which would later become the Text Encoding Initiative (TEI)– were founded, and associations and journals were created to accommodate the increasing number of scholarly publications related to the computing humanities.¹ A dimension Father Busa could have hardly imagined when he started his digitization enterprise, and for which traditional non-computerized scholars

¹ See an excellent introduction to the history of the Digital Humanities in the "Part 1" of Schreibman, Siemens, and Unsworth.

were not yet ready, as the treating of the “machine’s efficiency as a servant” rather than “its participant enabling of criticism” evidences (McCarty).

The past decade witnessed the rebranding and unification of all humanities and technology efforts under the now ubiquitous Digital Humanities brand (usually capitalized), or simply DH.² According to Kirschenbaum, the term was coined by John Usworth as a way to “shift the emphasis away from simple digitization” (5), and in doing so, Father Busa’s approach was left behind. It is becoming common practice in digital humanities research to employ a large range of software applications in the methodologies. Their practitioners, having previously utilized computer scientists and programmers as disposable labour in projects as a support service for the “real” humanists (Hayles 42-66) –instead of forming truly multidisciplinary teams–, are now exhausting all that can be done in the field by means of on-demand software.³ It is still easy to identify evidence of this in recent conferences, where some of the tools that were presented did not really contribute to any specific research question or intellectual inquiry, beyond that of the mere software engineering prospect (Scheinfeldt 56-60). Possibly led by a lack of solid formulation, this situation forced the update of the recently created discipline to a newer version. In the words of one of the authors of the second manifesto, “Digital Humanities 2.0 introduces entirely new disciplinary paradigms, convergent fields, hybrid methodologies, and even new publication models that are often not derived from or limited to print culture” (Presner 6). Thus, an attempt to address one of the often adduced problems of digital humanities: its lack of a critical apparatus. The criticism of the so-called *computational turn* is usually based on the postmodern condition of the metanarrative of science as argued by Lyotard (see *e.g.*, Hall 781-809). Faced with the impossibility of reconciling disciplines such as the humanities and the sciences, any justification for them in the form of a narrative is inherently unjust. This

² The foundation of the Alliance of Digital Humanities Organizations (ADHO), the creation of the National Endowment for the Humanities (NEH), and the Modern Language Association (MLA) 2009 meeting, were all key in the popularization and settlement of digital humanities.

³ In this respect, although not published academically, Susan Edwards from The Hammer Museum carried out a study in relation to digital art history. Her presentation is available at <http://www.slideshare.net/jolifanta/digital-art-history-from-practice-to-publication>.

disapproval has many forms and shapes, from cultural studies to art history, but it has been in literary criticism and textual analysis where it got more ferocious. In his infamous piece *Literature Is Not Data: Against Digital Humanities*, Stephen Marche alludes to the humanness in literature, leaving to the reader the suggestion of the inhumanness of data, conceived as the concretization of the object of study in the digital form (Schöch 2-13). He goes as far as putting algorithms at the level of fascism “because they give the comforting illusion of an alterity to human affairs.” In his opinion, analyzing a novel by computational means, regardless of the goal, is at the “limit of reductivism [and] removes all the refinement from criticism.” Others are a little more restrained in their defense of the traditional, and after pointing out the limitations of the computational turn, instead of highlighting its strengths (Ramsay 482), defend that computational approaches demand a new algorithmic critic, rather than regular literary critics judging a methodological effort by its lack of hermeneutics (491).

The main error that digital humanists fall into, according to Ramsay, is to “mistake questions about the properties of objects with questions about the phenomenal experience of observers,” two positions that are irreconcilable (483). Detractors of the computational approach usually operate under the assumption that the use of computers in the realms of the humanities is by default imposing the interpretative framework of science, accepting a sole and unique meaning of fact and evidence for the hermeneutical reading of the results. This might be a necessity for literary criticism, where a single concept of truth does not apply and the interpretation of the facts is usually, and constantly, called into question. However, artefacts such as algorithms, statistical measures, or computer programs that are employed by digital humanists must be validated within their own field of knowledge to be legitimized and used without falling into a methodological aberration. In a sense, digital humanists accept the axiomatic nature of computers and mathematics, while taking advantage of all they can do to approach inquiries that may otherwise be unfathomable.

This is especially important when the magnitude and scale of the object of study surpasses any existing theoretical framework. If a discipline still does not have the tools to deal with millions of books, pointing out at why that might not be of interest is one

position, tackling the problem by borrowing from others who had similar issues is what the computational turn enables (Borgman). In this context, Lev Manovich proposed his Cultural Analytics as a combined mixture of quantitative methodologies, and deep and critically constructed analysis: the result of marrying “expertise in computer science, statistics, and data mining” to rigorous theoretical critique and self-reflexivity (“How to Follow” 6; “Debates”). In doing so, Manovich aims for the creation of tools “to enable new type [sic] of cultural criticism and analysis appropriate for the era of cultural globalization and user-generated media” (“How to Follow” 21; “Cultural Analytics”). Although Manovich tries to avoid limiting the scope of his cultural analytics, it is usually applied to new media and contemporary objects of study. A very closely related concept is what Franco Moretti called “distant reading” (“Graphs”; “Distant reading”). At the same time, the appearance of studies such as Culturomics, the Historical Index of Popularity, the Framework for Cultural History, and Cultural Networks, are all applying such ideas in their respective fields (Suárez, McArthur, and Soto-Corominas 45-50; Schich et al. 558-562; Yu et al.; Michel et al. 176-182).⁴ They all concern a humanistic inquiry and resonate with the ideas of digital humanities and cultural analytics. In that sense, this is what this dissertation tries to accomplish.

One field that has skyrocketed in recent years inside the computer science is artificial intelligence, and more specifically, an algorithmic approach known as machine learning. Fed by what is called *big data*,⁵ the mathematical models used in machine learning are able to learn from previous examples (training) and make predictions about unseen data in a supervised learning fashion. Even with unlabeled samples, the models are still

⁴ Citing from Suárez, McArthur, and Soto-Corominas, “Schich et al. also focus on individuals in order to develop a data-driven macroscopic perspective, in which the study of statistical regularities is combined with the impact of the local deviations that are found in those general patterns,” “Yu et al., for example, approach the study of the geniuses of human culture production [...] across linguistic and cultural boundaries [...] measuring what figures are more recognized across these boundaries,” and “[t]he main characteristics of Michel et al.’s work are the study of text found in books, the fact that their applications of Culturomics techniques are focused on the past, and the lack of social contextualization provided by the study [...] Granularity, size of information, as well as time and linguistic extension are combined in order to reach a scale that is unprecedented in our approach to human history and culture.”

⁵ Succinctly, data that is produced fast (velocity), in gigantic amounts (volume), and in different formats (variety) (Beyer and Laney). In digital humanities we understand as data any artefact that can be stored and manipulated by digital means, *e.g.*, pictures of paintings, digital recordings, or digitized text (Borgman).

capable of estimating groupings among them through unsupervised learning. Recent claims have supported a stronger joint venture between humanities and data science (Manovich), although not all voices are in favour (Pinker; Konnikova). The rest of this dissertation highlights three different case studies in DH that also benefited from a deep understanding of the sciences involved, and that show the advantages and limitations of such approaches. If there is one direction that has marked this endeavour, it has been that certain methods and tools were created and/or adapted to respond to assumptions that question our understanding of the human condition as has been reflected in art and literature.

1.1 Beauty

Recently, Manovich dedicated a whole (invited) article in the newly created *Journal for Digital Art History* to explain the hidden details of data science and why it is important in the context of art history in particular and cultural analytics in general (“Science of Culture”). His foundational article on cultural analytics starts by asking some questions about culture and the possibilities of a quantitative, rather than computational, approach. Specifically, he asks about the possible ways in which we could “visually represent how cultural and lifestyle preferences –whether for music, forms, designs, or products– gradually change over time” (“Cultural Analytics” 1). In other studies, he insists that cultural analytics as an umbrella term is wide enough to account for the study of both “historical artifacts created by professionals” as well as “vernacular” contemporary creations that fall out of the traditional subjects of humanities.

In this sense, our first study consisted of an exploration of said trend when applied to art history, using images of paintings rather than texts. We were interested in the evolution of perceived attractiveness of faces in world painting as defined by today’s standards. After collecting a set of 120,000 paintings from different periods (which was a challenge in itself), we analyzed the depicted human faces between the 13th and the 20th centuries. Our goal was to establish whether there was a single canon of beauty or whether this has changed over time.

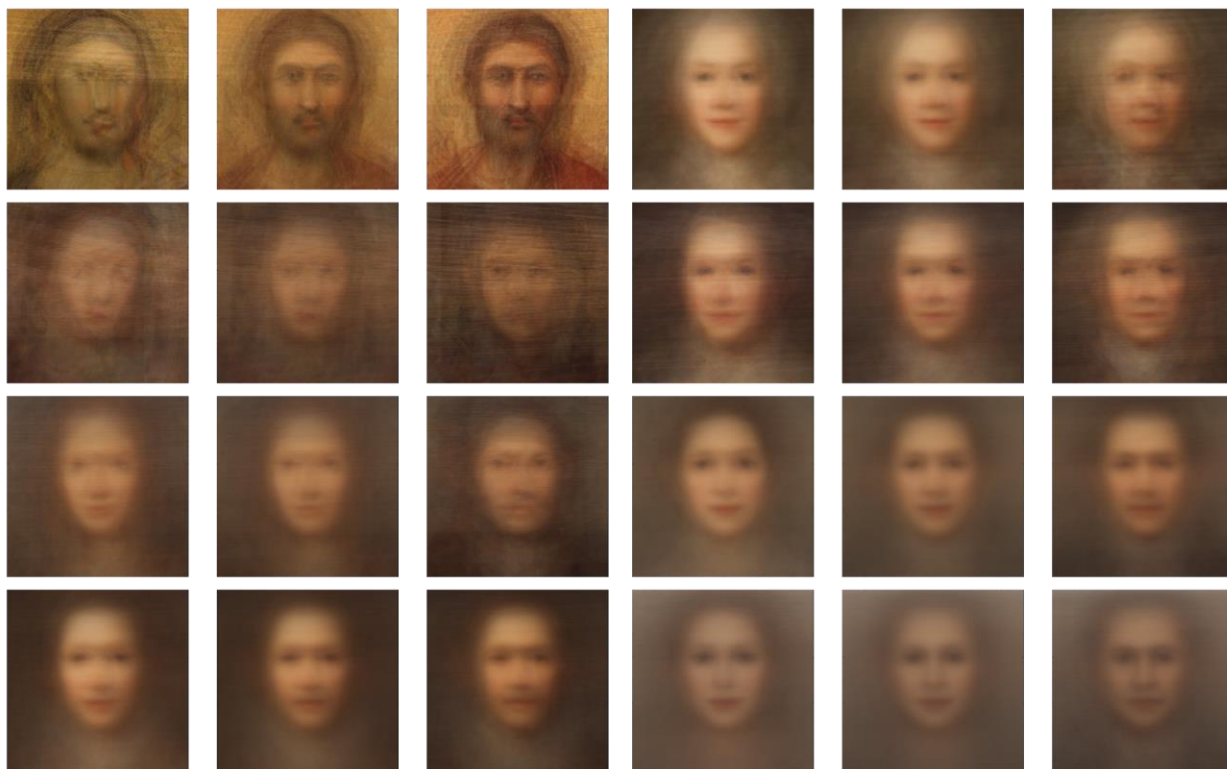


Figure 1-1: Average composites per century for female, both genders, and male.

We resorted to averageness and symmetry in the faces as proxies for their perceived attractiveness. Both concepts, borrowed from neuroscience, have an adequate definition tenable under evolution theory. On the other hand, machine learning methods for face identification were used as a base to build our indices of symmetry and averageness upon. Points detected by the computer vision algorithm were included in the calculation of such indices, which gave us a tool to analyze a large collection of paintings otherwise intractable.

Our study showed that when measuring averageness and symmetry, the representation of human faces has not remained constant and that there are substantial differences between the faces depicted between the 15th and 18th centuries when compared to those of both the 13th and 20th centuries. Especially significant is the decrease in the perceived beauty of faces in 20th-century paintings, as the freedom of artists and the openness of society fostered the representation of different types of human faces other than that of classical styles.

1.2 Emotions

Google's project of digitizing millions of books, and the "distant reading" approach that it makes possible, seemed to bother Stephen Marche. The Canadian writer did not seem to understand that these new approaches are changing and challenging our very own conception of culture and how we approach its study in the digital age. In DH, the term *project* is usually preferred to *study*, we believe, due to its involvement of multidisciplinary knowledge; these projects are creatively coming up with new ways to address literary-historical questions that could not be easily addressed without computers.

In our second study, we focused on the role of sentiments in the creation of the fictional characters of Spanish playwright Calderón de la Barca's *autos sacramentales* (dramatic plays of allegorical nature). This would help us understand how baroque theatre created massive successful performances for many decades precisely by appealing to sentiments and opinions that the audience may have shared. We tracked down the extent of the presence of emotions in the *autos* with the help of a massive and, at the same time, detailed study of the sentiments expressed by the characters that Calderón created. Furthermore, we delved into the distribution of these emotions by studying the occurrence of positive and negative sentiments among different typologies of characters, so that we could offer a more nuanced view of the psychology of these characters, even when they were of allegorical nature.

In recent years, brands have developed an interest in knowing how the public perceives them and their products. Early works by Turney and Pang set the foundation for the analysis of sentiments expressed in texts by means of supervised learning (Pang, Lee, and Vaithyanathan 79-86; Turney 417-424). From a corpus of products and movie reviews, they built a binary classifier—a model that assigns one of two categories—in order to estimate the polarity expressed: whether they were positive or negative reviews towards the object being reviewed. Their corpus and model have been used ever since to assess the sentiment in texts of different kinds that have little or nothing to do with consumer reviews. Although their methodology was applicable to our study, we were forced to build our own annotated corpus that would let us create a domain-specific classifier for two main reasons. Firstly, there is a clear difference in complexity between product

reviews and 17th-century Spanish Golden Age theatre. Secondly, there is a lack of annotated corpora available for sentiment analysis of theatre of this period. Creating our own annotated corpus allowed us to effectively apply Turney and Pang's methodology to better typify characters in Calderón's plays. This allowed us to see that it is hard to decide whether Calderón was using the characters' speeches to send clear religious messages or just as devices to fool his audience and play with the public.

1.3 Authorship

The analysis of texts sits at the core of humanities and DH itself. Identifying writing styles and authors of anonymous or wrongly attributed texts has been of interest to scholars at least since the invention of the printing press, when the availability of texts fostered comparative studies.⁶ The introduction of computers made it easier and affordable to analyze internal characteristics of texts and whole corpora. The successful attribution of the essays in *The Federalist* marked the start of modern authorship techniques powered by computers (Mosteller and Wallace). Mostly focused in English texts since its beginning, language-independent methods of attribution have later appeared as part of computational linguistics (Peng et al. 267-274).

⁶ See an introduction to the topic by Harold Love.

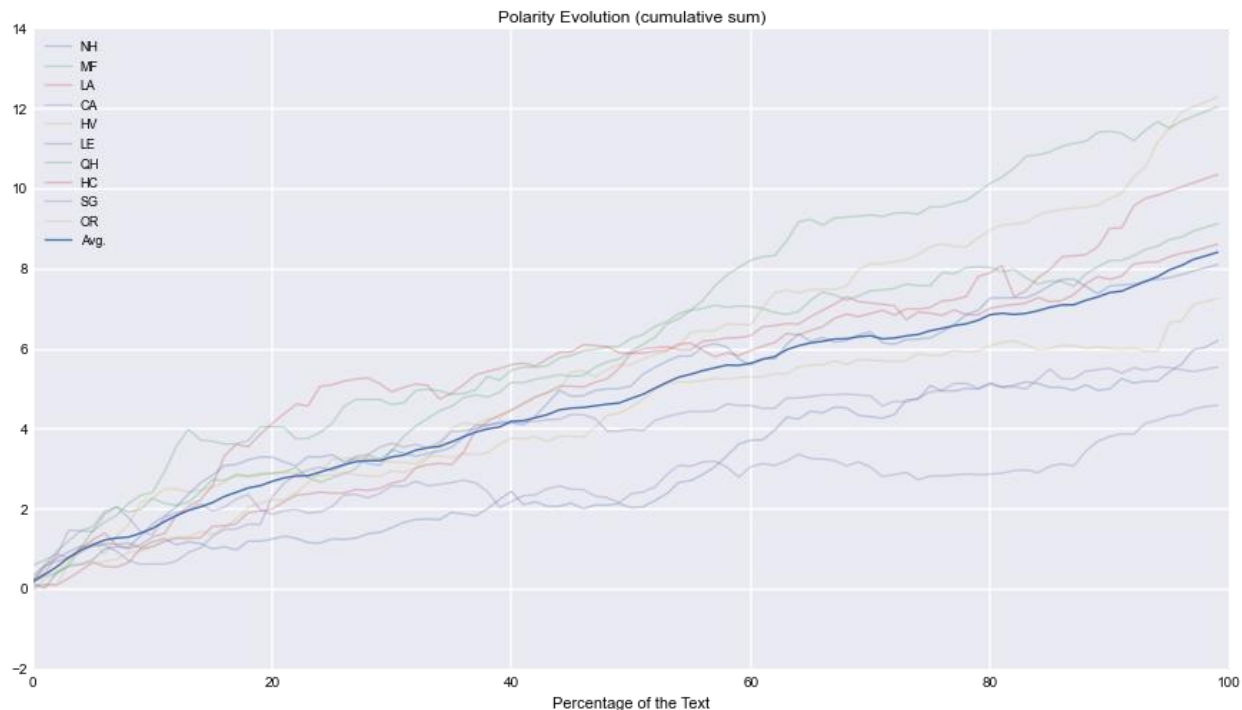


Figure 1-2: Cumulative sum of positive sentiment for the 10 plays used to train the classifier of Calderón’s *autos* normalized by their length. See Appendix in chapter 3 for legend codes.

We embarked in the difficult task of finding –or getting close to– the true author of what is considered the first modern novel, the Spanish *Lazarillo de Tormes*. Unlike closed-set attribution problems where the authors involved are known and the only task remaining is to identify who wrote what, *Lazarillo* turned out to be an open-set problem, where new authors are still being added to the pool of candidates. Digitization of original Spanish Golden Age manuscripts also presented some challenges, as modern editions of most authors’ works were missing. We solved the problem by building and using a crowdsourcing OCR reviewing tool which streamlined the process.⁷

⁷ Festos. October 30, 2015. <<http://festos.cultureplex.ca>>.

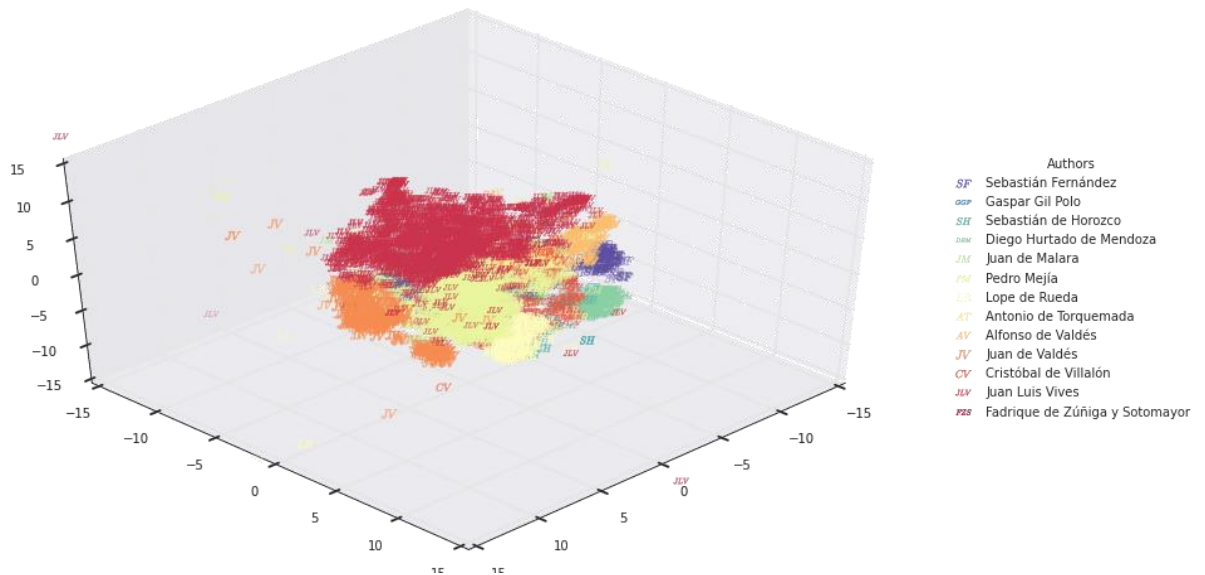


Figure 1-3: Unsupervised clustering of chunks of author’s works after applying dimensionality reduction (t-SNE).

In terms of the attribution itself, and building upon the latest research in the field, our final approach was comprised of three steps: first, we used unsupervised learning with features of different nature to reduce the pool of candidates.⁸ Then, applying supervised learning, we ranked possible authors. Finally, only six of these candidates were fed into an ensemble algorithm for “unmasking” the most likely author. Ensemble methods are, basically, combinations of simpler classifiers, as that is the name that supervised learning models receive. Computational authorship attribution endeavours always entail concerns about confidence, yet we found that by making the machine able to recognize different writing styles present in *Lazarillo* we could shed some light into a centuries old problem. At the same time, we contributed with our own algorithms and corpora.

⁸ Features are numerical representations of texts.

Chapter 2

2 A Quantitative Approach to Beauty. Perceived Attractiveness of Human Faces in World Painting

Has human beauty always been perceived in the same manner? We used a set of 120,000 paintings from different periods to analyze depicted human faces between the 13th and the 20th centuries in order to establish whether there has been a single canon of beauty or whether this has changed over time.

2.1 Introduction

The voters who participated in the “2012 Britain’s Most Beautiful Face” competition agreed on considering that Florence Colgate’s face was the most beautiful one and named her the winner among 8,000 entries (Kindelan). It turns out that the distance between her eyes and mouth is a 32% of her face, almost the exact third that Greeks considered to be the perfect proportion of a beautiful face. The results of this contest emphasized the long-standing human effort to scientifically estimate the features of beauty and to establish a method that allows for a reliable measurement of that which makes a face attractive.

The relation between the proportions of the human face and its perceived attractiveness have always captured attention and produced enormous fascination among scientists and artists alike. Even newborns seem to dedicate more time to attractive faces than to others (Grammer, Karl, and Thornhill, 223). How these proportions are meant to be the guidelines that define facial beauty has been the object of philosophic and scientific considerations since Plato’s time. However, binary approaches to beauty, such as Hogarth’s serpentine line (Hogarth), the Vitruvius’ “well-shaped man” (Rowland, Ingrid, and Howe), *divina proportione*, the golden ratio, or Fibonacci, have proven inconclusive to explain how beauty is actually perceived (Etcoff, “Survival”). As it has been considered that the expression of a face is the sum of a multitude of small details (Galton), we can also say that the attractiveness of a face is the sum of a varied set of distinct features. The latest investigations on evolutionary psychology and neuro-aesthetics point at similar conclusions. Beauty of unknown faces seems to include elements from averageness, symmetry, sexual dimorphism, pleasant expressions, and

youthfulness.⁹ While the existence of universal beauty standards should be explained in terms of an adaptationist approach to attractiveness, these standards should vary across cultures if they are the result of aesthetic judgments or culturally dependent values (Abramson and Pinkerton; Buss, 1-14; Cunningham et al., 261-279; Jones, and Hill, 271-296; Berry, 273-342).

The goal of setting the exact measurements that would help us establish the degree of beauty of a face suggests that these measures, and the beauty implicit in them, respond to the existence of a stereotype of physical attractiveness and that this stereotype might have remained constant throughout human history, even if it is a byproduct of the perceptual system's design and not the result of evolved psychological adaptations (Fink, and Penton-Voak, 154-158; Dion, Berscheid, and Walster, 285). That is, a face that was considered beautiful during the Renaissance would have also been attractive in the Baroque, Neoclassical or Modernist periods. And the reverse would also be true: faces that are considered beautiful today such as those of Brad Pitt, Angelina Jolie, or Johnny Depp would have been among the most attractive faces in centuries past. These would be timeless beauties. But, is this really the case? Can we infer that the astonishing resemblance of Scarlett Johansson to the woman depicted in Vermeer's *Girl with a Pearl Earring* is due to the existence of a constant canon of beauty in human history?

Given the abundance of data required to carry out a study that comprises as many periods and genres of art history as possible, we decided to take the concept of beauty in a measurable and comparable way. We are aware that an objective definition of beauty might not necessarily correlate with the ideals of the artists and, therefore, the assumption that artists intend to represent beauty might be theoretically disputable. We do not make such an assumption. We try to establish to what extent the result of artists' practices converges or deviates from numerically measurable standards of beauty as understood by the scientific discourse. Because of methodological reasons, in our study, the focus is placed on the current standards of beauty as defined by scientific methodology in terms of face symmetry and averageness. These two indices seem to be related to the perception

⁹ See the foundational works by Thornhill, and Gangestad ("Facial attractiveness" 452-460), Nigel (395-424), Douglas, and Shepard (321-322), and Perrett et al. (884-887).

of beauty: symmetrical faces are the result of a non-problematic development after puberty, and therefore guarantee a better offspring (Rhodes, and Zebrowitz, 1). Averageness, on the other hand, operates by the evolutionary pressure of Darwin's theory of natural selection: subjects with features close to the mean for a population are preferred to others, as the probability of them having harmful mutations is lower (Langlois, and Roggman, "Attractive" 115-121). Therefore, there is enough evidence to support the idea that both symmetry and averageness play a role in the perception of beauty: the more average and symmetrical, the more beautiful a face is usually ranked. A perfect combination of the external criterion –relation to the average face of a period– and the internal criterion –symmetry of features– would result in the most attractive face, turning a subjective opinion such as what face is beautiful into something measurable and objective.

Coming up with the right set of faces in order to determine levels of beauty in various historical periods, was not a straightforward path. Nowadays, it is becoming less difficult to perform studies on faces thanks to the overflow of photographs that we come across on any given day. The combination of digital technologies, ubiquity of cell phones and cameras, and widespread distribution of information through social networks make it relatively easy to get ahold of large data sets of faces on which to perform beauty analysis and validation.¹⁰ However, before the official birth of practical photography in 1839 and its subsequent popularization in the 20th century, the only historical record available of human images was that of art history. Drawings and paintings have always been prone to representations of human figures. Both in the portraiture genre and as part of more diverse compositions, human faces can be found in numerous works of art of most styles and historical periods. The question is how to use the faces represented in paintings such as *Mona Lisa* by Leonardo da Vinci, *Self-Portrait Without Beard* by Vincent van Gogh, or *The Night Watch* by Rembrandt as the subject of the type of analysis required to isolate features, measure distances, or determine metrics of averageness in a set of faces.

¹⁰ See Manovich's "Selfiecity." Web. January 1, 2015. <<http://selfiecity.net/>>; and "One Hundred Million Creative Commons Flickr Images for Research" *Yahoo! Labs*. Web. January 1, 2015. <<http://yahoolabs.tumblr.com/post/89783581601/one-hundred-million-creative-commons-flickr-images-for>>.

2.2 Materials and Methods

Surprisingly, the most extensive source of paintings, as well as the easiest to work with, came from a private collection of digital images curated for years and made available online for free.¹¹ Every painting has at least information about title, size, author, and date. However, accurate dates are only provided for paintings in the past two centuries –before the 1800s, the dataset only has the century in which the painting was produced (although some open collections have appeared more recently).¹² For this reason, we treated all paintings equally and decided to use the century information as the basic unit of time for this study. On the other hand, the resolution of the images of the paintings was not very important since face detection algorithms usually work by scaling high resolution images down. For the algorithm we used, images bigger than 1024px of height or width were resized before being processed.¹³ We used a Python script to download the meta-data for each image, perform the requests to the face recognition API, and collect, clean and organize the results.¹⁴ The algorithms for calculating symmetry and averageness indices were also written in Python, following the formulas detailed below.

Besides the calculation of the boundaries of a face and the position of several facial traits –such as eyes, nose, mouth, ears, or chin–, the algorithm we used also made guesses about the gender and age of the depicted faces, basing its estimations on the distribution and proportions of the traits and providing a threshold of confidence. Calculation of symmetry is commonly based on an early work of Grammer and Thornhill (“Homo sapiens”). Their method makes use of 12 different points (one more for averageness): 2 for each eye, 2 for the nose, 2 for the mouth, 2 for the cheekbones, and the last 2 for the jaw. With these points, they create lines for each pair and calculate their midpoints. In a perfectly symmetrical face, all midpoints must lie on the same vertical line. For our

¹¹ Ciudad de la Pintura. Web. November 1, 2013. <<http://pintura.aut.org>>.

¹² WikiArt, Virtual Art Encyclopedia. Web. January 1, 2015. <<http://www.wikiart.org/>>.

¹³ Summary tables of the dataset are shown in tables S1 to S4 and figures S2 to S5 in the section Supplementary Materials (SM).

¹⁴ We used the service faces.com before it was purchased and shut down by Facebook in 2012. “Facebook to buy facial-recognition startup: sources” *Reuter*. Web. January 1, 2015 <<http://uk.reuters.com/article/2012/06/18/us-facebook-face-idUKBRE85H1A320120618>>.

study, the algorithm used is significantly more limited compared to that, with 3 points for the mouth (left, center, and right), 1 for each pupil, and 1 for the nose. We could have considered ears or chin, but the number of faces in which these attributes were found with enough confidence (higher than 80%) is fairly insignificant (6%). Therefore, our method to calculate the symmetry of a face differs slightly from the one proposed by Grammer and Thornhill, while the main idea remains unchanged. Besides the points cited previously, the algorithm also gives us the centroid or geometric center of all detected features (Fig. 1A), which is supposed to coincide with the center of the face. From it, we can set a straight line that splits the face into two sides or hemi-faces. Figure 1B shows points 1 to 6 (P1 for left eye, P2 for right eye, P3 for nose, P4 for mouth center, P5 for left mouth corner, and P6 for right mouth corner), as well as the line H, that we assume to be the axis of face symmetry. We now trace segments: D1 between P1 and P2, and D2 between P5 and P6 (Fig. 1C). For these segments we calculate the midpoints M1 and M2. Symmetry is now obtained as the sum of the distances in pixels of M1, M2, P3 and P6 with respect to the line H. Only lateral symmetry is therefore estimated. For perfect symmetrical faces this value adds to zero; all symmetry values are normalized between 0 and 1, and we inverted the meaning to make plots clearer, where 1 means perfect symmetry, and 0 total asymmetry.

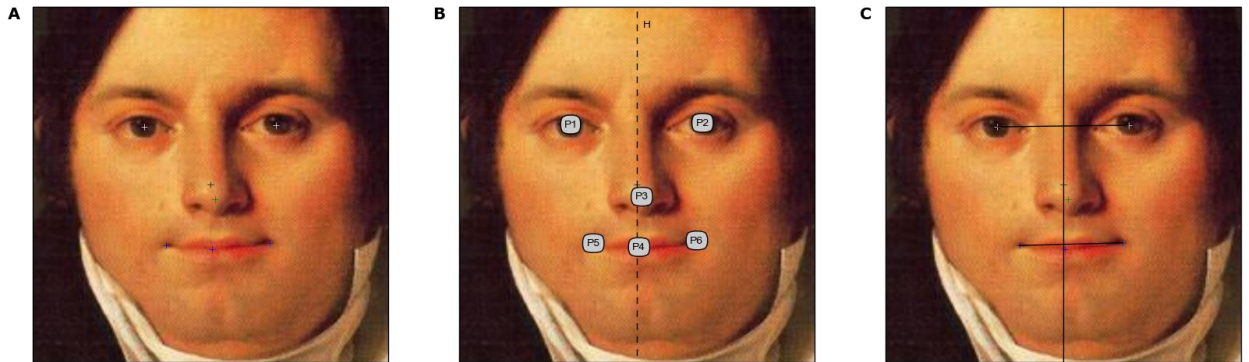


Figure 2-1: Steps for the calculation of the symmetry of a face. (A) Example of face and detected points for eyes, nose, mouth and center. (B) Vertical line, H, to divide the face into two hemi-faces, and enumerated points for all the features. (C) Lines for calculating distances between midpoints and hemi-face line.

Let be $(center_x, center_y)$ the point that defines the center of a face, and *roll* the rotation angle as returned by the algorithm, being 0° a perpendicular face with respect to the baseline of the frame of the painting. Then, we define the symmetry of face, Sym ,¹⁵ as follows:

$$Sym_{face} = 1 - \frac{Sym'_{face}}{max_{Sym'}} \quad (1)$$

$$Sym'_{face} = d_{H,M1} + d_{H,M2} + d_{H,P3} + d_{H,P6} \quad (2)$$

Where the hemi-face line, H , defined as:

$$H = mx + k \quad (3)$$

$$m = \tan(90 - roll) \quad (4)$$

$$k = center_y - mcenter_x \quad (5)$$

Formulas for the midpoints and the point to line distance are also described below:

¹⁵ A reference implementation of these formulas can be found in “Your Face in History,” Web. January 1, 2015. <<http://faces.cultureplex.ca/>>, a website that gives the user the chance to take a picture of herself and compare the obtained symmetry index with the symmetry of the faces included in this study and see, therefore, for which century her face would better work

$$M_{p1,p2} = \left(\frac{p1_x+p2_x}{2}, \frac{p1_y+p2_y}{2} \right) \quad (6)$$

$$d_{H,p} = \frac{|mp_x - p_y + k|}{\sqrt{(m^2+1)}} \quad (7)$$

On the other hand, the obtaining of averageness values involves a task much more demanding in terms of computer power. For each century an average face has been computer-generated for male, female and both (Fig. 2). In order to produce this averaged composite face, we first centered the faces according to the center point given by the face recognition algorithm. Faces were then resized to make them fit into a PNG canvas of 500 by 500 pixels at 300dpi of resolution, and given a height of 200 pixels; faces with height lower than 150 pixels were excluded to avoid blurred pixelation of the average face. This process was achieved by using affine and projective 2D transformations from the original painting to the desired canvas. Every face standardized by size was then converted into a 3D numerical matrix representing each of the layers of the RGB color model. A regular statistical mean was then calculated over the set of faces of each century in order to obtain the average value for each pixel. Once the average matrix was calculated, it was converted back into a PNG image. The resulting quality and averageness of the composite relied on the number of faces used in each century for generating the averaged face. The same face recognition algorithm used in the dataset was then applied on averaged composites. This allowed us to measure the averageness of an individual face as the difference between its symmetry and the symmetry of the average face for that particular period.

Let be F the set of k faces of a specific period of time, in our case, a century. Then we calculate the average composite as follows:

$$Avg_{face} = |Sym_{face} - Sym_{Comp}| \quad (8)$$

$$F = \{face_1, \dots, face_k\} \quad (9)$$

$$Comp_F = \frac{1}{k} \sum_{i=0}^k face_i = \frac{1}{k} \sum_{i=0}^k \langle R_i, G_i, B_i \rangle \quad (10)$$

Averageness refers to the degree to which a given face resembles the majority of faces. In

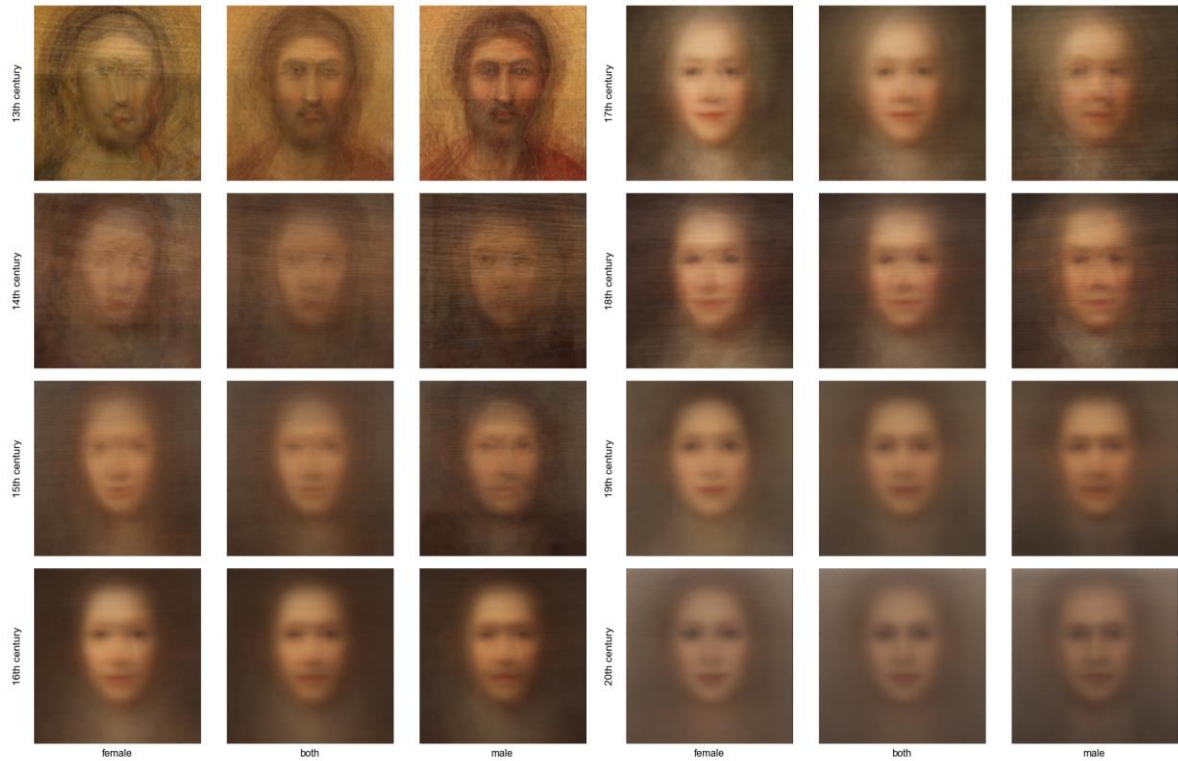


Figure 2-2: Average composites per century for female, both genders, and male. Each tuple of three images, starting from the rightmost side, represents the average composite of a given century for female, both genders, and male faces, respectively. These images were generated in order to calculate the values of averageness per century for each face. All-time composites are also available in SM as figure S1.

our study averageness values go from the most average, 1, to the least, 0. Figure 3, A and B, shows the histogram and the density estimation for the distributions of both symmetry and averageness values, respectively.

A considerable amount of paintings and faces were needed to draw valid conclusions about trends in human representation and facial attractiveness across historical periods. We retrieved and analyzed a data set with over 120,000 digital images of paintings covering styles and artistic periods spanning from the 13th to the 20th century. We

applied face recognition algorithms to these images to remove all paintings that had no recognizable faces in them, to end up with 25,000 paintings and over 47,000 human faces. For the current study only 5,800 faces that fulfill the following criteria were considered: frontal faces no smaller than 150 pixels in height, with pitch and yaw angles between 20° and -20° with respect to the vertical line, and with valid information for at least the following traits: eyes, nose, mouth, height, width, and center of the face. Face rotation or roll was fixed geometrically. Once we had identified the traits of the detected faces, and based on meta-analysis of symmetry and averageness (Rhodes, 199-226), we were able to compare the beauty and attractiveness of faces in order to determine different trends and variations across time periods as they appeared in the history of painting.

2.3 A Decline in Perceived Beauty

Average values of symmetry per century are shown in figure 4A for male, female, and both genders combined. It can be noted that most symmetrical female faces were found in the 15th century, while most symmetrical male faces occurred in the 18th century. After that, both genders rapidly became much more asymmetrically represented in all styles during the 19th and 20th centuries. From the 15th to the 18th century, representations of human faces seem to have moved within a stripe of relatively constant symmetry with maximums of symmetry around 0.35 and minimums of 0.32. This stripe of constant symmetry conforms to what we call the classical representation of the human face, which is the product of two factors: first, a cultural conception that placed the highest aesthetic valuation on previous models of beauty, specifically in the Greek and Roman models recovered during the Renaissance, and made their imitation and reproduction the goals of the artist; second, a training system based on workshops and academies that fostered an education around skills and models that helped achieve the former goals (Morrison; Gebauer, and Wulf; Gouwens, 55–82; Weinberg; Kristeller). Variation within the classical mode can be attributed to the action-reaction effects that certain schools provoked against the previous dominant style, such as the separation from the ideal of symmetry proposed by Rococo artists versus more traditional styles such as Baroque and Neoclassicism (Gombrich, “The Story”).

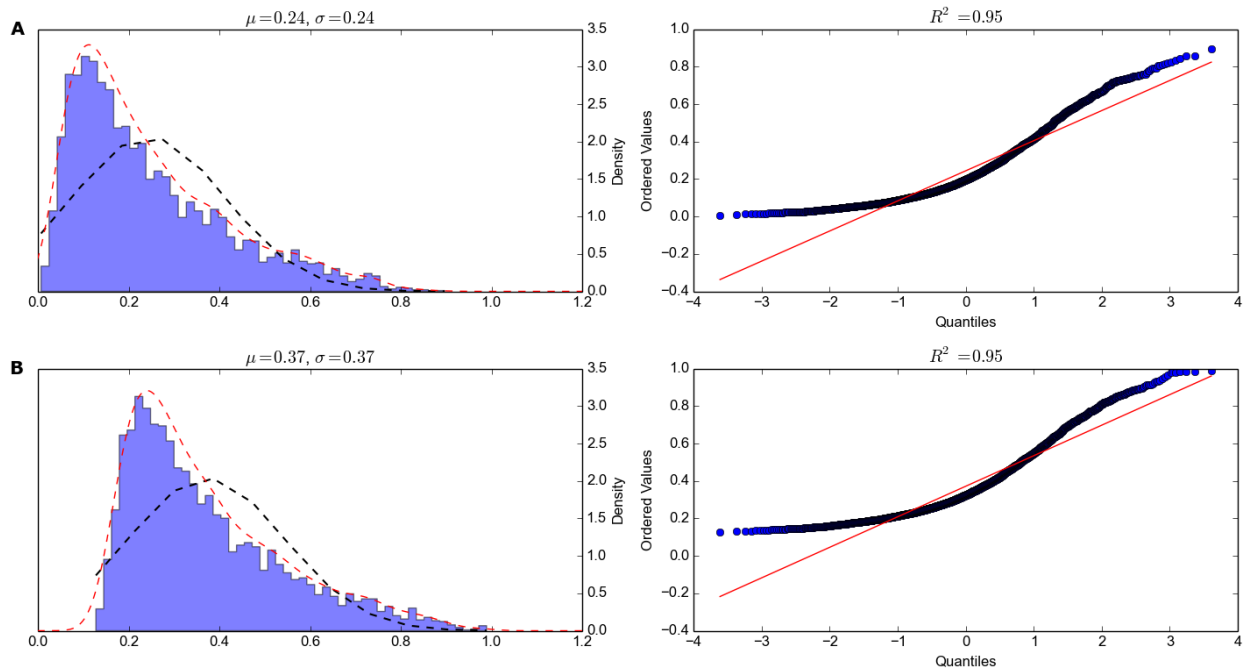


Figure 2-3: Normalized histograms (left) and Q-Q plots (right) for values of symmetry (A) and averageness (B). Gaussian density estimations are shown in dashed red lines, and probability density function estimations are shown in dashed black lines. Both distributions follow a normal distribution ($p=3.31e-05$ and $p=3.68e-05$, respectively, after running a KS test).

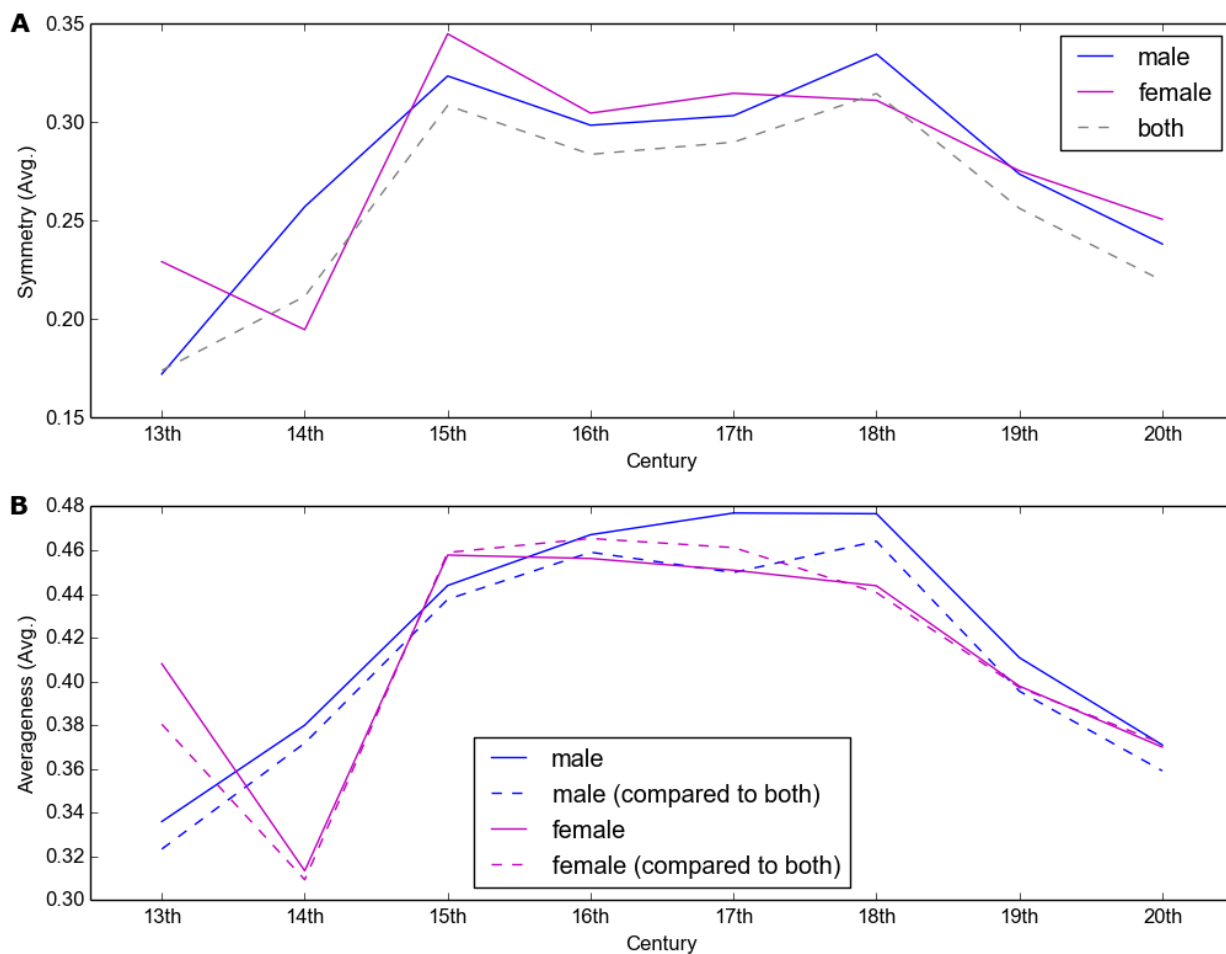


Figure 2-4: Peak values of symmetry and averageness are found in the 15th and 18th centuries, decreasing slightly in between, but notably cresting in the extremes of the period (values of 1 indicate perfect symmetry, while 0 means total asymmetry). After the 18th century both values decrease equally until the 20th century, where we encounter the lowest average of symmetry and averageness of the last five centuries. Corresponding figures for specific painting styles for each century can be found in tables S1 to S5. (A) Average values of symmetry for the period between the 13th and 20th centuries, represented for male, female and both genders combined. (B) Average values of averageness for the same period for male and female compared to the corresponding composite and the composite of both genders.

The appearance of disruptive styles in painting starting in the 19th century, a trend that became more acute throughout the 20th century when movements such as Modernism, Avant-Garde, Impressionism, Surrealism, Cubism, and Pop-Art dominated the art scene, came with a radical distancing from the ideal of symmetry in the representation of the human face. Paintings like Picasso's *Les Demoiselles d'Avignon*, Duchamp's *Nude Descending a Staircase, No. 2*, or Pollock's *Male and Female* responded to the new paradigms of human representation and to new approaches to beauty (Fig. 5).¹⁶ This ultimately led to a poor detection of such faces by the algorithm, and therefore it explains why the averaged faces for the 20th century are still close to the picture-perfect representation of a human face (Fig. 2).

In the 20th century we also observe a considerable decrease (Fig. 6) in the ratio of faces detected in paintings as most of the aforementioned styles did not render realistic models of the human, rejected beauty, or simply tended to focus on concepts, dreams, or ideas in which the human being was not the central object (Steiner; Eco, and McEwen). This trend coincided with both the irruption of photography as the favorite medium to represent the human face and the movement of nonrepresentational art observed at the beginning of the same century and characterized as the "dehumanization of art" (Ortega y Gasset).

A consequence of these differences in symmetry is reflected in the oscillations in averageness throughout art history. Figure 4B showed the distribution of averageness for male and female faces compared to their gender-specific averaged composite. In dashed lines we can also see the same distribution but with regards to the average face generated from both genders. A two-sample Kolmogorov–Smirnov test allows us to see that there is no significant difference between the two male distributions ($p=0.92$) and the two female ones ($p=0.51$).

¹⁶ For Pollock's *Male and Female*, see "Male and Female," *Philadelphia Museum of Art*. Web. January 1, 2015. <<http://www.philamuseum.org/collections/permanent/69527.html>>. "Les Demoiselles d'Avignon," *MOMA*. Web. January 1, 2015. <<http://www.moma.org/explore/conservation/demoiselles/>>. "Nude Descending a Staircase (No. 2)," *Philadelphia Museum of Art*. Web. January 1, 2015. <<http://www.philamuseum.org/collections/permanent/51449.html>>.

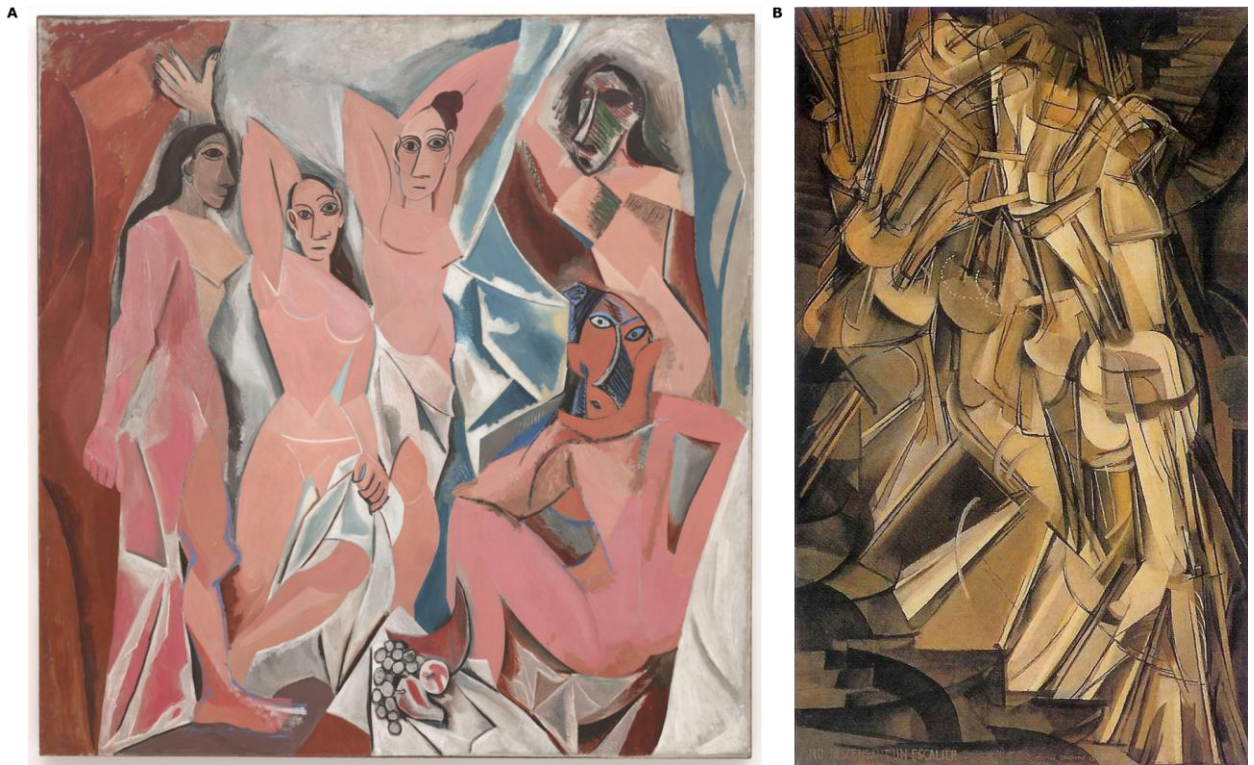


Figure 2-5: New representations of the human face arose in the past century. (A) Les Femmes d'Alger by Pablo Picasso, 1907 (oil over canvas, 96 in × 92 in). Museum of Modern Art, New York. Image in the public domain. (B) Nu descendant un escalier n° 2 by Marcel Duchamp, 1912 (oil over canvas, 57^{7/8} in × 35^{1/8} in). Philadelphia Museum of Art, Philadelphia. Image in the public domain.

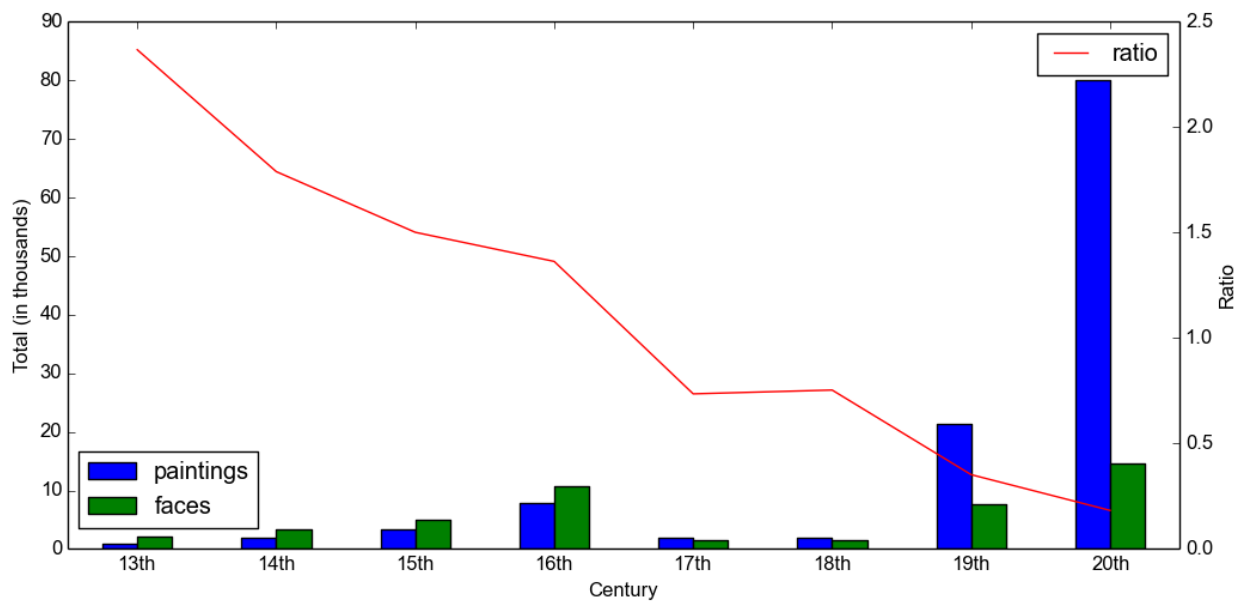


Figure 2-6: Number of paintings and faces per century, and ratio (faces per painting) between both.

Averageness, the difference between a face and the averaged composite face of each century, can shed light on how similar faces are to each other. For male faces, we observe that the levels of averageness are low in the 13th century, but then begin to increase until the 17th century, when averageness of faces gradually decreases until the minimums recorded in 20th-century painting styles.

2.4 Culturomics of Art History

Exact measurements such as averageness and symmetry help us better understand the various ways in which human faces have been depicted throughout the history of painting. However, as attested by art historians through traditional scholarship, these representations have not always remained constant, as different artistic styles have attempted their own ways of capturing facial beauty. After our analysis, we can conclude that there have been variations in the form in which facial beauty has been represented over time, and that these variations can be measured and tracked accurately. Of course, as in all data-based research endeavors, the better the dataset, the better the conclusions we can infer from our analysis. While there is a clear stripe conforming to features of classical representation of the human face from the 15th to the 18th centuries, both the

13th century –Gothic style– and contemporary art have shown clear deviations from the classical paradigm. Especially interesting is the data from 20th-century artistic styles, which shows low levels of both symmetry and averageness as well as a reduced proportion of total faces captured when compared with previous centuries.

These results conform to the views of art historians regarding the aesthetic and methodological disruptions that occurred after the vanguards. There has arguably been a change in the concept of art itself as well as in the theories that explain and criticize it. It is nowadays accepted that the representation of the human does not necessarily attempt to represent beauty. This shift in thought is clear in the data analysis and opens the door to a second phase of the investigation. By contrasting the aesthetic theories of specific periods and artists against the data, we would be able to establish their levels of conformity to and deviation from the objective measures of beauty. This would allow us to complement the qualitative and conceptual analysis of art history with the study of quantitative data. Combining these two levels appropriately should be one of the methodological aims of any culturomics science.

The separation from the classical mode of representing the human in contemporary art also serves as a reminder of the bias that we imposed on the analysis of perceived beauty by employing such accurate measuring systems. This bias also shows the interesting close relationship between classic ideas of beauty and art in Western cultures, and mathematical notions that support data-driven methods of research. While it is evident that the examples in Picasso's, Duchamp's, and Pollock's works show deviations from painting styles which depict faces that conform better to measures of symmetry and averageness, the judgment of whether these human faces are more or less beautiful than previous cases remains as aesthetic one. The contingency of aesthetic values is subject to fads, trends, reactions, and public opinion (Dutton).

Better algorithms can help us be more precise in the measurement of objective elements, although it has to be noted that the discipline that studies how social movements get started, become important and disappear, remains in its infancy (Pentland). Once we have improved the way to measure and analyze both the internal features of art works and the

dynamics of social movements that create judgments about those works, we will be able to approach these types of problems in a more accurate manner.

Another relevant factor to take into account has to do with how representative the sampling used for this study is. While we are certain about the validity of the used set as related to art history, it is impossible to ascertain how representative these faces are of the real populations living in the various historical periods. However, we have observed that there is a correlation between the preservation –perhaps even the production– of various types of media and the size of the human population in various countries throughout time (Fig. 7, A and B). The more people, the more media is preserved ($p=1.02e-05$ for books). This correlation remains true for paintings ($p=3.92e-04$, see figure 7C).

Although not explicitly discussed in this work, we have also verified that age, gender and face orientation, along with symmetry and averageness in the representation of human faces in paintings can become a complementary and objective way to identify and characterize styles and movements. Along with the exhaustive tagging for techniques, materials and the analysis and recording of chemical products used in art production, this could become the basis for the culturomics of art history (Michel et al., 176–182).

Nevertheless, and although this does not contradict our findings, it is clear that there is also a variety of complex social, aesthetic and evolutionary elements that influence our judgment on beauty. Capturing these constructs into proper algorithms has not resulted yet in perfect solutions to account for changes in perceived beauty. As we have previously stated, this has to do in part with the close relation between classic ideas and mathematical models that biased the analysis towards certain ideas of beauty. It is also important to note that many of these variations are due to the pressure that culture exerts in the short term on the adoption of different traits, and the deviations that this provokes from well-established, long term genetic features related to beauty, reproduction, and social acceptance and belonging (Suárez, Sancho, and de la Rosa, 281-281). Thus, it is important that any approach to the culturomics of art history and beauty also takes into account cultural evolution and cultural history as forces that shape the results we find in the data, and that have to contribute to the explanation of those results.

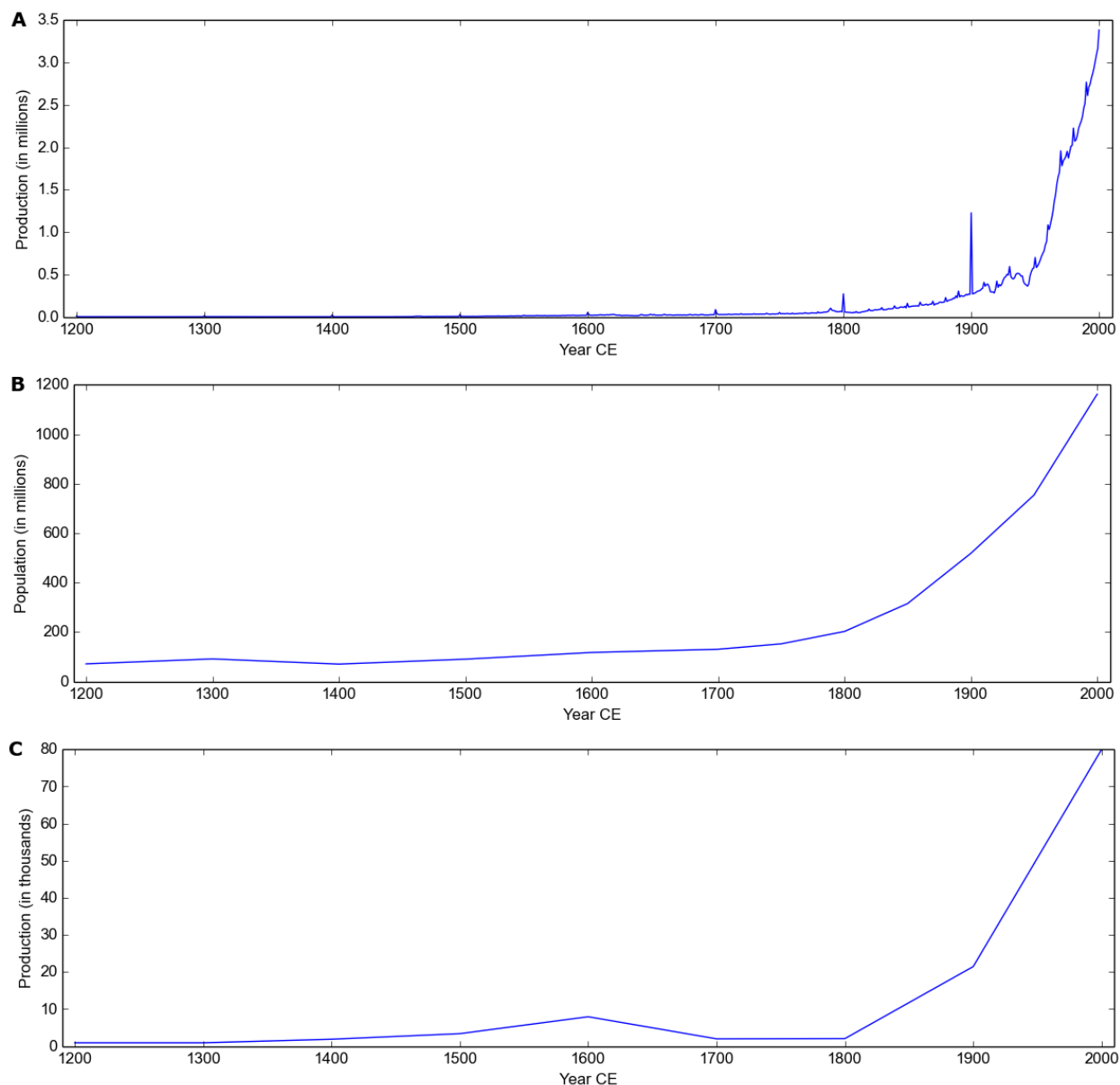


Figure 2-7: Population growth and media preservation over time. (A) Book production as contained in WorldCat since year 1200. (B) Population growth of Europe, where most paintings are from, in the same period. (C) Paintings in our dataset. World and Europe population growths seem to follow a similar trend (Fig. S5).

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2.5 Supplementary Materials



Figure 2-8, S1: All-time average composites for female, both genders, and male.

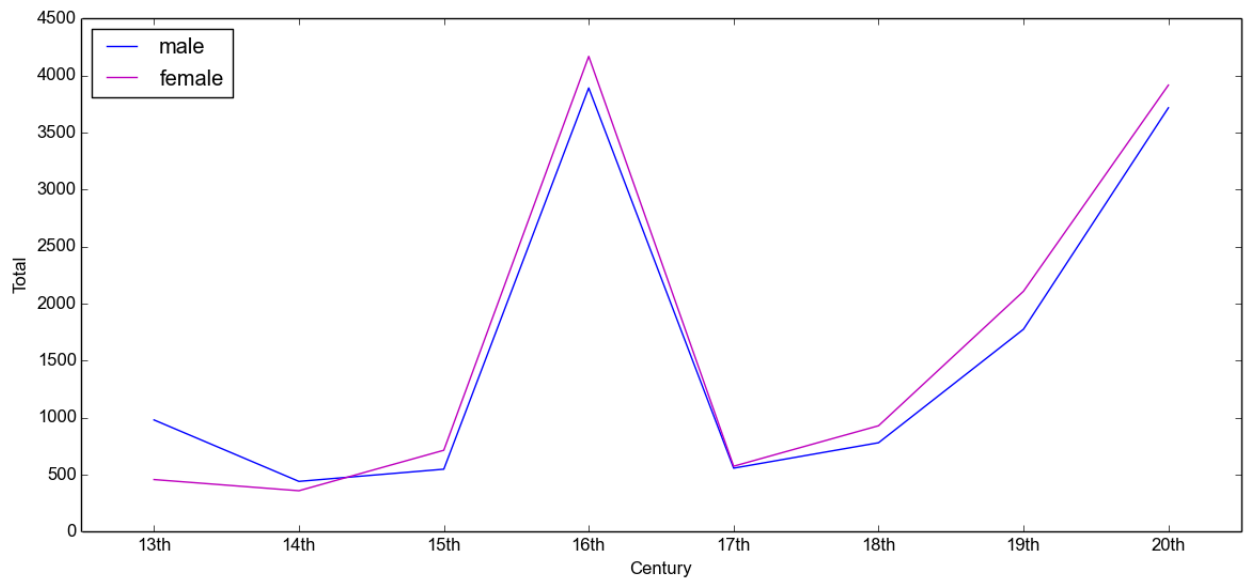


Figure 2-9, S2: Total number of depicted faces per gender as detected by the face detection algorithm. Male and female faces are depicted equally in number and consistently throughout time.

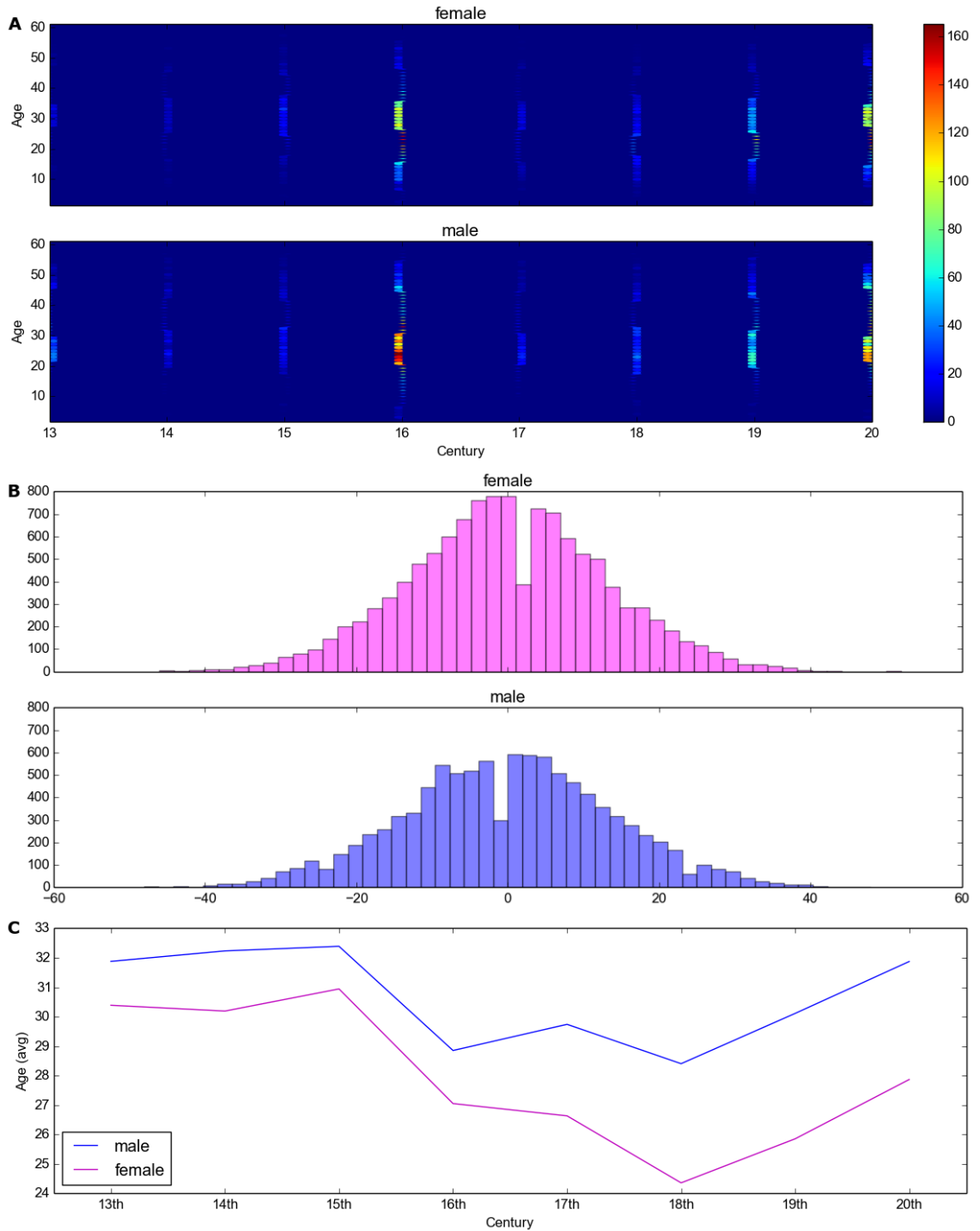


Figure 2-10, S3: Distribution of the age of depicted faces as estimated by the face detection algorithm. (A) Heat-map of the values of age per gender and century. (B) Histogram of the difference between consecutive estimations of age. (C) Average values of age per gender and century.

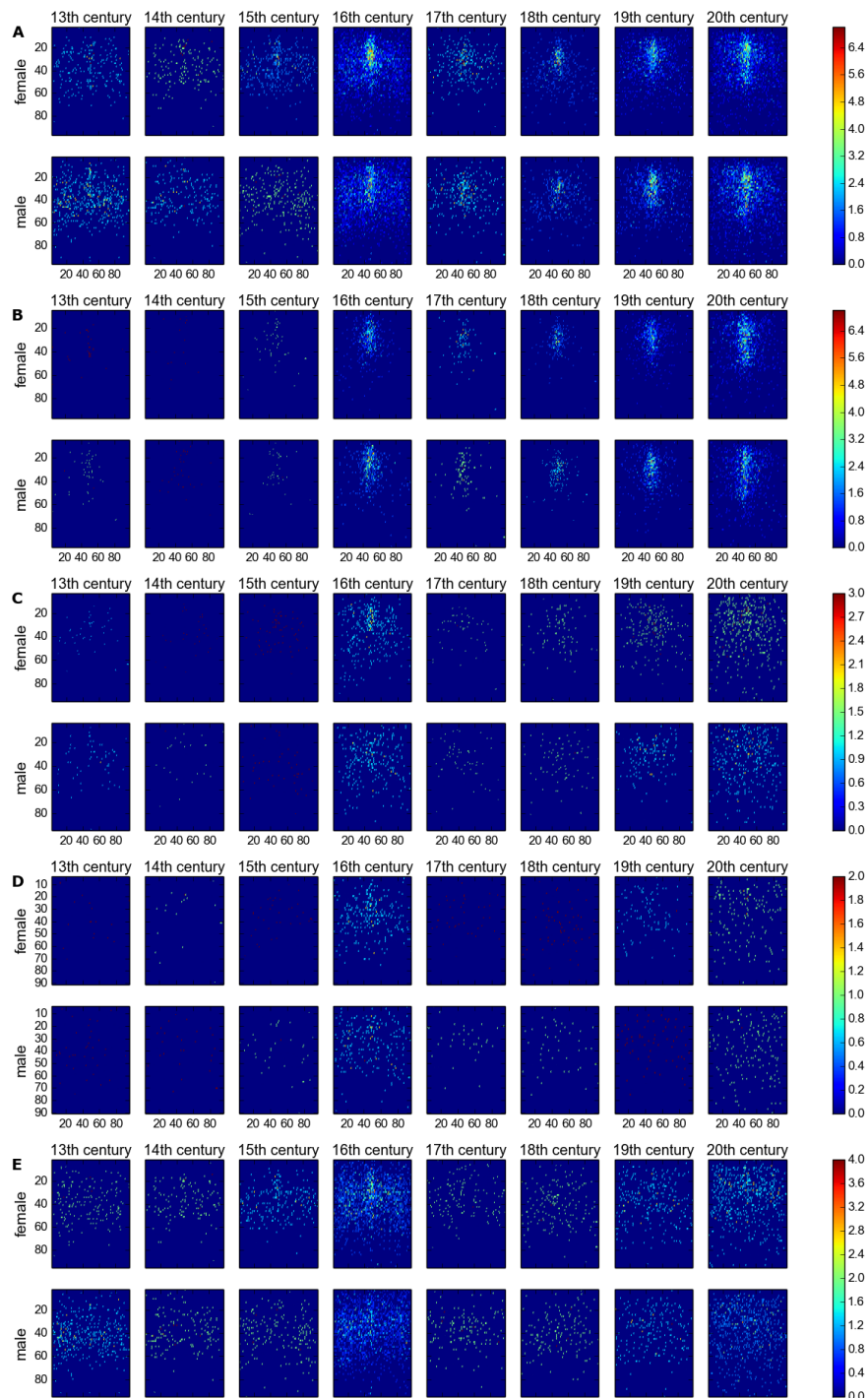


Figure 2-11, S4: Not only portraits. Heat-maps with the positions of the centers of the faces per gender and century for all paintings (A), paintings containing only 1 face (B), 2 faces (C), 3 faces (D), and 4 or more faces (E). Canvas sizes are converted into squares and center points are transformed to a percentage from the right edge for the coordinate x of the center, and from the upper edge for the coordinate y (images are represented with the coordinate (0, 0) occupying the left upper corner).

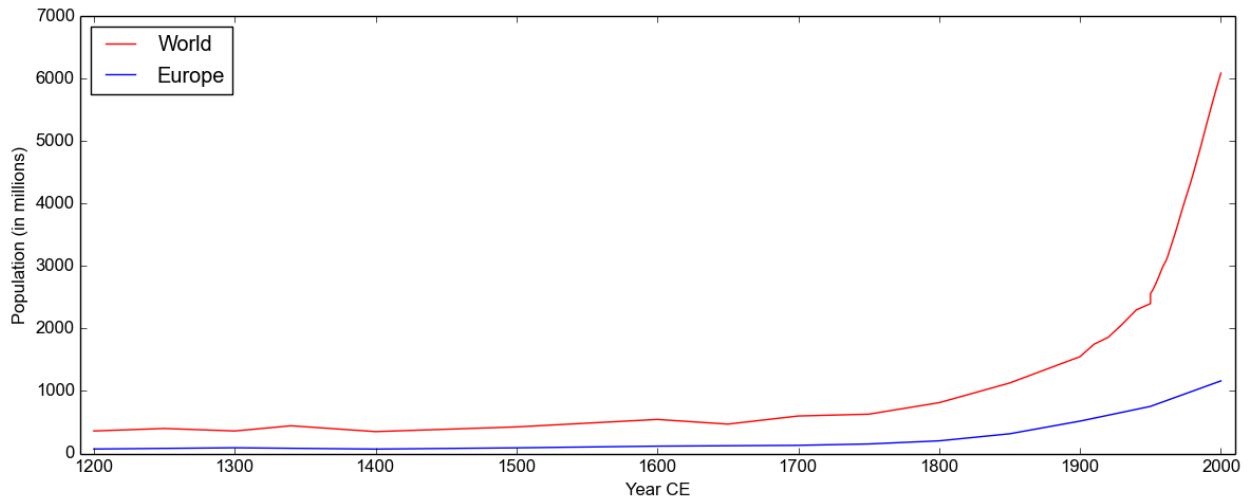


Figure 2-12, S5: World and Europe populations. Populations estimates vary from source to source, although all of them seem to follow an exponential growth (Schich et al., 558–562). European population growth follows the world trend (Bos et al., 515). See the reports by United Nations Department of Economic and Social Affairs Estimates, U.S. Population Reference Bureau and U.S. Census Bureau, and the summary table in Wikipedia. For related work see Clark, Durand, Thomlinson, McEvedy, and Jones. Also related are Noël Biraben (655-663), Tanton (162–173), Maddison, Klein Goldewijk, and G. van Drecht, and Bouwman, Kram, and Klein Goldewijk (93–112)

Table 2-1, S2: Number of total paintings and faces per century

| Century | Paintings | Faces |
|---------|-----------|-------|
| 13th | 884 | 2093 |
| 14th | 1846 | 3304 |
| 15th | 3350 | 5032 |
| 16th | 7909 | 10787 |
| 17th | 1950 | 1435 |
| 18th | 2015 | 1519 |
| 19th | 21441 | 7562 |
| 20th | 79998 | 14648 |

Table 2-2, S2: Number of paintings (with faces) and faces per painting style and century prior 20th century

| Century | Painting style | Paintings | Faces |
|----------------|---------------------------|------------------|--------------|
| 13th | Gothic | 790 | 2051 |
| 14th | Gothic | 173 | 273 |
| | Renaissance | 1600 | 2999 |
| 15th | Gothic | 526 | 1338 |
| | Renaissance | 2739 | 3642 |
| 16th | Baroque | 5012 | 5861 |
| | Mannerism | 2751 | 4824 |
| 17th | Rococo | 1859 | 1336 |
| 18th | Neoclassicism | 1954 | 1467 |
| 19th | Africanists | 226 | 74 |
| | Impressionism | 2838 | 891 |
| | Les Nabis | 340 | 67 |
| | Modernism | 4501 | 1327 |
| | Orientalists | 299 | 256 |
| | Pointillism | 219 | 13 |
| | Post-Impressionism | 2181 | 399 |
| | Realism | 5040 | 1476 |
| | Romanticism | 3645 | 2158 |
| | Symbolism | 1986 | 832 |

Table 2-3, S3: Number of paintings (with faces) and faces for the 20th century transavantgarde art movement

| Style | Paintings | Faces |
|--|------------------|--------------|
| Transavantgarde / Academicist Realism | 1730 | 515 |
| Transavantgarde / Contemplative Art | 244 | 0 |
| Transavantgarde / Critical Realism | 3038 | 912 |
| Transavantgarde / Figurative Expressionism | 4525 | 536 |
| Transavantgarde / Hard-Edge | 262 | 0 |
| Transavantgarde / Hyperrealism | 903 | 268 |
| Transavantgarde / Informalism | 2509 | 29 |
| Transavantgarde / Kinetic Art | 483 | 13 |
| Transavantgarde / Mexican Muralism | 839 | 484 |
| Transavantgarde / Minimalism | 139 | 0 |
| Transavantgarde / Misc. | 2475 | 121 |
| Transavantgarde / Monochrome Painting | 125 | 0 |
| Transavantgarde / Neo-Dada | 323 | 97 |
| Transavantgarde / Neo-cubism | 467 | 26 |
| Transavantgarde / Neo-figurative | 2194 | 454 |
| Transavantgarde / Neoconcretism | 304 | 1 |
| Transavantgarde / Neosurrealism | 2295 | 460 |
| Transavantgarde / Pop Art | 1635 | 580 |
| Transavantgarde / Spatialism | 597 | 2 |

Table 2-4, S4: Number of paintings (with faces) and faces for the 20th century avant-garde art movement.

| Style | Paintings | Faces |
|-----------------------------|------------------|--------------|
| Avant-garde / Abstraction | 2124 | 95 |
| Avant-garde / Cubism | 1404 | 77 |
| Avant-garde / Dadaism | 183 | 41 |
| Avant-garde / Expressionism | 3602 | 697 |
| Avant-garde / Fauvism | 597 | 114 |
| Avant-garde / Futurism | 682 | 28 |
| Avant-garde / Metaphysical | 405 | 49 |
| Avant-garde / Naïve | 526 | 320 |
| Avant-garde / Realism | 6695 | 2807 |
| Avant-garde / Surrealism | 5037 | 721 |

Table 2-5, S5: Number of paintings (with faces) and faces in the 20th century for painting styles other than avant-garde and transavantgarde.

| Style | Paintings | Faces |
|---------------------------|------------------|--------------|
| Current Art / Abstraction | 4380 | 83 |
| Current Art / Animals | 277 | 15 |
| Current Art / Still lifes | 1139 | 62 |
| Current Art / Draws | 1101 | 8 |
| Current Art / Geometry | 1821 | 6 |
| Current Art / Graphic Art | 977 | 40 |
| Current Art / Interiors | 1606 | 472 |

| | | |
|--------------------------------|------|------|
| Current Art / Landscapes | 1983 | 39 |
| Current Art / Myths | 671 | 235 |
| Current Art / Nude | 509 | 132 |
| Current Art / Other | 2272 | 314 |
| Current Art / Portraits | 2269 | 1162 |
| Current Art / Sketch | 4184 | 512 |
| Current Art / Urban Landscapes | 651 | 29 |
| Illustration | 1163 | 364 |
| New Objectivity | 369 | 163 |
| School of Paris | 1038 | 316 |
| Spanish Paintings | 6055 | 1012 |

External Database S1. List of paintings and metadata, paintings.xlsx.

External Database S2. List of faces and features, faces.xlsx.

External Database S3. List of authors and number of paintings, authors.xlsx.

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Chapter 3

3 It's All a Sham! The Role of Emotions in the Characters of Calderón de la Barca's *Autos Sacramentales*

3.1 Introduction

More than 60 years passed between Lope de Vega's (1562-1635) hegemony as the most successful theatre play author and the rise in popularity of Calderón de la Barca (henceforth Calderón) (1600-1681) as the most celebrated and popular author of the second half of the 1630 decade (Arellano, "Historia" 139-140). During this period, emotions were the only constant element in the poetry and the literary production of all the authors that attained success. For the long time in which theatre was mainly considered a global spectacle and only later a publishable product (Arellano, "Historia" 61), the theatre practice made increasingly more use of dramatic artefacts in order to build a sort of stack of dramatic techniques in which more recent methods would never cancel out the previous ones (Arellano, "Historia" 84).

Although in its first phase theatre was especially dependant upon poetic text –keep in mind that this theatre is always written in verse (Sánchez Escribano and Porqueras)–, the construction of the Coliseo del Palacio del Buen Retiro (1634),¹⁷ as part of the cultural propaganda and support of the arts by the Conde-Duque de Olivares, meant the beginning of a new cycle that would be transferred to all theatre stages (Brown and Elliott). For the inauguration of the Coliseo del Retiro, Calderón composed the comedy *El nuevo Palacio del Retiro* ("The new Palace of el Retiro," NP, 1634) and began to work with Italian scenographers Cosme Lotti and Baccio del Bianco in a collaborative process that would produce even more sophisticated works in terms of special effects, use of technology and elaborated scenography. Lotti and del Bianco were in fact engineers who had previously

¹⁷ Parque del Retiro is currently a park in the centre of Madrid but in the decade of 1630 it was one of the palaces in the outskirts of town where the king would spend most of his leisure time surrounded by the tamed nature, thanks to the work of engineers. The kings' habitual residence was located in the Palacio de Alcázar (currently known as Palacio Real), which had originally been a Muslim fortress that burnt down in 1734.

arrived to Madrid to take charge of different tasks related to ponds, gardens and theatres of royal palaces.

The use of varied spaces in theatre constituted the second line of development of Calderón's theatre of imagination (Suárez, "El Escenario"). Calderón exploits a concept of theatrical space and of theatre as a total show that stem from the notion of imaginary space. This conception has its source in the theatres of memory of Renaissance humanism –it is important to bear in mind that in some versions of the psychological theory of senses, imagination and memory overlap– and in the Jesuitical conception of imagination as the place of negotiation of affection. Calderón had studied in Colegio Imperial in Madrid, a school run by Jesuits, and therefore was well acquainted with both sources. A proof of this are the most theoretical reflections about art that Calderón puts in his characters' mouths, in which theatre is conceived as a stage of imagination (Suárez, "El Escenario"). In this sense, imagination is the conduct that triggers the affection of the characters' senses by means of the actor's body and his voice (Rodríguez Cuadros): horror, admiration, news, marvels, and the linguistic effects of the conceptist rhetoric of baroque poetry.

While this meta-theatrical conception manifests itself in all of the texts by Calderón, its practical implementation changes depending on the dramatic spaces. Spanish baroque authors initially worked in public theatres, which were known as *corrales* ("farmyards") at the time –the most famous ones are in Madrid: el Corral del Príncipe ("the prince's farmyard") and el Corral de la Cruz ("the cross's farmyard"). These *corrales* had a relatively small stage that had, at its sides, stands where the public could sit and, at the back, a wall that was known as the dressing building. It was precisely this wall that would open up in several ways to uncover different spaces that would oftentimes represent balconies which would accommodate the representation of remote places, magical effects or extraordinary events that extended the boundaries of reality (Ruano de la Haza and Allen). On the other hand, the Coliseo of Buen Retiro was already a theatre of Italian-type plant, based on the Teatro Farnese in Parma (1618) with a larger stage, a proscenium arch, a curtain, space at the back to create the illusion of perspective, and machines to recreate special effects.

Apart from these indoor theatres, which were mainly dedicated to the public from the city and from the court, Calderón used to work in open spaces such as palace gardens –*Amor, honor y poder* (“Love, honour, and power,” 1623) was represented on three different stages; each act took place on a different stage—, ponds in Parque del Retiro, and diverse public venues such as squares and streets in Madrid. This diversity of theatrical spaces correlates well with the diversity of genres that were popular at the time and that could go from traditional comedy (“normal plays”), and *autos sacramentales* (religious plays of allegorical nature), the so-called brief genres (*entremeses, jácaras, mojigangas*, etc.), to *zarzuela* and opera. Although *zarzuelas* and operas were typically created with a royal theatre in mind, they were often represented in commercial theatres with less technology. This variety, which in Lope de Vega’s poetry is key to satisfying the taste of his demanding audience, manifests itself in the diversity of topics that these works deal with, which range from honour plays to *comedias de capa y espada* (cloak-and-dagger comedies) or *enredo* (comedies of situation) to the progressively more frequent presence of mythological topics in Calderón’s most spectacular plays (Neumeister).

Independently of spaces and topics, it may be claimed that Spanish baroque theatre is a theatre of emotions that evolves thanks to its public’s unquenchable thirst for plays that were full of novelty and excitement. It is clear that as theatre plays gain in spectacularity, more technological and musical resources are used by the playwright to surprise his audience. On the other hand, literary and theatre devices are always present and were barely smothered by technology and special effects. Spanish baroque theatre had the intention to affect its audience’s imagination and senses, which, after all, shape their emotions.

In the aforementioned division of Calderón’s works into comedies and *autos sacramentales*, it is commonplace to attribute a greater emotional content to the former since their rhetorical structure and the possible range of topics and characters allowed for greater creative freedom. The manner in which comedies were composed in Calderón’s time generally followed the rules and formalities postulated by Lope de Vega in his *Arte nuevo de hacer comedias en este tiempo* (“New Art of Writing Plays in This Time,” 1609). However, authors were subject to an ever changing market due to the great

number of plays being presented at the same time and due to the sociological characteristics of the audience that attended the plays.

The thematic scope of the *autos sacramentales*, always played in public venues during the feast of Corpus Christi and written to exalt the mystery of Eucharist (Casa, García Lorenzo and Vega García-Luengos, 19), is relatively more limited compared to other genres. To start with, the plays to be presented were selected by the city hall. As a consequence, only the most popular authors of the time were likely to be chosen to write the plays. In addition, the topic of the play was restricted to just the mystery of the Eucharist, which, at least, could be approached from a variety of perspectives, such as biblically or historically (Varey). It was certainly the allegorical nature of the majority of the characters –*el Autor* (the author), *el Mundo* (the world), *el Pastor* (the priest), *la Belleza* (the beauty), etc.– that restricted the rhetorical possibilities of authors such as Calderón (Arellano, “Historia” 691-697). In many passages, the *autos* devote many verses to gloss over very abstract theological issues such as guilt, freedom, grace or Creation, or use the characters as bearers of virtues and vices. Due to this, the *autos sacramentales* have been frequently studied as “intellectual” plays with an important theological and philosophical component that sent a specific anti-Protestant message to a homogeneous audience (Arellano, “Historia” 690-691), and are an essential part of the baroque counter-reformist Catholicism (Orozco).

On the contrary, the reality of the *autos* is rather different as these are very complex works that appeal to the religious inclinations of spectators also by targeting their emotions (Suárez, “Complejidad” 58-74). If the social setting of the *autos* is marked by the Corpus Christi festivities and the celebration of the Eucharist, and there are strong theological messages that conform to the Catholic dogma, the dramatic nature of the *autos* still lives off the artist’ freedom and the open nature of the baroque work that are typical of 17th-century Spanish drama (Suárez, “El paisaje” 59-93). Regardless the social and religious role of the *autos* –or precisely, in order to be effective in fulfilling that

social role—, the main goal of the playwright was to move their audience by playing with emotions in the language, the staging and the evolution of the characters.¹⁸

In this study, we have tracked down the extent of the presence of emotions in the text of Calderón's *autos* with the help of a massive and, at the same time, detailed study of the sentiments expressed by the characters that Calderón created. Also, we have delved into the distribution of these emotions by studying the occurrence of positive and negative sentiments among different typologies of characters,¹⁹ so that we can offer a more nuanced view of the psychology of these characters, even when they are of allegorical nature.

It may be claimed that the *autos sacramentales* fulfil the four characteristics that José Antonio Maravall used to describe the culture of the Baroque —directed, massive, urban, and conservative (Maravall, “La cultura”). They are, above all, dramatic spectacles that play an important role in spreading an ideological agenda more related to the Catholic Church and religion than to the apparatus of the state. As spectacles infused with the poetics of the Baroque, the *autos sacramentales* are very complex pieces of theatre, structured in such a way that they can appeal in different ways to the various social and economic groups that are the audience of early modern cities. That is, neither the homogeneity of the theological message that the *autos* are to convey nor the allegorical nature of the characters, precluded the authors from composing multi-layered plays that made the emotional brain of the spectator as their desired target.

Thus, it is also true that the range of emotions and the intensity in which they were presented in the *autos* by Calderón also lent his craft to the principles of extremism and suspension that Maravall uses to define baroque techniques. That is, even if we accept that Calderón's *autos*, and especially *El gran teatro del Mundo* (“The great theatre of the

¹⁸ Hilaire Kallendorf has argued in her *Conscience on Stage. The Comedia as Casuistry in Early Modern Spain* that baroque plays are built in part as complex and detailed arguments of casuistry and that in many cases these plays put on stage “troubled consciences” (159-162).

¹⁹ “Sentiment” is the preferred term used in artificial intelligence to refer “the use of natural language processing, text analysis and computational linguistics to identify and extract subjective information in source materials.” (Wikipedia).

world,” GT, 1635), are the best example of Maravall’s vision of the Spanish baroque, these same *autos* are built through a toolbox of rhetorical resources that rely on the senses, the imagination, and the emotions of the spectators. The rhetorical and spectacular resource to emotions and feelings in order to play with the audience’s emotional states fits in very well with what Angela Ndaliansis called the “assault on the sensorium” (Ndaliansis, *Neo-Baroque*), that Calderón exploits through the classical theory of imagination (Suárez, *Escenario*).

This theory of imagination, based on Aristotelian psychology and brought to modernity thanks to multiple transformations, such as the one made by Avicena in his *Canon* (1020) or Pico della Mirandola in *On the imagination* (1536), claimed that imagination –one of the humans’ inner senses– was part of the human being and was used to filter what was perceived by external senses in its way to the most noble parts of the soul. In the neoplatonic branch of this tradition that highlights metaphorical knowledge (Martin, 46), imagination was also part of the human being and it had been formed with materials of the superior world, which was useful in order to explain why men had access to phenomena that belong to afterlife, to magic and astrology. Calderón would later on exploit all these elements as part of his theatrical practice in an attempt to amaze, affect, and suspend his audience’s emotions. The transition from psychology to dramatic poetry –also the poetry of baroque sermons– took place thanks to plays like *Examen de ingenios para las ciencias* (“The Examination of Men’s Wits,” 1575) by Huarte de San Juan and *Philosophía Antigua Poética* (1596) by Alonso López Pinciano (Suárez, *Escenario*). In this way, when Lope de Vega composed his *Arte nuevo* in 1609 and claimed that satisfying spectators’ thirst is the only criterion that an author should follow in order to be successful in the Spanish scene, he is basically adapting the theory of imagination within a baroque and modern aesthetics. In order to develop his theatre of imagination and emotions, Calderón was inspired by this aesthetic position and by diverse established practices in different decades of commercial theatre and public performances.

In this way, a comprehensive study of the role of sentiments in the creation of the characters of the *autos* will help us understand how baroque theatre created massive successful performances for many decades precisely by appealing to sentiments and

opinions that the audience may have shared. It seems likely that the sensorium apparatus of the baroque theatre was much more complex and more dependent on the creation of emotions and sentiments than had been previously believed by mainstream critics of Calderón's work (*e.g.*, Neumeister; Orozco).

In recent years, with the emergence of the World Wide Web and the so-called Web 2.0 (O'Reilly), sentiment analysis has become an essential technique in the decision-making process.²⁰ Most companies and brands covet consumers' perceptions and opinions of their latest products so that their marketing strategies can be modified accordingly. The basic computational treatment of opinions consists in determining the semantic orientation of a text; that is, whether the text is expressing a positive or negative message. In order to establish this polarity, previously evaluated texts need to be provided to be used as a baseline upon which assess new and unseen text. Sentiment analysis is typically conducted using massive amounts of online comments and reviews already evaluated in popular sites, forums or social networks. Given this set of texts assessed by humans, techniques from natural language processing and machine learning allow us to build software programs able to predict the polarity of an arbitrary text. This software, usually referred to as classifier, allows companies to gain insight into what consumers loved most of their new car or what people disliked of their new gadget, always based on past opinions.

In this process, the flow always goes from the people to the products, since it is the people who influence how the product will be modified in the future. The question we ought to ask, then, is whether we could use the inverse approach in order to influence how people feel by purposely altering a product feature. Taking this one step further, we could also ask whether people's reactions could be altered by creating a specific discourse. Looking at the field of psychology, there seems to be evidence that one may do so. The anchoring effect, by which individuals, when given a hint or an "anchor" in a question, tend to choose a response that bears a relation to the initial anchor, is an example of how people's reactions can be modified by the presence of a specific previous

²⁰ Also known as *opinion mining*.

discourse (Strack and Mussweiler, 437). Whereas previous studies have examined the extent of this effect mainly through the interaction of a question and a subsequent response, we speculate that adding anchors in a more subtle way, namely, by using the power of the theatrical metaphor, rhetorical tools and interpretation will yield similar results. In fact, the importance of language in the creation of emotion experiences and perceptions has been recently brought to light in developmental and cognitive science: “language plays a role in emotion because language supports the conceptual knowledge used to make meaning of sensations from the body and world in a given context” (Lindquist, MacCormack, and Shablack). This notion of language as a “glue” that binds concepts to embodied experiences would allow Calderón to shape the processing of sensory information to create emotional experiences and perceptions.

If this is so, we would be able to understand why Maravall plays around in his theory with two sets of ideas that are apparently contradictory. On the one hand, he defines baroque culture as a culture that is focused on the control of masses. On the other hand, he refers to certain mechanisms of play and baroque work creation that appeal fundamentally to the individual emotions of spectators. But if we accept that the massive nature of baroque plays makes the dispersion of ideological and religious information more efficient and that this dispersion makes use of mechanisms such as the provocation of emotional responses by means of the careful construction of the dramatic discourse, both parts of the Maravallian theory would be harmonised. In addition, we would have a more nuanced explanation of the complementarity of the resources that targeted the masses and those resources that targeted the emotional individuality of the urban spectators of different social classes. Thus, we hypothesise that this resource has been extensively used by authors of plays of all times. Specifically, we believe that Calderón de la Barca voluntarily used deception as a sophistry to spread subliminal messages to his audience, by means of having them empathise with some of the characters in his plays.

Furthermore, the beginnings of the printing press in Spain, which brought with it the first articulation of mass media methods of dissemination in the 17th Century, also played an important role in the space occupied by Calderón in the machinery of sentiment-creation in baroque Spain. There is evidence to believe that as the coverage of an issue in the

media increases, the more accessible it will remain in the audience's memories (Iyengar, 1-15). It is very unlikely that gazette editors at the time knew about this effect known as the accessibility bias, and still personalities such as Juan de Austria, King Charles II of Spain's favourite, commanded the creation of a gazette to promote his popularity. However, it would take at least another hundred years for the newspaper to become popular among the low class with the apparition of almanacs and signs. During this time the *corrales* filled the absence of an affordable medium ready to be consumed by a mostly illiterate population. Therefore, we propose that Calderón was one of the several successful subtle and elegant mass influencers of his time. We hypothesize that, through his works and their representations, Calderón had an influential effect on his audience similar to that of mass media nowadays (Ndalianis, *Neo-Baroque*).

In order to demonstrate how Calderón tried to influence his audience's reactions through his discourse, we based our study on the characters created by him in his *autos* as characterised by the *Diccionario de los autos sacramentales de Calderón* ("Dictionary of the autos sacramentales by Calderón"), first published in 2002 by Ignacio Arellano ("Diccionario"), which is, to this day, the most exhaustive and extensive account of the *autos*. We used the speeches of the characters as inputs for an automatic classifier previously built upon averaged real evaluations of all the sentences in 10 of the *autos*.

3.2 Methodology

Our dataset is composed of 73 of the plays included in the collection of *autos* by Calderón de la Barca edited by GRISO-Universidad de Navarra and Edition Reichenberger.²¹ This collection, which started in 1992 and is close to being completed, has achieved a major effort by collating a set of volumes with critical editions of all the *autos* ever written by Calderón de la Barca (including some of dubious attribution).²² As of today, 76 of the *autos* have been already edited, out of which only 3 were not included

²¹ See <<http://www.unav.edu/centro/griso/>>.

²² For a list of the specific *autos* used in this study see Appendix.

in this study since this project demanded that the *autos* had the date of composition or the date of first publication.²³

In the critical editions of the *autos*, some criteria were taken into account by the *autos* editors that we disregarded for the purpose of our analysis. The first measure we took was to accept all the added omissions as part of the original text (i.e. [*Nembrot y Salvajes*], where the brackets mean that the text was originally missing and was later added by the editor, becomes simply *Nembrot y Salvajes* for us). We also decided to ignore all the texts that are not part of the speech of a character. This includes the omnipresent introduction of *chirimías* (shawms),²⁴ and all the stage directions given by Calderón about where the character must go or who he/she must talk to, among other notes. Normalization of the names of the characters was another necessary step, so that, for example, the three variations of *Melchisedech* (*Melquisedec*, *Melquisedech*, and *Melchisedec*) could be treated as only one in our analysis. Unfortunately, this process was less straightforward in other cases, as is the case with *Primer Adán* (first Adam) and *Segundo Adán* (second Adam). As the purpose of our study was to identify how the characters' speeches are perceived, we merged both Adams together despite their obvious different conceptions (Arellano, "Diccionario"), thus creating a unique *Adán* that would subsequently be included in a bigger category of characters. Furthermore, speeches made by more than one character at the same time were unified under the term *Varios* (several), which is a grouping of characters that does not appear *per se* in the *autos*. At the same time, *Varios* should not be confused with *Todos* (everyone), *Toda la Música* (all the music), or other variants, as these groupings of characters keep their original name in Calderón's text and in our analysis. Finally, the verses that make up the speech of each character were put together and then split into sentences and words using a Punkt tokenizer for Spanish, a tool that is included in the software for natural language processing NLTK (Bird; Kiss and Strunk, 485-525). An example of some verses

²³ Only plays with a date were considered as we aimed to find patterns of emotions over time.

²⁴ A shawm is a wind instrument profusely used by Calderón in his plays. Every time a shawm was introduced, and given its penetrating tone, usually a change took place in the play, either characters leaving or entering the scene, and end of act, or some other dramatic circumstance.

converted into the final data format can be seen below (*La torre de Babilonia*, TB, 1675) and in table 1.

| | | |
|-------------|--------------------------------------|-----|
| Noah | Sovereign paranymp, | |
| | faithful entrusted to your | 580 |
| | word, I depart where | |
| | with constant faith | |
| | I will always be waiting for the day | |
| | when I return to see again | |
| | the innumerable family | 585 |
| | of the sons of Noah. | |
| | Because you command I leave, | |
| | if your feet I don't kiss is | |
| | because I do not deserve to touch | |
| | the sandals of your feet. | 590 |

He leaves.

| | | |
|-------------|----------------------------|-----|
| (Noé | Paraninfo soberano | |
| | en tu palabra fiel | 580 |
| | confiado, parto donde | |
| | con siempre constante fe | |
| | estaré esperando el día | |
| | en que he de volver a ver | |
| | la familia innumerable | 585 |
| | de los hijos de Noé. | |
| | Porque lo mandas me parto, | |
| | si el pie no te beso es | |
| | porque tocar no merezco | |
| | las sandalias de tus pies. | 590 |

Vase)

Table 3-1: Same excerpt now split into sentences and converted into tabular data.

| Code | Title | Year | Character | Start | End | Speech | Words |
|-----------|-----------------------|------|-----------|-------|-----|---|-------|
| TB | La torre de Babilonia | 1673 | Noah | 579 | 586 | Auditorium sovereign, faithful entrusted to your word, I depart where with constant faith I will always be waiting for the day when I return to see again the innumerable families of the sons of Noah. | 35 |
| TB | La torre de Babilonia | 1673 | Noah | 587 | 590 | Because you command I leave, if your feet I don't kiss is because I do not deserve to touch the sandals of your feet. | 20 |

Once the texts were tabulated, we started the creation of a sentiment classifier in order to apply sentiment analysis on the texts. Sentiment analysis can be defined as the task of classifying the sentiment expressed in, or perceived from, a medium, normally a text. The type of materials that undergo sentiment analysis are typically user-generated content, such as texts extracted from social networks or review sites. For these cases, which present a lot of texts to be handled at the same time, an automated approach to classifying is much more desirable. Binary classification of text has existed in machine learning for a long time and current implementations of automatic classifiers are based on early works by Peter Turney and Bo Pang (Turney; Pang, Lee and Vaithyanathan),²⁵ whose main goal was to identify the polarity (whether they were positive or negative) of products and movie reviews, like those in Amazon.com and IMDb.com web sites, respectively. Although their methodology was applicable to our study, we were forced to build our

²⁵ For binary classification of text in machine learning see Joachims.

own annotated corpus that would let us create a domain-specific classifier for two main reasons. Firstly, there is a clear difference in complexity between product reviews and 17th-century Spanish Golden Age theatre. Secondly, there is a lack of annotated corpora available for sentiment analysis of theatre of this period. Creating our own annotated corpus allowed us to apply Turney and Pang's methodology effectively.

From the aforementioned set of *autos*,²⁶ we randomly selected ten to be used as a training set for the rest of the *autos*: *El cubo de la Almudena* ("Almudenas's pail," CA, 1651), *La humildad coronada de las plantas* ("The crowned humility of plants," HC, 1644), *La hidalga del valle* ("The noblewoman of the valley," HV, 1634), *El lirio y la azucena* ("The iris and the lily," LA, 1660), *Llamados y escogidos* ("Called ones and chosen ones," LE, 1649), *El árbol del mejor fruto* ("The tree of the best fruit," MF, 1661), *No hay más fortuna que Dios* ("No more fortune than God," NH, 1653), *El orden de Melchisedech* ("Melchisedech's order," OR, 1657), *Quién hallará mujer fuerte* ("Who will find strong women," QH, 1676), *El socorro general* ("The general relief," SG, 1644).²⁷ We then extracted the different sentences (more than 5,000) and fed two different crowd-sourcing systems with them. The first system was our own deployment of the open-source Python-based PyBossa,²⁸ which asked 7 subject participants to read and assess the sentiment associated to the given sentences by using a discrete scale from -2 to 2 ("Very Negative", "Negative", "Neutral", "Positive", "Very Positive"), until a redundancy of 3 evaluations per sentence was achieved. These participants were educated adults, between the age of 18 and 30 who completed the task for compensation. The second system was the Amazon Mechanical Turk (Paolacci, 411-419), where three different persons (which shared the profile of our PyBossa participants) assessed all the sentences. In this case, however, we were not able to define the scale and finished with a gradation from -1 to 1 ("Negative", "Neutral", and "Positive") and also a redundancy of

²⁶ See Appendix for the complete list of *autos* and their corresponding codes.

²⁷ Free translations of titles. There are no translations in English of the given titles; some titles are very culture-dependent and may not make sense in English. Articles and research that focus on *autos* consistently use the Spanish titles.

²⁸ See <<http://bossa.cultureplex.ca/>>.

3. In other words, we gauged positive and negative responses (including scales of intensity in each) which relate to emotional responses and that can serve as proxies of the emotional responses of Calderón’s audiences to the characters represented in the *autos*. The results derived from this study were used to build the database from which, later on, the classifier was developed.

After normalising the different scales and averaging per sentence evaluation, we assigned the tag “pos” for values greater than 0, “neg” for lesser than 0, and rejected the rest since we were not interested in neutral evaluations. In order to create a binary classifier, which would be able to predict, given a sentence, which class it belonged to, “pos” or “neg”, we used the scikit-learn library (Pedregosa et al., 2825-2830), along with Pandas and the IPython Notebook (McKinney). We randomly split the annotated corpus into two sets: a training set with 80% of the sentences and a testing set with the remaining 20%. The slicing of the original corpus was later cross-validated. After trying several models, a stochastic gradient descent estimator (SDGC) with tf-idf weighting outperformed any other combination with an accuracy of 73.71%, precision of 75.26%, recall of 92.80% and an unweighted F-score of 83.11% (Blei, Ng and Jordan, 993-1022; Bifet and Frank).²⁹ While a 73.81% might be seen as not accurate enough, Amazon Mechanical Turk reported that humans only agree 79% of the time,³⁰ which makes the performance of our classifier almost as accurate as that of humans.

We ran the classifier against the rest of the sentences (more than 30,000) and calculated the probability of a sentence being classified as either “pos” or “neg”. We also calculated the lexical diversity (defined as the number of distinct words divided by the total number of words), and the ratios of words per sentence and per verse, as the complexity of a text measured in terms of its lexicon is usually used for the assessment of the sentiment expressed. This gives us the materials to assess the emotional response to Calderón’s

²⁹ Precision is a measure of hits vs. errors, while recall is a measure of hits vs. misses. High precision means that positive sentences do not end up classified as negative; high recall means that no negative sentences end up classified as positive. For a further explanation on the measures see Lewis and Ringette.

³⁰ See <<http://aws.amazon.com/mturk/>>.

texts and, therefore, to better understand the psychological evolution of these complex, albeit allegorical figures that make up the *autos sacramentales*.

3.3 Typology of Characters

In baroque Spanish comedies there are several typical characters –the villain, the young lady, the gallant, the king, the joker– that in some occasions are also used in the *autos*. When they are used in the *autos*, the allegorical side of the characters are wrapped up around these types. For example, the young lady can also be representing Beauty or the vice of Luxury, depending on the works, whereas the old man would be playing the figure of the Author. Given the hundreds of plays composed for the stage during this period –critics estimate that just Lope wrote around 500 plays– and the development of an appreciation for this theatre by the public, it is reasonable to assume that the public had certain expectations about the range of behaviours and emotions embodied by specific types of characters. At the same time, there is a level of ambiguity built into the poetics of Spanish baroque theatre as the model popularised by Lope in his *Arte nuevo* proclaimed the need to mix the comic and the tragic and make of hybrids a resource to surprise and impact the public.

Some characters in the *autos* may seem to fall into recognisable types that could engage with specific emotional responses, as in the case of villains or heroes. Since there is a lack of a complete dictionary of the characters in the *autos*, an important part of our approach was to classify characters into different groups to locate the defining features of each. There is previous research on some of Calderón’s characters, either in specific plays or globally,³¹ but none that we are aware of have tried to classify all the characters into categories and analyse the positiveness of each group. In this context, “positive” means that the sentences of the characters of a category have been classified as positive by our classifier, and therefore those sentences would likely be assessed as expressing a positive sentiment by a human reader, and vice-versa for negativeness. We propose the next, not mutually exclusive, types of characters and let the analysis of the text declare

³¹ For example, see Ignacio Arellano (“Autos Sacramentales”), Entwistle (223), or Reyre

how the characters can be classified. With this classification we attempt to dispose of as much subjectivity as possible in order to avoid entering into the hermeneutics of the Calderón's creations.

3.3.1 Gender

Guessing the sex of a character was evident sometimes, but other times it was very deceptive. Characters such as *Aarón*, *Adán*, *el Rey* (the king), or *Isaías* are undoubtedly males. Incidentally, all the seven deadly sins, among other concepts usually perceived as negative, are feminine characters; as suggested by James Maraniss, this could have more to do with the Spanish language itself or even the Christian tradition than with a deliberate action on the part of Calderón, although it still “suits Calderón’s thought well enough” (Maraniss, 18-28). Therefore, when the sex of the character was not disclosed in the text, we proceeded in two different steps. To start with, if the character’s name coincided with a common noun of Spanish, such as *Voz* (voice), which is a feminine noun, we used the gender of the noun to tag the character as either male or female. If, on the contrary, the gender of the character could not be deduced from other accounts (such as historical or biblical) and its name was not an existing noun in Spanish, we used the gender of modifying articles and adjectives to assign masculine or feminine gender to the character. This was the case of *Amalec*, who could be a biblical figure or the representation of a tribe or a place. In this case, we classified this character as masculine because of the expression “Amalec valeroso” (brave Amalec), where the adjective is overtly masculine.

3.3.2 (Existential) Plane

This category covers the following cases in order of precedence: biblical characters such as *Saulo* (Saint Paul), theological abstractions like *Penitencia* (penance), allegorical incarnations as in *los Cinco Sentidos* (the five senses), mythological beings such as *Andrómeda* (in the Greek tradition, daughter of Cepheus and Cassiopeia), historical figures such as *Almanzor* (the *de facto* ruler of al-Andalus in the late 10th to early 11th centuries), or just people (real or fictional) in supporting roles, like *Soldado* (soldier) or *Criado* (servant). *Gedeón*, an actual historical warrior and biblical judge, is annotated

only as a biblical character because his biblical role has precedence over the historical one.

3.3.3 Sphere

This category encapsulates the social sphere that the character is normally associated with. As an example, *el Rey* is almost always linked to nobility, unlike the *Segador* (reaper), who is usually related to laymen, or *el Sacerdote* (priest), bound to clergy. With this classification we avoid the questionable class distinctions between ‘high and low’ character status and, at the same time, we come closer to a more sociological approach that goes beyond the traditional types normally described in the manuals of literary history. As proposed by Maravall, a realistic social distribution adds an “objective” sociological dimension based on the principles of identity, totality, and opposition which are expressed not in the individuals’ opinions, but in the collective action of the members of a specific sphere.³² Although this seems to fit well with some of the characters in the *autos*, others would not play a role in society as we usually conceive it nowadays, albeit being of vital importance in the allegorical world of Calderón. Examples of these characters are saints or allusions to Jesus Christ (classified as supernatural) and concepts of moral or psychological dimensions, such as *Entendimiento* (understanding), *Justicia* (justice) or *Razón* (reasoning).

3.3.4 Role

Occasionally, Calderón himself added additional information about the characters, either in the text or at the beginning of the play in the *Personas* (characters) section. Different values such as villain, gallant, shepherd, wise man, gipsy, or priest are included in this category. It was also very common that some characters, biblical or historical, were intended to be played as themselves.

We could have created a typology as exhaustive as we would have wanted, for example, by splitting the social sphere to also cover the supposed addressee in the real world of

³² See García Lorenzo (“Calderón”) and Maravall and Martínez-Lázaro (“Estratificación” 48).

each character's speeches or by differentiating their existential planes to include virtual artefacts, as in *Labranza* (farming), or physical ones, as in *Esqueleto* (skull) (Suárez, "Para Una Teoría"). However, such fine grained categorisations would end up having almost as many sections as there are characters, as such is the complexity of Calderón's creations, thus becoming a pointless classification. Secondly, it would rely too much on the interpretation of the texts, losing all traces of the first intended objectivity. The categories we proposed are nuanced enough to differentiate almost each one of the characters, i.e., *Levita* is classified as a feminine character, in an allegorical plane of existence, member of the clergy, and playing the role of a priest in the *auto*. No other character in the *autos* shares the same classification.

3.4 Quantitative Analysis of *Autos*

We analysed more than 430 characters, whose combined discourses produced around 613,000 words distributed in 140,000 verses and 37,000 sentences.³³ The longest *auto* is *El convite general* ("The general reception," CG, 1648) with 3,249 verses, followed by *La nave del mercader* ("The merchant's ship," NM, 1674), *La viña del Señor* ("The Lord's vineyard," VI, 1674), *El cordero de Isaías* ("The lamb of Isaiah," CI, 1681) and *El día mayor de los días* ("The greatest day of the days," DD, 1678). In the lower bottom of the list we find *El primer blasón del Austria* ("The first blazon of the Austria," PB, 1635), the shortest, and then *El divino Jasón* ("The divine Jason," DJ, 1630), *El gran duque de Gandía* ("The Grand Duke of Gandía," GD, 1639), *La iglesia sitiada* ("The besieged church," IS, 1630), and *Los encantos de la culpa* ("The charms of guilt," EC, 1645). Regarding the complexity of the plays, Figure 2 shows their lexical diversity, sorted by year and ranging between 0 for texts with no unique words, to 1 for texts that never repeat a single word. The *autos* *La vida es sueño* ("Life is a dream," VSP, 1635) and *El divino Jasón* ("The divine Jason," DJ, 1630) are ranked as the most lexically diverse, whereas *El convite general* ("The general reception," CG, 1648) and *El día mayor de los días* ("The greatest day of the days," DD, 1678) as the least.

³³ More than 4,500 stage directions were only used to annotate characters' categories but not analysed.

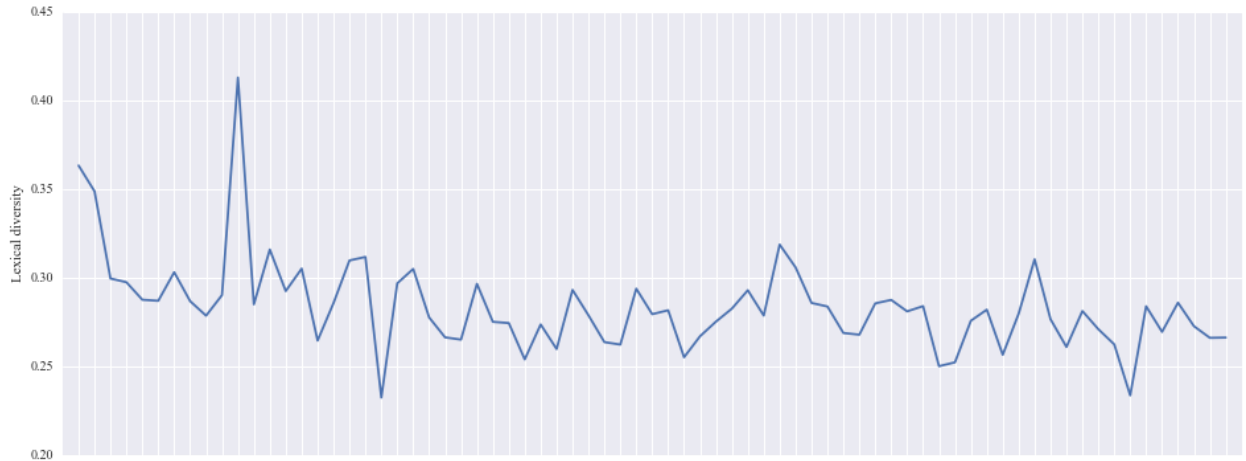


Figure 3-1: Lexical diversity of *autos* over time. This graph illustrates the lexical diversity of the *autos* sorted by year.

However, what is really important to notice is the fluctuation of lexical diversity as time progresses. In fact, this tendency still holds when grouping the *autos* by year, as shown in Figure 3. There seem to be no historical reasons for this and we cannot help but wonder whether this is an intended result by Calderón or just mere coincidence.

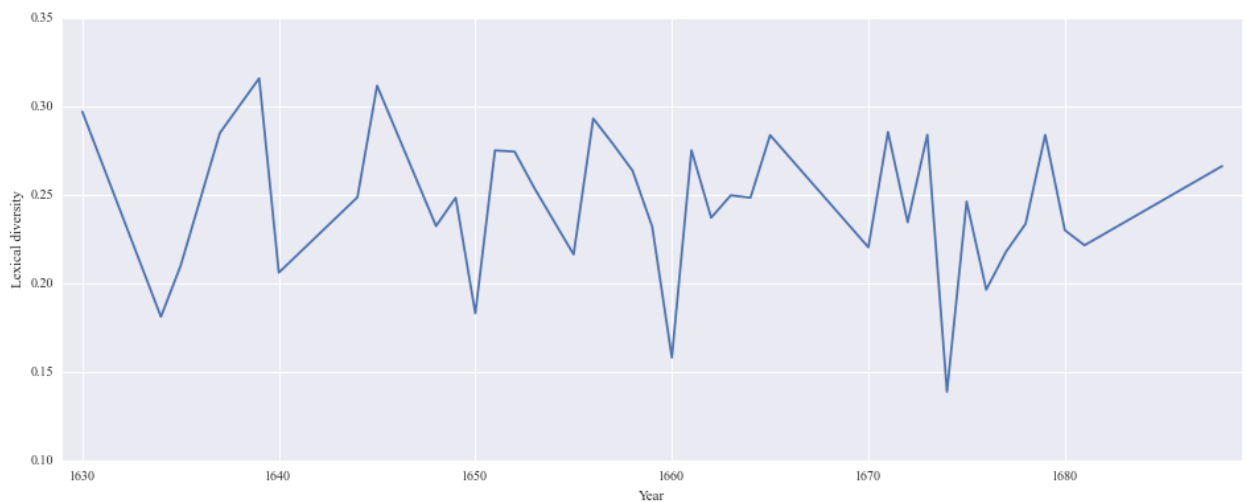


Figure 3-2: Lexical diversity over time. Lexical diversity of *autos* averaged by year.

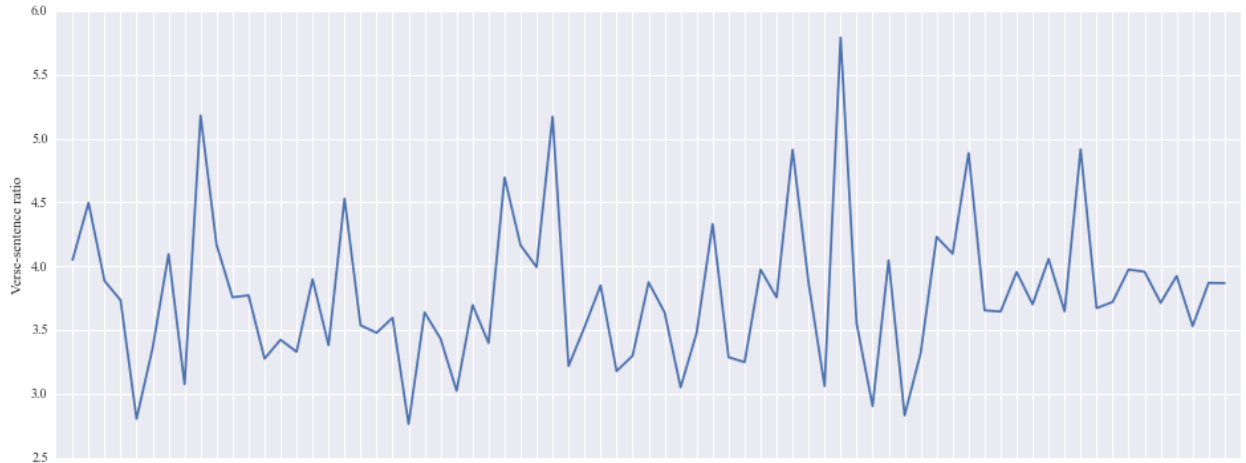


Figure 3-3: Verse-sentence ratio of *autos* over time. Number of verses per sentence in *autos* sorted by year.

Given the fact that almost nothing is accidental in his work and that the diversity of a play is a measure of its richness, we hypothesise that Calderón was adjusting the complexity of his texts according to their audience. To further demonstrate this, we used a rough approximation of complexity: the ratio between the number of verses divided by the number of sentences. Longer sentences are split among many verses, thus making their meaning more difficult for the audience to grasp. Figures 4 and 5 show consistency with this result, although correlation is only significant between averaged values of lexical diversity and verse-sentence ratio, both grouped by year (Pearson coefficient of 0.73, p-value < 0.01). Results are very similar for word-sentence ratio, and distributions are practically the same in both ratios (Pearson 0.97, p-value < 0.01).

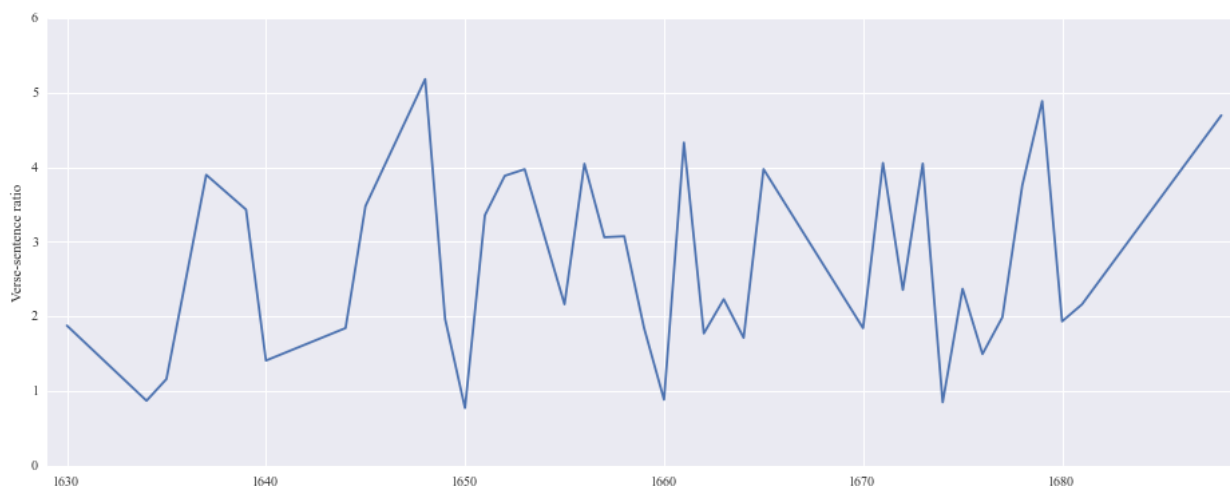


Figure 3-4: Verse-sentence ratio over time. Average number of verses per sentence grouped by year.

Furthermore, the length of the *autos* grouped by year is also inversely correlated with both verse-sentence ratio (Pearson -0.80, p-value < 0.01) and diversity (Pearson -0.90, p-value < 0.01). In line with our intuitions, the longer the play, the less diverse and lower the number of verses per sentence. This could be a generalizable result or a clue about who the intended audience of each play was. On the other hand, the only relation between sentiments and the length of a play is a weak correlation with respect to the probability of a sentence being positive (the probability of a sentence being negative is just the opposite case) and averaged by *auto* (Pearson 0.46, p-value < 0.01, see Figure 5).

This fact adds to our previous result about the length of *autos*, the longer the *auto*, the more positive is the overall sentiment classification of the play by our algorithm, which suggests that different *autos* were conceived with different emphasis for different audiences. Long, rich and positive plays, possibly with denser backgrounds and deeper meanings, could have been primarily intended for nobles and well-educated people. Short, plain, and negative *autos* were presumably addressed for the least educated sector of the population. Examples of the former include *El convite general* (“The general reception,” CG, 1648) or *Lo que va del hombre a Dios* (“So far this man to God,” LQ, 1640), and *Los encantos de la culpa* (“The charms of guilt,” EC, 1645) or *Los misterios de la misa* (“The mysteries of the mass”, MM, 1640) for the latter. To further support this

idea, we resorted to our typology of characters, and discovered that shorter plays usually have more representation of characters in the social sphere of the laymen. In particular, we found that in the 10 shortest *autos*, the amount of verses of characters under the laymen category outnumbered those under clergy by an average factor of 12, those under nobility by 7, and those under supernatural by 4.

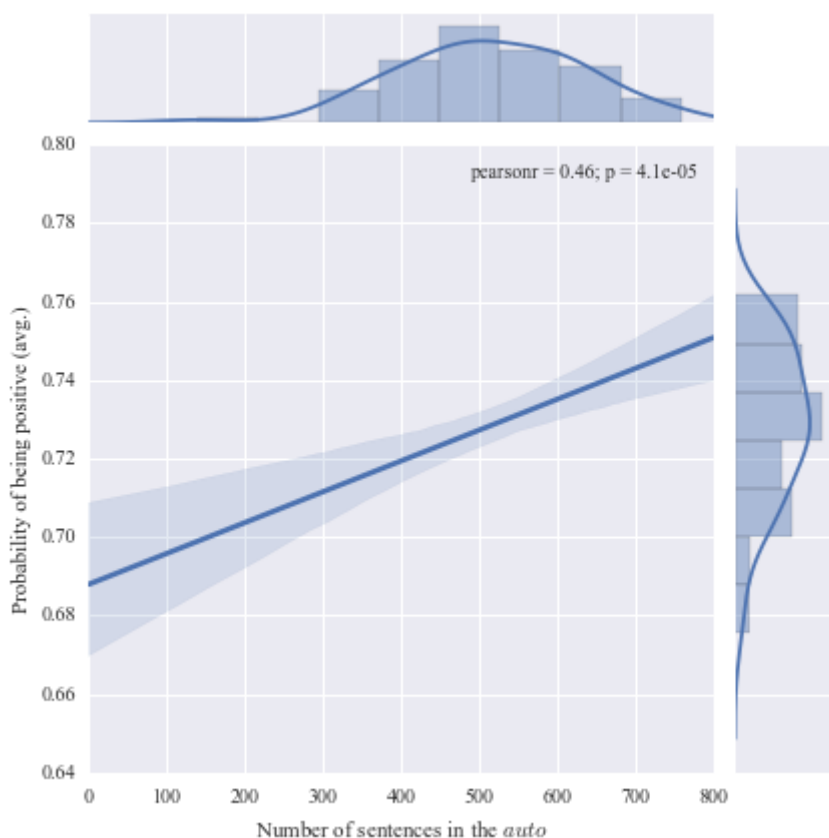


Figure 3-5: Correlation between sentiment and length of *autos*. Distribution of the number of sentences in an *auto* and the probability of the *auto* being positive, calculated as the average of the probabilities of its sentences.

These are the first pieces of evidence of Calderón's attempts to empathise with his audience. Not only that, but these results would show a conscious effort from Calderón to engage in emotionally different ways with diverse audiences. This is to say that if the shorter *autos* show a tendency towards low social class characters and, in addition, send a generally negative message, we could hypothesise that such negativity outlines a feeling of fear that would drive these social classes to assent to their socio-political condition

without questioning the social and economic *status quo*. This conservative version of the baroque has been traditionally defended by many critics, who have typically centred their arguments on the auto *El gran teatro del Mundo* (“The great theatre of the world,” GT, 1635). This auto certainly seems to support this political vision from a religious interpretation of the world: each of us has to accept the role they have been assigned in the play of life.

It should be taken into account that the vast majority of *autos* ended up being represented in front of a diverse audience since they were meant to be shown in public celebrations in the streets of Madrid (and other cities). The fact that all sorts of audiences had access to these plays would question our hypothesis unless it were the case that the identification of the different types of public with their social equivalents was so strong and their sympathy for these characters was so profound that this psychological mechanism constituted a tool for Calderón to address his audiences in different ways.

Another important aspect that should be explored more carefully is the relation between longer plays and the festive nature that is typically associated with later plays, which featured more musical and mythological content. This comparison is complicated because we do not always have specific information regarding the representations of the places and, in many cases, all we have is the dramatic text and some scattered information. We have proven that generally, the later the *autos* are composed the longer they are and, also, the more positive they become in terms of the emotions they convey. This is a direct result of the fact that later in his career Calderón devoted more and more effort to develop works of mythological theme that made part of the so-called baroque total art work and that became the backbone of festive spectacles filled up with technology, special effects, and music: they are the very first works of entertainment of the Early Modern Age. These pieces of entertainment water down the negative load of sentiments associated to earlier and more conservative plays.

In any case, these results clearly show the intention and command of Calderón over the emotional effect that his plays would have on his public, his capability to regulate positiveness and negativeness of emotional messages, the choice of different social

groups are the main object of his poetry and the capability to alleviate emotionally the messages when play become more spectacular and technologically advances. Calderón would, therefore, be following what one of his characters says in the auto *Los encantos de la culpa* (“The charms of guilt,” EC, 1645):

Don't you see
that they are Human senses
and that in the end it is needed
relieves that divert them
from the fatigues they were born!

(No ves
que son sentidos Humanos
y que al fin es menester
alivios que los diviertan
de las fatigas en que han nacido!)

3.5 Character's Sentiments

Unfortunately, total numbers and global statistics do not contribute much to the understanding of the characters and audience's perception of them. If Calderón was actually trying to promulgate empathy for specific characters, we need to look at the prevailing sentiment of their specific interventions. Using the results provided by our classifier and the different categories that we annotated the characters with, we know that characters such as *Nacor*, *Criado* (servant) or *Leproso* (leper) are among the ones with the most positive discourse as classified by our algorithm; while the interventions by *Bernardo*, *Leví* or *Teutónico* receive the most negative perception. Even with an impressive average probability of 98% of being positive, *Nacor* is not representative as his participation, which only takes place in the auto *El viático cordero* (“The viaticum lamb,” VC, 1665), barely counts up to 0.19%. For this reason, we ignore characters whose participation ratio is lower than 1%, measured as the result of dividing the number of verses of a character's interventions by the total number of verses of the play. If the character appeared in more than one play, then the ratio of participation is averaged.

After excluding those, the characters with the most positive message are *Dentro* (the undetermined character used in the plays to designate that someone or some people are speaking outside the stage), *Centro* (center), *Aqueronte*, *Aminta*, *Panadero* (baker), *Levita* (Levite), *Labranza* (farming), *Sísara*, and *Saúl*. On the other side, the ones with the more negative sentiment are *Ley* (law), *Melchisedech*, *Tiburtina*, *Pérsica*, *Orden Sacerdotal* (priestly order), *Felipe*, *Baptista*, *Templanza* (temperance), *Isaías*, and *Fortaleza* (strength). Although this seems to be a hodgepodge of characters (both males and females, in different existential planes, and playing a variety of roles) some patterns start to emerge.

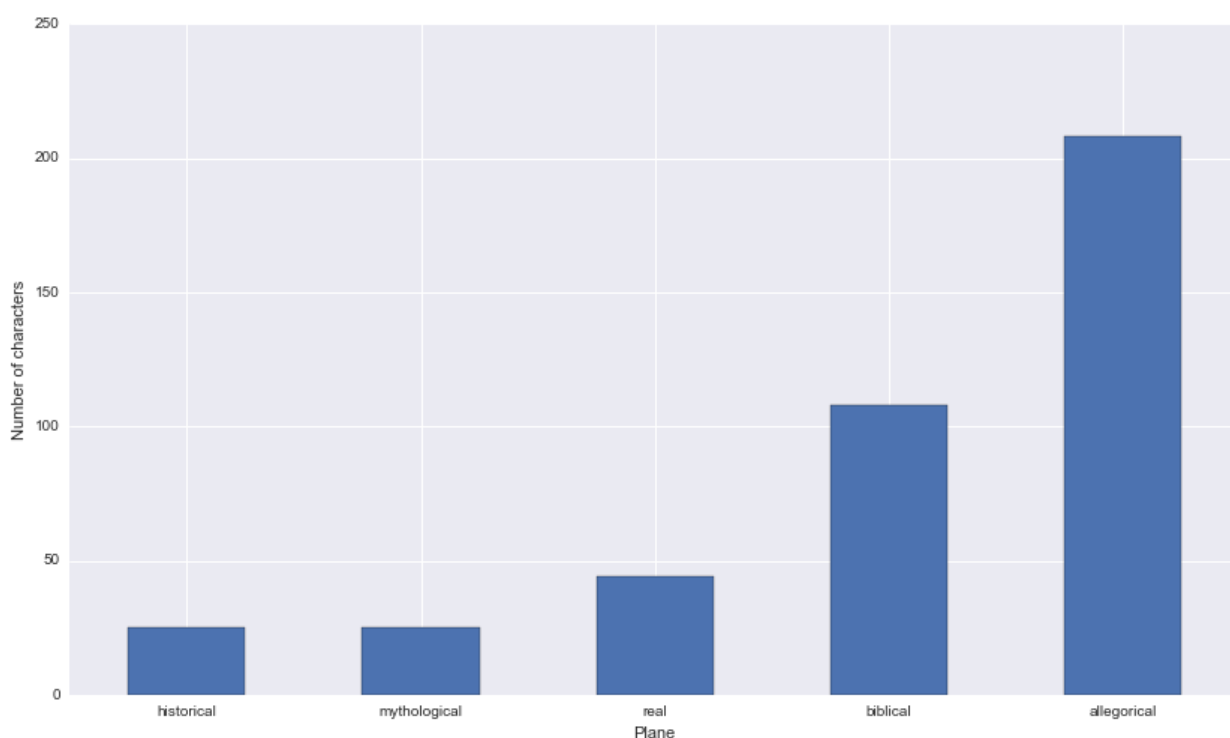


Figure 3-6: Number of characters by plane. Total number of characters of each type in the category of existential plane

As shown in Figure 6, allegorical characters represent the majority of cases in Calderón's *autos*, followed by biblical characters, and then by the rest after a big gap. This result is in line with the notion of the *autos* serving as part of the machinery of the Catholic Church that sought to spread their values by means of allegories (Díaz Balsera, 87-88). Regarding our extended version of the social sphere, laymen count with the highest

number of characters, followed closely by nobility, theological, and moral (see Figure 7), which supports our previous claims and the importance given to spiritual affairs.

Afterwards, supernatural, natural, and clerical characters form the next step, as they seem to be less represented in the play. Places, bureaucrats, and psychological concepts are in the lower bottom with the least number of characters.

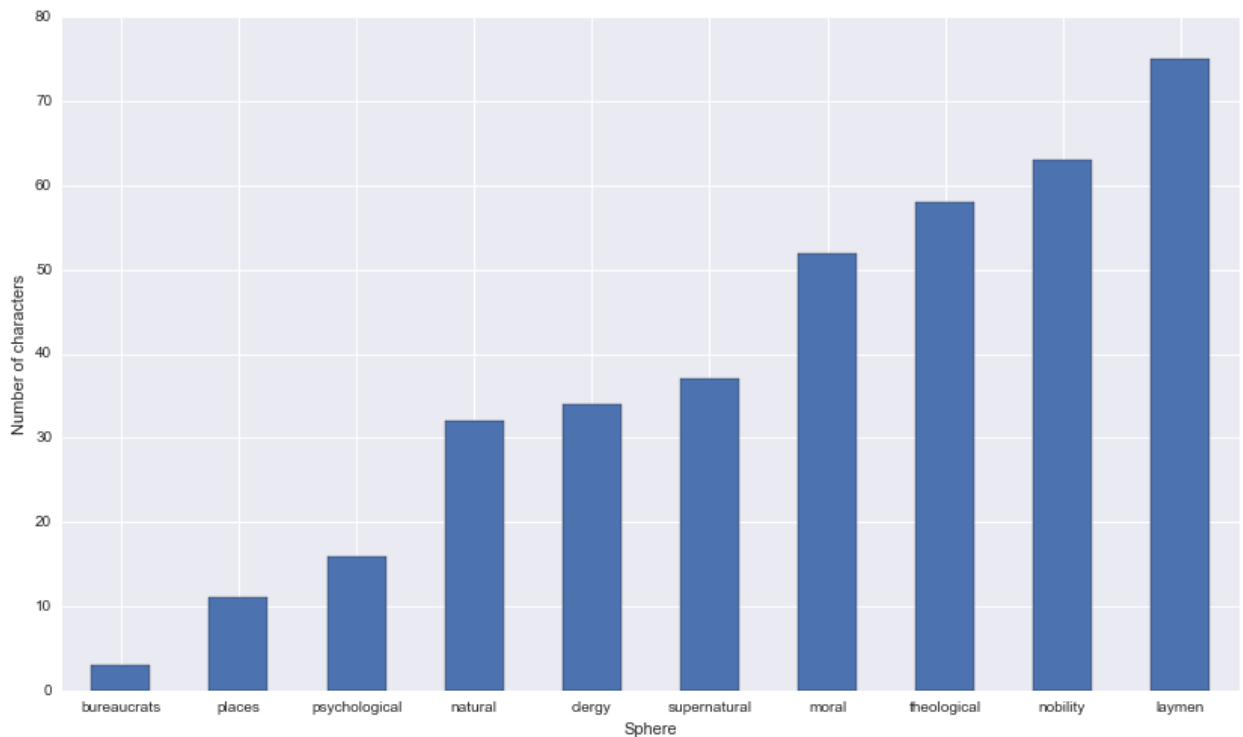


Figure 3-7: Number of characters by sphere. Total number of characters of each type in the category of the social sphere.

In terms of positiveness of message, historical and allegorical characters count with the highest values, whereas biblical and mythological with the lowest ones; with respect to the social sphere, laymen, moral, and theological characters have the highest number of sentences classified as positive, while supernatural and members of the clergy have the lowest (see median values in Figure 8). Saints and other characters of the biblical dimension are the ones who have the most negative use of sentiments as derived from the artificially intelligent analysis of their interventions, sending a message that could be understood as them being non merciful. Allegorical allusions to laymen and abstract artefacts related to the moral and theological characters are sending positive messages to

the audience. We hypothesise that Calderón had a twofold purpose in doing so. Firstly, he intended to make his audience identify with certain types of characters of the play. Secondly, he also attempted to show his audience that the morality of the Catholic doctrine was positive for them. This would be in line with ideological interpretations of baroque theatre as an instrument to maintain social order and confirm the world view sustained by the Catholic faith.

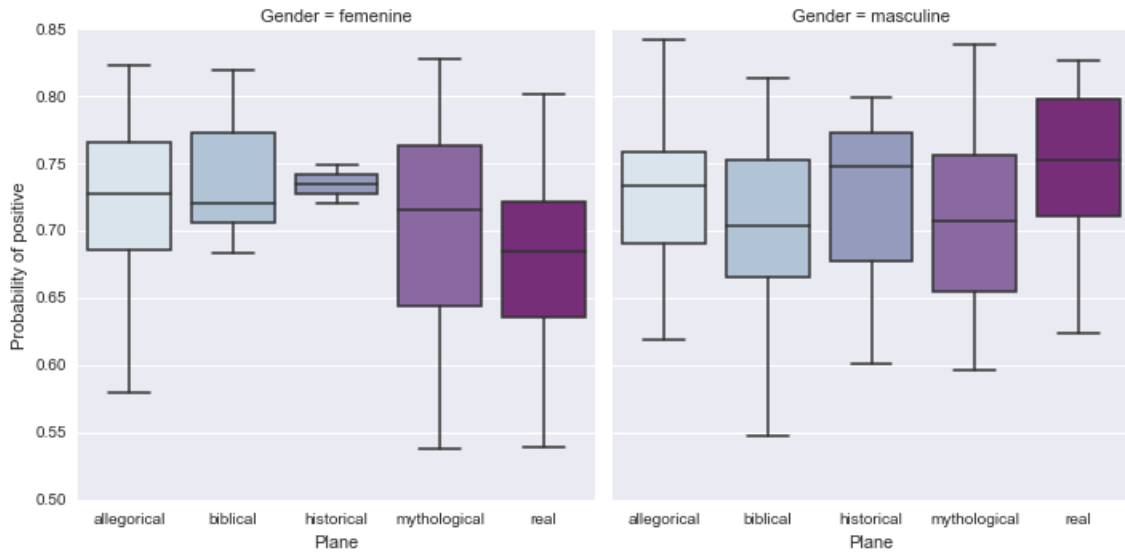


Figure 3-8: Distributions of sentiment by plane and gender. Distributions of averaged values of probability of positive sentiment by existential plane and gender.

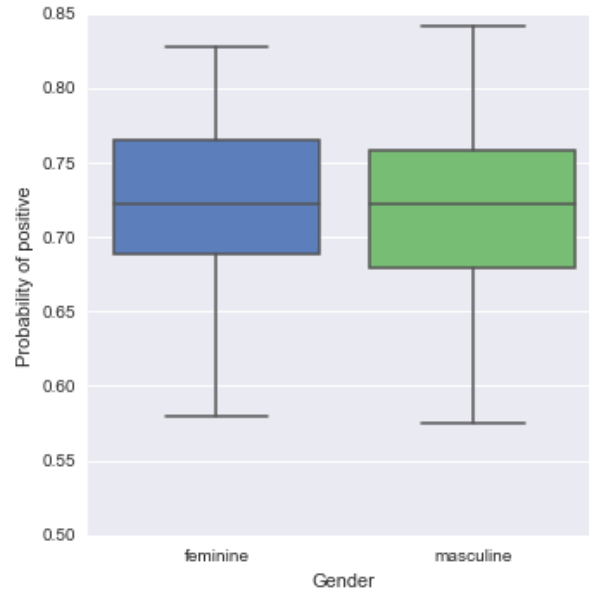


Figure 3-9: Probability of positive sentence by gender. Probability of a sentence being classified as positive grouped by the gender of the character.

With regard to gender, both masculine and feminine characters follow similar distributions, with female characters' interventions having a slightly more positive perception (see Figure 8). However, it should be noted that the amount of female characters is half of males' (55%). Therefore, women are under-represented in Calderón's *autos*. When considering the total number of sentences and verses, the difference narrows down; female characters produce "only" 22% less sentences than men.

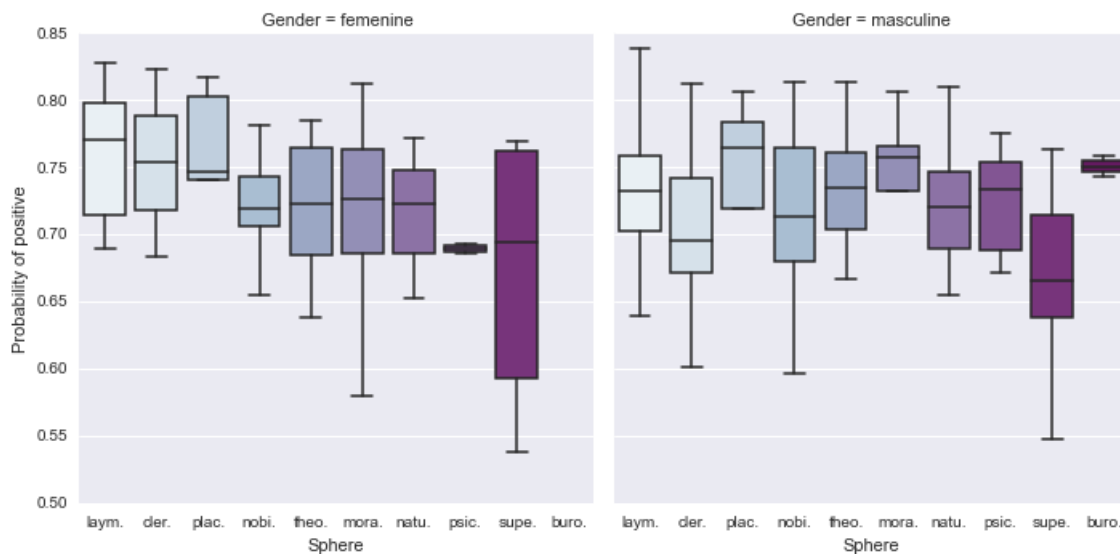


Figure 3-10: Distributions of sentiment by sphere and gender. Distributions of averaged values of probability of positive sentiment by social sphere and gender.

However, the distinction between genders is accentuated when the existential planes and social spheres of the characters are analysed. Figures 8 and 10 show distributions of probability of positive sentiment for the categories of plane and sphere. In the existential plane, female characters of allegorical, biblical, or mythological nature have more sentences classified as positive than male ones, although historical figures seem to be more positive when incarnated as male characters. The case of real people –characters who do not represent historical nor biblical figures– shows the biggest difference, as female characters are depicted with a more negative sentiment than males. Regarding the social sphere, and excluding the case of bureaucrats, for which only a couple of masculine characters are found, median values of positive sentiment are higher for female characters when they represent characters in the laymen, clergy, nobility, nature, and supernatural spheres.

Antonio Regalado, whose monograph on Calderón takes two volumes and over 1,800 pages, discusses a feminism by Calderón in his comedies which would consist of representing the archetypal and mythical dimensions of the feminine figure in a context in which the vision of the feminine characters refutes the stereotypes and vulgarities about women (“Calderón” 981). The feminine figure shows the sensuality associated with

the feminine body and the complex intelligence of characters such as *Semíramis* in *La hija del aire* or the sorceress *Circe* in *El mayor encanto amor*. These are characters that clearly differ from their masculine counterparts. They are, in many cases, women that need to navigate the social difficulties of their time but they find an audience of their own in the women that would attend the theatres and would have a section for themselves to avoid contact with men and musketeers.

Regarding the *autos sacramentales*, the topic of feminine eroticism stems from the adaptation of the comedy *El mayor encanto amor* as the *auto Los encantos de la culpa* (“The charms of guilt,” EC, 1645), in which the lecherous *Circe* represents, in a very nuanced manner, the pleasures that surround sin. On one hand, the religious and sinful dimension of pleasure has a presence. On the other hand, spectators witnessed the pleasures that derive from sexual intercourse and erotic games. *Circe/Sin* embodies a subjectivation of the world rooted in the myth and tries to compensate for the excesses of rationality and contempt with the world that the very *auto* imposes in its dimension of theological discourse. This subjective dimension, a sort of emotional identity typical of feminine characters, becomes apparent in the computational analysis of the *autos* and supports the coexistence of different ideological and emotional levels in the complex plays of baroque theatre.

Finally, we examine the case of the explicit role as assigned by Calderón himself in the *autos*. This case is especially intricate, as sometimes, although not very often, some characters start playing a role and during the play they change to a different one –for instance, in *Las espigas de Ruth* (“The [wheat] ears of Ruth,” ER, 1663), *Ruth* starts as a reaper and ends playing the role of villain in the same play. In those cases, we kept the first identifiable role. As Figure 11 illustrates, there is no correlation between the number of characters playing a specific role and the probability of their sentences being positive. However, some interesting results can still be extracted when observing the data. The set of the three more numerous roles, gallants (with 22 women and 11 men), villains (12 and 17), and characters being played as themselves (8 and 23), account for almost 25% of all the characters, with values of probability of positive sentiment around the average of 70%, although villains have a slightly higher value. This suggests that Calderón was

trying to polarise the main discourse of the *autos* by having on stage characters that were easily identifiable, while he added all the necessary complexity to make the plays interesting and surprising by making the discourse of other types of characters more positive.

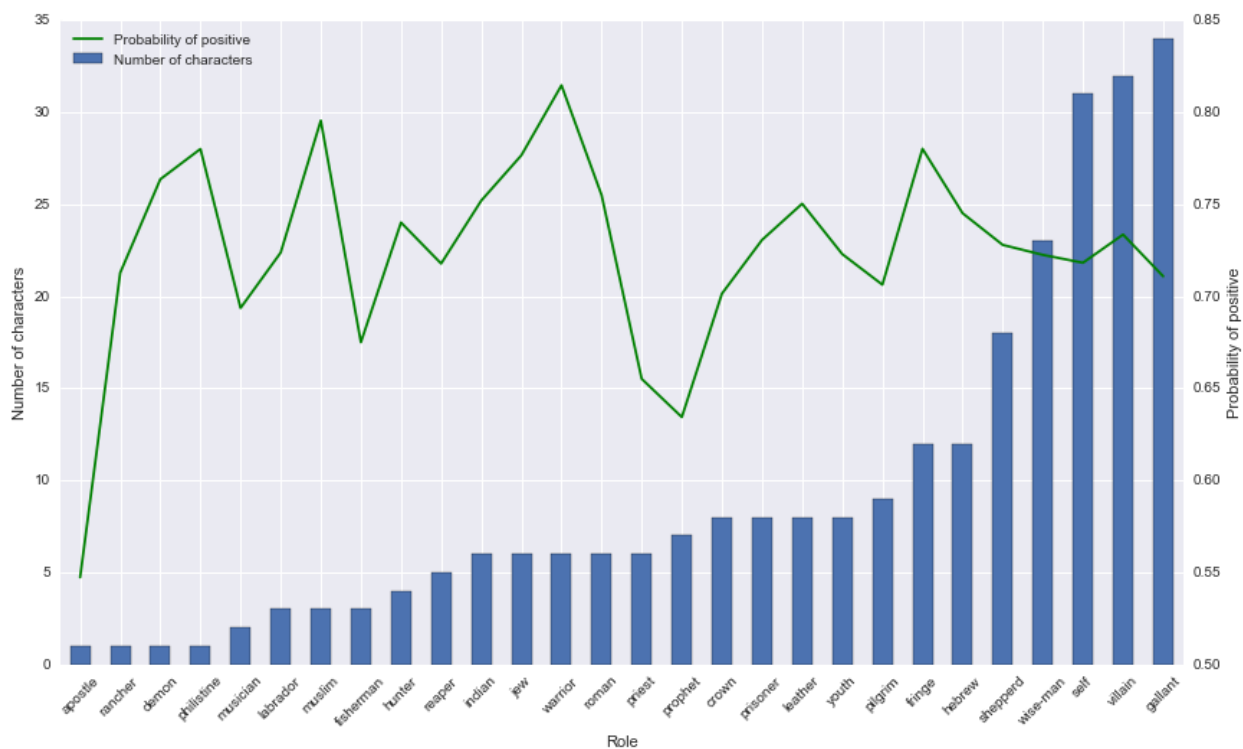


Figure 3-11: Number of characters and probability of positive sentiment by role. Total number of characters of each type in the category of the role given explicitly by Calderón in the *auto*, as well as the probability (from 0 to 1) of their sentences being classified as positive.

Moreover, counter-intuitively, the characters with the highest values of probability of positive sentiment are those of non-Christian tradition: Muslims, Philistines, Jews, and Hebrews. This, again, was an exercise of Calderón to mislead the audience with arguments that not always fit the expected character prototype. Sentences from apostles, priests and prophets, although not very numerous, have the highest probability of being classified as negative, which apparently contradicts the idea of Baroque plays and *autos*

specially as being homogeneous representations of a given ideology and religious world view.

3.6 Discussion

Our results show agreement with the proposed thesis of this study. Analysing characters and their speeches in Spanish Golden Age theatre in an objective manner is not an easy task, and some of the assumptions and decisions we made could be argued against. Machine learning techniques and natural language processing are obviously worthwhile when applied to vast amounts of texts, but this study does not try to substitute the thorough job of the traditional philological analysis of the experts in the field. On the contrary, it tries to complement and give them support by providing them with a valuable source of information and data. Even the most accurate of the classifiers can be in trouble when facing rhetorical figures. This is why we tried to take into account as much data as possible so that we minimise the effect of outliers.

3.7 Conclusions

Alongside this study, we have analysed almost 37,000 sentences constructed from verses in dramatic and allegorical plays. Since our main objective was to demonstrate whether Calderón could be considered a mass influencer or not and what artefacts he used to do so, we built an automated classifier to annotate all the sentences in his works. Afterwards, we tagged all the sentences and characters of the plays and discovered the predominance of characters of allegorical and biblical dimension in the social spheres of nobility, laymen, and theological abstractions, which clearly compose the intended audience of the *autos* as these were stage in public spaces and free of charge for all the population of Madrid.

Women seem to be slightly under-represented when compared to men, which could be considered normal taking into account the different society and the time the plays were written. On the other hand, female members of lay, clergy, nobility, and supernatural spheres, have more sentences classified as positive, which leaves men as the authority of moral and soul-related affairs, as long as our typology of characters is concerned.

We can conclude by saying that the architecture of sentiments in Calderón's *autos* is as complex as the dramatic structure of baroque plays, and that the various metaphysical and rhetorical interconnected levels of baroque technologies of speech make it difficult to draw firm conclusions about the empathy of the characters and the machination of the messages by baroque authors. Data, however, can be contradictory sometimes. For example, according to our methodology, villains' speeches are classified as positive, which is in line with the notion of the *engaño* (deceit) practised in the Baroque, but villains are not the ones with the highest values of positive messages –Philistines, Muslims, and Jews count even higher values. In other cases, it is hard to decide whether Calderón was using characters' speeches to send clear religious messages or just as devices to fooling the audience and playing with the public. Be that as it may, the twisted nature of the Baroque is once again brought to light.

Acknowledgments. This study has been possible thanks to the collaboration of GRISO Group at Universidad de Navarra, who kindly provided us with electronic text versions of all the plays, and the funding provided by the Social Sciences and Humanities Research Council of Canada.

3.8 Appendix. Code, Name, and Date of *Autos*³⁴

[AD] El arca de Dios cautiva (1673)

de la Barca, Pedro Calderón. *El arca de Dios cautiva*. Edited by Catalina Buezo. Vol. 32. Edition Reichenberger, 2002.

[AH] Los alimentos del hombre (1676)

de la Barca, Pedro Calderón. *Los alimentos del hombre*. Edited by Miguel Zugasti. Vol. 67. Edition Reichenberger, 2009.

[AM] El año santo en Madrid (1652)

de la Barca, Pedro Calderón. *El año santo en Madrid*. Edited by Ignacio Arellano and Carlos Mata. Vol. 50. Edition Reichenberger, 2005.

[AP] Andrómeda y Perseo (1680)

de la Barca, Pedro Calderón. *Andrómeda y Perseo*. Edited by José María Ruano de la Haza. Vol. 7. Edition Reichenberger, 1995.

[AR] El año santo de Roma (1650)

de la Barca, Pedro Calderón. *El año santo de Roma*. Edited by Ignacio Arellano y Ángel L. Cilveti. Vol. 4. Edition Reichenberger, 1995.

[CA] El cubo de la Almudena (1651)

de la Barca, Pedro Calderón. *El cubo de la Almudena*. Edited by Luis Galván. Vol. 43. Edition Reichenberger, 2004.

[CB] La cena del rey Baltasar (1634)

de la Barca, Pedro Calderón. *La cena del rey Baltasar*. Edited by Antonio Sánchez Jiménez and Adrián J. Sáez. Vol. 85. Edition Reichenberger, 2013.

³⁴ The codes are actually acronyms of the titles of plays following Arellano's directions ("Diccionario").

[CE] La cura y la enfermedad (1658)

de la Barca, Pedro Calderón. *La cura y la enfermedad*. Edited by Ignacio Arellano. Vol. 3. Edition Reichenberger, 1987.

[CG] El convite general (1648)

de la Barca, Pedro Calderón. *El convite general (atribución insegura)*. Edited by Catalina Buezo. Vol. 70. Edition Reichenberger, 2010.

[CI] El cordero de Isaías (1681)

de la Barca, Pedro Calderón. *El cordero de Isaías*. Edited by M^a Carmen Pinillos. Vol. 10. Edition Reichenberger, 1996.

[DD] El día mayor de los días (1678)

de la Barca, Pedro Calderón. *El día mayor de los días*. Edited by Catalina Buezo. Vol. 45. Edition Reichenberger, 2004.

[DF] Amar y ser amado y divina Filotea (1681)

de la Barca, Pedro Calderón. *La divina Filotea*. Edited by Luis Galván. Vol. 53. Edition Reichenberger, 2006.

[DI] El diablo mudo (primera versión) (1660)

de la Barca, Pedro Calderón. *El diablo mudo (primera versión)*. Edited by Celsa Carmen García Valdés. Vol. 26. Edition Reichenberger, 1999.

[DIS] El diablo mudo (segunda versión) (1660)

de la Barca, Pedro Calderón. *El diablo mudo (segunda versión)*. Edited by Celsa Carmen García Valdés. Vol. 26. Edition Reichenberger, 1999.

[DJ] El divino Jasón (1630)

de la Barca, Pedro Calderón. *El divino Jasón*. Edited by Ignacio Arellano and Ángel L. Cilveti. Vol. 1. Edition Reichenberger, 1992.

[DM] La devoción de la misa (1637)

de la Barca, Pedro Calderón. *La devoción de la misa*. Edited by Enrique Duarte. Vol. 34. Edition Reichenberger, 2001.

- [DOP] El divino Orfeo (primera versión) (1634)
de la Barca, Pedro Calderón. *El divino Orfeo (Primera y segunda versión)*. Edited by J. Enrique Duarte. Vol. 24. Edition Reichenberger, 1999.
- [DOS] El divino Orfeo (segunda versión) (1663)
de la Barca, Pedro Calderón. *El divino Orfeo (Primera y segunda versión)*. Edited by J. Enrique Duarte. Vol. 24. Edition Reichenberger, 1999.
- [DP] El verdadero Dios Pan (1670)
de la Barca, Pedro Calderón. *El verdadero Dios Pan*. Edited by Fausta Antonucci. Vol. 48. Edition Reichenberger, 2005.
- [EC] Los encantos de la culpa (1645)
de la Barca, Pedro Calderón. *Los encantos de la culpa*. Edited by Juan Manuel Escudero. Vol. 46. Edition Reichenberger, 2004.
- [ER] Las espigas de Ruth (1663)
de la Barca, Pedro Calderón. *Las espigas de Ruth*. Edited by Catalina Buezo. Vol. 57. Edition Reichenberger, 2006.
- [FC] La primera flor del Carmelo (1650)
de la Barca, Pedro Calderón. *La primer flor del Carmelo*. Edited by Fernando Plata Parga. Vol. 22. Edition Reichenberger, 1998.
- [FI] El pastor Fido (1677)
de la Barca, Pedro Calderón. *El pastor Fido*. Edited by Fernando Plata Parga. Vol. 40. Edition Reichenberger, 2003.
- [GD] El gran duque de Gandía (1639)
de la Barca, Pedro Calderón. *El gran duque de Gandía (apócrifo)*. Edited by Ignacio Arellano. Vol. 71. Edition Reichenberger, 2010.
- [GM] El gran mercado del Mundo (1635)
de la Barca, Pedro Calderón. *El gran mercado del Mundo*. Edited by Ana Suárez Miramón. Vol. 39. Edition Reichenberger, 2003.

[GT] El gran teatro del Mundo (1635)

de la Barca, Pedro Calderón. *El gran teatro del Mundo*. Edited by Jordi Bernal. Vol. 84. Edition Reichenberger, 2007.

[HC] La humildad coronada de las plantas (1644)

de la Barca, Pedro Calderón. *La humildad coronada*. Edited by Ignacio Arellano. Vol. 38. Edition Reichenberger, 2002.

[HP] El nuevo hospicio de pobres (1688)

de la Barca, Pedro Calderón. *El nuevo hospicio de pobres*. Edited by Ignacio Arellano. Vol. 6. Edition Reichenberger, 1995.

[HV] La hidalga del valle (1634)

de la Barca, Pedro Calderón. *La hidalga del valle*. Edited by Mary Lorene Thomas. Vol. 80. Edition Reichenberger, 2013.

[IG] El indulto general (1680)

de la Barca, Pedro Calderón. *El indulto general*. Edited by Ignacio Arellano and Juan Manuel Escudero. Vol. 9. Edition Reichenberger, 1996.

[IM] No hay instante sin milagro (1672)

de la Barca, Pedro Calderón. *No hay instante sin milagro*. Edited by Ignacio Arellano, Ildefonso Adeva and Rafael Zafra. Vol. 5. Edition Reichenberger, 1995.

[IN] La inmunidad del sagrado (1664)

de la Barca, Pedro Calderón. *La inmunidad del sagrado*. Edited by José María Ruano de la Haza, Delia Gavela and Rafael Martín. Vol. 17. Edition Reichenberger, 1997.

[IS] La iglesia sitiada (1630)

de la Barca, Pedro Calderón. *La iglesia sitiada*. Edited by B. Baczynska. Vol. 68. Edition Reichenberger, 2009.

[JF] El jardín de Falerina (1675)

de la Barca, Pedro Calderón. *El jardín de Falerina*. Edited by Luis Galván and Carlos Mata Induráin. Vol. 58. Edition Reichenberger, 2007.

[LA] El lirio y la azucena (1660)

de la Barca, Pedro Calderón. *El lirio y el azucena*. Edited by Victoriano Roncero. Vol. 59. Edition Reichenberger, 2007.

[LC] La lepra de Constantino (1660)

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Chapter 4

4 The Life of *Lazarillo de Tormes* and of His Machine Learning Adversities. Non-traditional authorship attribution techniques in the context of the *Lazarillo*

Summit work of the Spanish Golden Age and forefather of the so-called picaresque novel, *The Life of Lazarillo de Tormes and of His Fortunes and Adversities* still remains an anonymous text. Although distinguished scholars have tried to attribute it to different authors based on a variety of criteria, a consensus has yet to be reached. The list of candidates is long and not all of them enjoy the same support within the scholarly community. Four of the most recently supported and plausible candidates are the diplomat Diego Hurtado de Mendoza, defended by alleged historiographic and paratextual evidence; Alfonso de Valdés, humanist, chancellor of the Emperor Charles V, and brother of Juan de Valdés, both proposed as authors according to their writing style and biographical circumstance; and Juan Luis Vives, scholar and godfather of psychology, whose authorship candidacy follows the same precepts than those of Alfonso de Valdés. The last one, and one of the most recent candidates is the jurist from Valladolid Juan Arce de Otálora, who graduated in Law in the city of Salamanca and apparently suits the internal statistical evidence. In this study we build upon knowledge collected by experts on the topic to create a valid pool of possible candidates. Analyzing their works from a data-driven perspective and applying machine learning techniques for style and text fingerprinting, we shed light on the authorship of the *Lazarillo*. As in a state-of-the-art survey, we discuss the methods used and how they perform in our specific case.

4.1 Introduction

The authorship of *The Life of Lazarillo de Tormes and of His Fortunes and Adversities* – usually referred to as the *Lazarillo de Tormes*, or just (and henceforth) the *Lazarillo*– is a topic that has interested researchers ever since the story was first published. The earliest

preserved editions were printed in 1554 in Burgos (Spain), Alcalá de Henares (Spain), Medina del Campo (Spain),³⁵ and Antwerp (Belgium), although there might be at least two earlier editions yet to be found that complete the phylogenetic tree (figure 1 shows a possible stemma).³⁶ After a short period of popularity, in 1559 it was added to the *Index* of forbidden books compiled by the Inquisitor General Fernando de Valdés,³⁷ and therefore banned from public circulation due to its acid anti-clerical criticism.³⁸ The text's religious aspects have been particularly influential in scholars' attempts to create an accurate profile of the anonymous writer. The author has been therefore considered to be a converted Jew (Castro, "Perspectiva" 123-138; "Hacia Cervantes" 149-166), an illuminist (Asensio, "La intención religiosa" 78-102; Asensio, "Más sobre el Lazarillo" 245-50), or an erasmist (Márquez Villanueva, 107-137), but these theses have been deeply questioned by acclaimed critics such as Marcel Bataillon and Eugenio Asensio, who depict the author as a humanist (Bataillon, "Erasmus y España" 609-611; "Novedad y fecundidad" 1-25; *Pícaros y picaresca* 215-243; Asensio, "El erasmismo" 31-99; Asensio, "La peculiaridad" 339-343). Nevertheless, the notion of an author in contact with such spiritual and ideological interests still persists in the literature, which could have informed their decision not to sign the little book.

³⁵ The edition of Medina del Campo is the newest found. It appeared in 1992 hidden inside a wall, together with other texts that could be considered problematic by the Inquisition (Cañas Murillo).

³⁶ It is believed that the editions of 1554 are actually second editions following the success of a first edition of the book published as early as 1538, as suggested by Navarro Durán as the post quem of the little book: "el autor sólo puede referirse a las primeras [Cortes] porque no sabe que se van a celebrar unas segundas, ya que el Lazarillo se escribió antes de 1538," ("the author can only be referring to the the first [Cortes] as he does not know that there will second ones, due to the fact that the Lazarillo was written before 1538") (Navarro Durán 2002a, 7-13). See also the analysis by Francisco Rico in his introduction to his edition (Anónimo ed. Rico, 13-15), or the section "Las ediciones desconocidas" by José Caso González's (Anónimo ed. Caso González, 11-14; Caso González, "La primera edición" 189-206). More recently, Arturo Rodríguez and Alfredo Rodríguez López-Vázquez based on weak documental proof (not the edition itself) and stemmatics supported an earliest edition in 1550 (Rodríguez and Rodríguez López-Vázquez).

³⁷ Later Rome's *Index Librorum Prohibitorum* by Pope Pius VI also included books that could be re-edited prior partial censorship.

³⁸ See for example Manuel J. Asensio ("La intención" 78-102) and Víctor De la Concha (243-77). Reyes Coll-Tellechea argues that the real reason for the addition of the *Lazarillo* to the *Index* was the publication of the second part *Segunda Parte del Lazarillo de Tormes*, which was read as a political provocation and therefore never released again until the end of the *Index* ("The Spanish" 75-97).

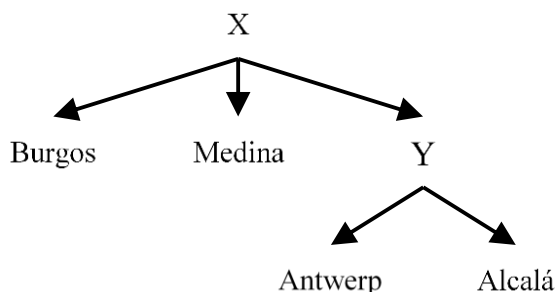


Figure 4-1: Stemma for the editions of the *Lazarillo* of 1554 as structured by Jesús Cañas Murillo. *X* and *Y* denote lost editions, being *X* the *editio princeps* or “true first edition”.³⁹ Aldo Ruffinatto’s stemma also takes into consideration Juan López de Velasco’s *Lazarillo Castigado* after an analysis following the principles of *ecdótica* (ecdotic analysis) (Anónimo ed. Aldo Ruffinatto; Ruffinatto, “La princeps” 249-96; “Algo más” 523-36).

It was not until 1573 that a censored version was circulated again in Spain, but omitting treatises 4 and 5 and assorted paragraphs from other parts of the book. Juan López de Velasco, Philip II of Spain’s cosmographer and historian, was the person responsible for the trimming of the *Lazarillo*, whose edition is known as the *Lazarillo Castigado* (*Lazarillo Punished*) (Asensio, “La intención”). The exerted censorship was subtle but radical as it transformed the identity of the *Lazarillo* turning the protagonist from “a victim of the socio-economic circumstances into a Lázaro responsible of his own social and moral condition” (“[Dichas alteraciones] estaban dirigidas a transformar la imagen de un Lázaro víctima de las circunstancias socioeconómicas en un Lázaro responsable de su

³⁹ In Cañas Murillo (134):

El texto de Medina del Campo no procede directamente de ninguna de las versiones hasta ahora conservadas. Forma una rama textual independiente. Dada su proximidad a Burgos, que, procede directamente del arquetipo X perdido, y la mayor limpieza de sus lecciones, parte de las cuales coinciden significativamente con Amberes, más corregido, insistimos, que Burgos y Alcalá, hay que concluir que dicha rama hay que hacerla depender también directamente del arquetipo X.

(The text of Medina del Campo does not come from any of the versions preserved until now. It constitutes an independent textual branch. Given its proximity to that of Burgos, which comes from the lost archetype X, and the greater cleanness of its lessons, many of which significantly match with Amberes, more proofread, we insist, than Burgos and Alcalá, we conclude that such branch must depend on the archetype X too.)

condición social y moral.”)⁴⁰ Although the work by Juan López de Velasco allowed the *Lazarillo* to leave the list of forbidden books, by then the Antwerp’s edition, translated to different languages, had already spread over Europe.⁴¹ It is suggested that the book that actually started the picaresque novel and influenced so many authors afterwards was in fact the censored edition. Until the final abolition of the Inquisition and the end of the *Index* in 1834, the *Lazarillo Castigado* was the only edition officially available in Spain for more than 250 years. If the *Lazarillo Castigado* was indeed the seed of the picaresque genre, then we would possibly have a preliminary explanation for two gaps unaccounted for: first, the time elapsed between the publication of *Lazarillo* in 1554 and the appearance in 1626 of the next considered picaresque novel, *The Swindler (El Buscón)* by Quevedo; and second, the difference between the deterministic style of the *Lazarillo* and the cruel reality that punishes the rogue for his aspirations in the following titles that became later on a more common topic in the genre. Unfortunately, the argument of *Lazarillo Castigado* being the book that started the picaresque genre does not count with the discussion around the date of the *princeps* and relies heavily on the idea of nobody using alternative channels of distribution or being rebellious against the establishment. Given the circumstances involved in the discovery of the edition of Medina del Campo we must take this suggestion with uncertainty (Alberto Martino, *Lazarillo*). Nevertheless, the importance of the figure of Juan López de Velasco does not end with his cleverly expurgated edition, as we will see soon.

4.2 A Book by Many Authors

The list of possible authors has grown with the years along with the painstaking effort of many researchers who devoted their time, intelligence, and expertise –sometimes even through their entire careers (see tables 1 and S1)– to this text. A noble and scientific goal has guided them to put an end to the enigma and to unveil the true identity of the author

⁴⁰ See Coll-Tellechea (“*Lazarillo Castigado*” 32-33). Others limit the extent to which the trimming affected the story of Lázaro (Agulló y Cobo, *A vueltas*).

⁴¹ By 1596 there were already editions published in London (England) with Diego Hurtado de Mendoza as the author. See chapter 2 of the precise and exhaustive work by Alberto Martino, and also his second volume dedicated to the reception of the *Lazarillo* in Europe.

of the *Lazarillo*. These 400 years of attributions have left us an insane, nearly intractable, amount of bibliography that must be reviewed and studied before dreaming of making a contribution to the state-of-the-art. It has become very hard to avoid certain feelings of genuine *argumentum ad verecundiam*, at least in the initial stages of the research. This amount of bibliography, paradoxically, instead of keeping novel scholars away has not been a deterrent and new proposals are still being added to the pool of candidates today, although some of them using modern and less explored methods (mostly computational) that were not available a decade or so ago. It is with respect to these techniques that we try to limit ourselves in the present study.

Chronologically, the first attribution occurred more than half a century after the earliest known edition. In 1605 the Hieronymite Friar José de Sigüenza was the first to propose a possible author: the also friar, Juan de Ortega. Father Sigüenza's *Historia de la Orden de San Jerónimo (History of the Order of Saint Jerome)* gathers his finding of a manuscript of the *Lazarillo* in the cell of Juan de Ortega (Sigüenza, 145):

It is said that while being a student in Salamanca [i.e., Juan de Ortega], as a young man, he had such a fresh and gallant ingenuity, that he created that little book that moves around titled Lazarillo de Tormes, where he shows in that humble subject his mastery of the Castilian language and the decorum of the people introduced with such singular artifice and grace, that it deserves to be read by those of excellent taste. The reason for this was the discovery of the draft in his cell, handwritten by him.

(Dicen que siendo [i.e., Juan de Ortega] estudiante en Salamanca, mancebo, como tenía un ingenio tan galán y fresco, hizo aquel librito que anda por ahí, llamado Lazarillo de Tormes, mostrando en un sujeto tan humilde la propiedad de la lengua castellana y el decoro de las personas que introduce con tan singular artificio y donaire, que merece ser leído de los que tienen buen gusto. El indicio desto fue haberle hallado el borrador en la celda, de su propia mano escrito).

Although a draft was indeed found in the friar's cell, the circulation of handwritten copies was a common practice during the Spanish Golden Age (Botrel and Salaün). The claim that Father Ortega was the author is hard to sustain as the draft does not seem to be enough proof: it could have been the original as much as a handwritten copy or some annotated summary made by Juan de Ortega.

More than three centuries had to go by until the French hispanist Marcel Bataillon revisited the candidacy of Father Ortega, finding a satisfactory explanation for the anonymity of the *Lazarillo*. Friar Juan de Ortega received the habit in the Salamancan municipality of Alba de Tormes, and soon was chosen by King Charles V, Holy Roman Emperor, as archbishop of Chiapas in Mexico. He later became General of the Hieronymites from 1522 to 1555, which according to Bataillon, would sufficiently and objectively explain the reason of his not signing the little book around its publication in 1554.⁴² Supporters of Bataillon's candidate include Claudio Guillén or Antonio Alatorre, who in 2002, and as a very final assertion, stated that "there is nothing comparable to the testimony of Friar José de Sigüenza" ("No hay nada comparable al testimonio de fray José de Sigüenza"), suggesting that his sole mention was enough evidence (Alatorre, 447). It is likely that his statement be based on the idea defended by Bataillon that a book of the tone and kind of the *Lazarillo* would not be gratuitously attributed to a Hieronymite Friar. However, as noted by Francisco Rico, it is hard to know whether Father Sigüenza was even referring to the *right* Juan de Ortega (Anónimo ed. Rico, 120).

A couple of years after the proposal of Friar Juan de Ortega, another name took the centre stage and has probably been the most studied candidate ever since. In 2010 Alexander Sandy Wilkinson found editions of the *Lazarillo* made in 1599 in Zaragoza (Spain) by Juan Pérez de Valdivieso, and in 1600 in Rome (Italy) by Antonio Facchetti; both attributed the book to the diplomat and Governor of Grenade Diego Hurtado de Mendoza.⁴³ Surprisingly, these references went unnoticed, as it was only after his mention in the *Catalogus clarorum Hispaniae scriptorium* that the candidacy of the poet

⁴² To this respect see the works by Marcel Bataillon (*El sentido; Novedad y fecundidad*).

⁴³ Following the citation in Corencia Cruz (16); see Wilkinson (652 and 414).

became popular. The Flemish bibliographer Valerio Andrés Taxandro wrote his *Catalogus* in 1607,⁴⁴ and in it he said that Diego Hurtado de Mendoza “owned a rich library of Greek authors, that he gifted to King Philip II of Spain on his death. He [*i.e.*, Diego Hurtado de Mendoza] also wrote romance poetry and the book of entertainment titled *Lazarillo de Tormes*” (“Poseía rica biblioteca de autores griegos, que dejó al morir a Felipe II. Compuso también poesías en romance y el libro de entretenimiento llamado *Lazarillo de Tormes*”) (Anónimo ed. Cejador y Frauca). A year later the Jesuit Andrés Schott also supported the attribution in his *Hispaniae bibliotheca*: “It is thought that the *Lazarillo de Tormes* is a work of his, book of satire and entertainment of his time as a student of civil law in Salamanca” (“Se piensa ser obra suya el *Lazarillo de Tormes*, libro de sátira y entretenimiento de cuando andaba estudiando derecho civil en Salamanca”).⁴⁵ Accepting the attribution as true, Tomás Tamayo de Vargas confirmed it again in his *Collection of books the biggest that Spain has ever seen in its language up to 1624* (*Junta de libros la mayor que ha visto España en su lengua hasta 1624*): “Book of the most ingenious of Spain, and I do not know if in the foreign nations there is another of similar finesse in its subject. Valladolid by Luis Sánchez. 1603. 16°. Usually it is attributed this gracious birth to the ingenuity of Mr. Diego de Mendoza” (“Libro de los mas ingeniosos de España, i no sè si en las naciones estranjeras hai otro de igual festividad en su assumpto. Valladolid por Luis Sanchez. 1603. 16°. Communmente se atribuíe este graciosissimo parto al ingenio de D. Diego de Mendoza”).⁴⁶ Nicolás Antonio also contributed to the diffusion of Hurtado de Mendoza as the author, although he never completely rejected the previous candidate, Friar Juan de Ortega.⁴⁷ Despite the vague explanations, based mostly on the lack of evidence against him and some biographical similarities between him and Lázaro’s life, the attribution proved to be extremely

⁴⁴ Some authors argue that Valerio Andrés Taxandro was a pseudonym of Andrés Schott, see for example Francisco Calero (“Vives y el Lazarillo”).

⁴⁵ The citation can be found virtually in any edition of the *Lazarillo* or study about its authorship, we use Rico’s 2011 edition. However, the original, in latin, belongs to Andreas Schott.

⁴⁶ As edited in her PhD thesis María Cristina González Hernández (401).

⁴⁷ Although the edition preserved is from 1783, Nicolás Antonio wrote it in 1672.

popular. For about three centuries book catalogues all over Europe recorded Diego Hurtado de Mendoza as the author of the *Lazarillo*.

The first serious criticism against this authorship came from another French hispanist Alfred Morel-Fatio, who in 1888 proposed a new candidate, Juan de Valdés –to whom we will come back later–, giving a start to the modern attribution wars of the *Lazarillo* (Morel-Fatio, 112-76). Alfred Morel-Fatio’s main claim was alluding to the number of attributions granted to Hurtado de Mendoza that were based solely on his reputation as *enfant terrible*, literarily speaking. All the objections against Hurtado de Mendoza that Morel-Fatio formulated were refuted several times by Ángel González Palencia.⁴⁸ The Arabist and literary critic also noted some analogies between the uninhibited character of the *Lazarillo* and the tone employed by Hurtado de Mendoza in his private correspondence; albeit of acknowledging the stylistic dissimilarities to later conclude that the attribution “is not unlikely” (“no es improbable”) (González Palencia, “Leyendo el *Lazarillo*” 36):

It shall not be emphasized the stylistic aspect of the Lazarillo with purposes of comparison to the works by Mendoza: the dry, short, and succinct style of the Lazarillo agrees to that of Mendoza’s letters and others prose works of him. However, this aspect should not be highlighted, considering that such writings, as a post data, and for commenting news or events, had to be written inevitably hastily, in a shortened, fast, and edgy way.

(No puede hacerse gran hincapié en el aspecto estilístico del Lazarillo para compararlo con los escritos de Mendoza: el estilo seco, cortado y conciso del Lazarillo concuerda con el de estas cartas de Mendoza y con otras obras en prosa suyas. Pero acaso no se le pueda y deba dar gran valor a este punto, teniendo en cuenta que tales escritos, en forma de postdata, y para comentar una

⁴⁸ See his edition of the *Lazarillo* (Anónimo ed. González Palencia; “Leyendo el *Lazarillo*” 3-39). From 1941 to 1943, and together with Eugenio Mele, they also collected, edited, and published the works and biography of Diego Hurtado de Mendoza (González Palencia and Mele).

noticia o un suceso, habían de escribirse forzosamente de prisa, en forma abreviada, rápida y nerviosa).

The ideas presented by the critic laid the foundations for other scholars, specially for Erika Spivakovsky. Unlike González Palencia, who believed that Hurtado de Mendoza wrote the *Lazarillo* when still young –following on Andrés Schott’s footsteps–, the American researcher gave a much later date for the conception of the book, effectively defending that the little novel was written in 1553, which coincided with the mature years of Diego de Mendoza. “We have few notices about Mendoza during 1553-1554 [writes Erika Spivakovsky]. Yet so much is known that, remarkably, he did not only had just the time and opportunity to do some writing for his own pleasure, but it seems to have been, in fact, the only period of his active middle years when he might have found a few weeks of complete leisure to perfect such as masterpiece” (“The Lazarillo” 273). The sentence summarizes her most important contribution to the debate: a noticeably precise series of parallels drawn between Hurtado de Mendoza’s life and the fortunes and adversities of Lázaro de Tormes and those whom he found in his path. The analogies are numerous, *e.g.* between Pope Paul III and the Blindman, the Sienese conspirator Amerigo Amerighi and the Cleric, or Charles V and the young Squire.⁴⁹

As convincing as it may sound, without factual evidence the intellectual exercise by Spivakovsky, and the whole Diego Hurtado de Mendoza candidacy, falls exclusively on the realms of metaphor and hermeneutics. At least until 2010, when Mercedes Agulló claimed to have found the missing piece of the puzzle. The Madrilenian historian published a monograph detailing the testament and inventory of goods of Diego Hurtado de Mendoza, as recorded at his death by the administrator of his estate, Juan López de Velasco. In one of the drawers containing books of López de Velasco,⁵⁰ among other

⁴⁹ See Spivakovsky (“¿Valdés o Mendoza?” 15-23) her book *Son of the Alhambra*. Others such as Olivia Crouch and Charles Vincent Aubrun also supported the idea, but added little to the discussion (Crouch, 11-23; Aubrun, 240).

⁵⁰ The drawer was part of López de Velasco’s will, but Agulló defends that since everything that was in the drawer belonged to Hurtado, and Velasco was the executor of Hurtado’s will, the drawer belonged to Hurtado as well.

panniers belonging to Diego Hurtado de Mendoza, there was one that read: “a bundle of corrections made for the printing of *Lazarillo* and *Propaladia*” (“Vn legajo de correçiones hechas para la ynpressi3n de *Laçarillo* y *Propaladia*”) (Agull3 y Cobo, *A vueltas* 44). The sentence, together with other surrounding historical circumstances, was sufficient for Mercedes Agull3 to cautiously relaunch the old candidacy of the diplomat.⁵¹ The finding must not be minimized though, as it is the best documentary evidence to date. However, it is also true that all the documents were released as part of Juan de Vald3s’ will, the lawyer who made the inventory of Juan L3pez de Velasco’s fortune, which in turn included that of Hurtado de Mendoza. Although Agull3 argues that Diego Hurtado de Mendoza’s files were bundled together and distinguishable from those of the executor of his will, the fact that L3pez de Velasco was the person in charge of the *Lazarillo Castigado* makes the statement gain some uncertainty: the corrections as such are lost and another book is mentioned along with the *Lazarillo*. Strong reactions and criticism came shortly after Agull3 published her work. In the same year several essays appeared refuting her findings, all of them mostly centered around the aforementioned questions about the impossibility of stating much about Diego Hurtado de Mendoza’s authorship: it is not clear why Hurtado de Mendoza would have made corrections to Bartolom3 Torres Naharro’s *Propalladia* (*Propaladia*); and it might make more sense that the corrections were made by the censor Juan L3pez de Velasco himself prior to the preparation of his expurgated edition.⁵² And although some openly supported Mercedes Agull3,⁵³ she defended herself in a second article published a year later. The historian suggested then that L3pez de Velasco, in order to work on his expurgated edition, called

⁵¹ The most notable is the overtly expressed desire of Philip II of acquiring the extensive and rich library of Diego Hurtado de Mendoza. The rejection of Mendoza to the king might be, in Mercedes Agull3’s opinion, the root of all enmity between them both, and the factor that would determine Philip II’s decisions in relation to Diego Hurtado de Mendoza’s fate.

⁵² Example of this are Navarro Dur3n (“Diego Hurtado”), Javier Blasco (“Book Review” 1-9) or Fernando Rodr3guez Mansilla (“A vueltas” 37). Jos3 Luis Madrigal carried an independent computational analysis to later conclude that there were no traces of Diego Hurtado de Mendoza’s writing in the *Lazarillo* (“Hurtado de Mendoza y el Lazarillo”).

⁵³ Supporting Mercedes Agull3, Pablo Jauralde Pou wrote a very detailed biography of Diego Hurtado de Mendoza relating for each of his life events the equivalent in the story of L3zaro, defending that the Grenadian wrote the little book after falling from the grace of Emperor (“Sin que de mi nombre”). See also Coll-Tellechea (“Book Review” 1-9).

upon Hurtado de Mendoza to provide him with the right corrections, thus being the nature of the *legajo* (bundle) referred in López de Velasco's documents. Agulló uses the attribution to explain the nature of a book: Hurtado de Mendoza sent a letter to his nephew, to which said book was attached. In this letter, Hurtado asked his relative to hand in the book to Philip II, then still a young prince, and to warn the future king not to take the book too seriously, as Hurtado did not want to be on the spotlight on account of the told "necedades" ("follies").⁵⁴ She leaves, however, other mysteries to the reader, such as the reason for the absence in Hurtado's library of many of the books that are believed to have influenced the *Lazarillo*, arguments sometimes used against Hurtado de Mendoza's candidacy but that require a more thorough research.⁵⁵

In the long process of debating against Diego Hurtado de Mendoza's authorship, other names were brought to light. In 1867 José María Asensio published previously unseen work by the dramatist, jurist, and Toledo born, Sebastián de Horozco. *Representación de la historia evangélica del capítulo nono de San Juan (Representation of the evangelical history of the ninth chapter of Saint John)* exhibits –according to José María Asensio– some similarities between a blind man guide character named Lázaro and the protagonist of the *Lazarillo* (*Sebastián de Horozco* 46), Julio Cejador y Frauca, after rejecting other authors such as the Valdés brothers, Cristóbal de Villalón, or Lope de Rueda, took José María Asensio's suggestion and supported it with ever more similitudes, matches of themes and characters, and some biographic coincidences: "It was written, by whoever, in Toledo, even though [the author] sets the beginning of the action in Salamanca and appears himself knowledgeable about that city [...], this points out [...] entirely to Sebastián de Horozco" ("Escribiolo, fuera quien fuera, en Toledo, aunque ponga el comienzo de la acción en Salamanca y se muestre bien enterado de aquella ciudad [...] esto compete [...] de lleno a Sebastián de Horozco").⁵⁶ The inclination towards popular

⁵⁴ "Vuestra Merced no se le dexé mucho en las manos porque no / Me anden exsaminando necedades" ("Your Grace does not leave it for long in the hands so / [they] do not start examining me follies") (Agulló y Cobo, "Un par de vueltas más" 273-276).

⁵⁵ See for example Rico's edition. The library of Diego Hurtado de Mendoza is well described by Anthony Hobson.

⁵⁶ In Cejador's edition of the *Lazarillo* (30).

sayings in Horozco's works ended up convincing Cejador of the candidacy of the Toledan. However, just a year later Emilio Cotarelo started the publication of Sebastián de Horozco's *Refranes glosados* (*Glossed sayings*), where the candidacy of the jurist was solidly rejected and abandoned by everyone else ever since (Horozco ed. Cotarelo). It was forty years later when Francisco Márquez de Villanueva brought this candidacy back without adding much to the debate; his name and authority, however, would suffice for many others to also rethink about and support it. Up to two times Francisco Rico rejected Horozco's candidacy arguing that the use of the language was very different between the two books. While it seems to be evident that the Toledan took some inspiration from the *Lazarillo*, Rico states that the rich linguistic inventory and expressive power in the little book surpasses any effort made in the *Representación*, which accents the vulgarity of folk speech and exposes a lack of narrative imagination (Márquez Villanueva, "Sebastián de Horozco" 253-339; Anónimo ed. Rico 1987 and 2011).⁵⁷

Shortly after José María Asensio proposed Horozco, Morel-Fatio, based on the anticlerical tone of the little book, pointed towards the circle of humanists surrounding the Valdés brothers (Morel-Fatio, *Recherches* 164-166). From there, some decades later Manuel J. Asensio built his case in favor of the younger brother,⁵⁸ the reformist Juan de Valdés, placing the writing of the *Lazarillo* near Escalona and Toledo around 1525 (Asensio, *La intención religiosa*; Asensio, "El Lazarillo" 101-28). As Asensio himself defended, his prudent proposal never pretended to be a conclusive argument to justify the attribution, but rather a clue for others to follow. Joseph V. Ricapito took the lead on this matter when in 1976 he supported "a very risky hypothesis" ("una hipótesis arriesgadísima") of the attribution of the *Lazarillo* to the older of the Valdés brother, Alfonso, chancellor and Royal Secretary of Indian Letters of Emperor Charles V. In Ricapito's own words, if Alfonso de Valdés was not the author, "it had to be someone suchlike him and someone who belonged to the same intellectual circles" ("tuvo que ser

⁵⁷ Among the supporters of Horozco after Villanueva, are worth mention Fernando González Ollé ("Interpretación"), Jaime Sánchez Romeralo ("Lázaro en Toledo" 189-202) and José Gómez-Menor Fuentes ("*Nuevos datos*" 247-285), who contributed with other interesting but circumstantial facts.

⁵⁸ Manuel Amores argued that the brothers might have been in fact identical twins (28).

alguien semejante a él y alguien que perteneciera a los mismos círculos intelectuales”) (Anónimo ed. Ricapito). More recently, after carefully editing the *Diálogo de las cosas acaecidas en Roma* (*Dialogue of the things occurred in Rome*) and the *Diálogo de Mercurio y Carón* (*Dialogue of Mercury and Charon*) –both apparently wrongly attributed to Juan de Valdés until the end of 19th-century and 1925, respectively–, Rosa Navarro Durán came into the discussion to also back up the candidacy of Alfonso de Valdés (Navarro Durán, *Alfonso de Valdés*). The Catalan philologist carried out a detailed study of the books that influenced the author of the *Lazarillo*, whoever that might be, and the readings that inspired Alfonso de Valdés in his works. Finding that both the *Diálogos*’s and our little book’s author shared the same literary roots, Navarro Durán concluded that the writers must have been the same person. The problem with this strong assumption is that it implies a very early date for the conception of the *Lazarillo*, as the older of the Valdés brothers died of the plague in Vienna in 1532. Conveniently, all the books that apparently served as source for Alfonso de Valdés in the writing of the *Lazarillo* were available before that date (works such as *La Celestina* [*Tragicomedy of Calisto and Melibea*] by Fernando de Rojas, the *Propalladia* by Torres Naharro, the anonymous *Comedia Thebaida* [*Comedy called Thebasis*], *La lozana andaluza* [*The lusty Andalusian woman*] by Francisco Delicado, or even the *Relox de príncipes* [*Watch of Princes*] by Antonio de Guevara). And when not, as Francisco Rico noted in relation to the *Dichos graciosos de españoles* (*Funny sayings of Spaniards*) collected by Chevalier or the *Baldus* by Folengo, Navarro Durán interprets it as the *Lazarillo* influencing other works, instead of being influenced by them (Navarro Durán, *Lazarillo*; “«Lazarillo de Tormes»“).

As noted many times, the last paragraph of the prologue in the *Lazarillo* does not seem to correspond with the authorial voice present in the rest of the little book.⁵⁹ Navarro defends that two different discourses can be identified: one coming from the author himself, and the other from Lázaro, the character, narrating “the case” (“el caso”) to “Your Grace” (“Vuestra Merced”). The philologist also points in the direction of a

⁵⁹ Others argue that the prologue must be read in the last place, as a final treatise (Lázaro Carreter 134; Sieber).

supposedly disappeared folio that used to accompany all literary works in the 16th-century, and that would split the prologue and the body, separating in practice the two distinct narratives. She imagines an *Argumento* (Argument) of erasmist nature articulated upon the secret of confession, in her opinion key for the correct understanding of the little book and she precisely defends that it was because of this that the page was torn off. Furthermore, and exhibiting a laudable creative dexterity, she proposes that “Vuestra Merced” is in fact a woman, who having confessed to the Archpriest of San Salvador, gets worried after discovering his *amancebamiento* (de facto relationship) with a maidservant married to no one less than a town crier of the wines of Toledo, our own Lázaro de Tormes, to whom “Vuestra Merced” asks for explaining the case and dispel her doubts (Navarro Durán, “El caso” 3-9; *La verdad*). While this adds little to the question of the author, her reflections resonated with some scholars who encumbered her at the peak of erudition.⁶⁰ Others carried out studies dismantling every aspect of her theory. Despite the efforts of the Catalan framing the *Lazarillo* as erasmist to harmonize with the style of Alfonso de Valdés, and the recent support in 2010 by the pioneer of the attribution (Ricapito, “Further Comments” 95) –possibly aimed by the popularity reaped by Navarro Durán–, there are still strong reasons against Valdés. To cite a few: the lack of solid linguistic concordances, the difference in style and genre (Alfonso de Valdés wrote mostly theological works), the aforementioned gap between the writing date and the first known editions of 1554, and the fact that the second part of the little book (which Navarro grants to Hurtado de Mendoza) starts with Lázaro enrolled to the war in Argel in 1541.⁶¹

At the beginning of the 20th-century, Fonger de Haan related the existence in 1538 of a town crier of Toledo named Lope de Rueda. Julio Cejador y Frauca accounts for the fact and, as part of his arguments in favour of Sebastián de Horozco, rejects what he considered to be a weak proposal for the authorship of the *Lazarillo* (Anónimo ed.

⁶⁰ In favor we can mention Juan Goytisolo (sec. 26).

⁶¹ Against the thesis of Navarro Durán notable works include Alatorre (*Los denigradores*; “El Lazarillo” 143-51), Félix Carrasco (“Lazarillo” 9; “¿Errata o lectio difficilior?” 23), Francisco Márquez Villanueva (“El Lazarillo y sus autores” 137), Valentín Pérez Vénzala (“El Lazarillo” 46), Marco Antonio Ramírez López (“Fortunas” 43), Pedro Martín Baños (“Nuevos asedios” 2).

Cejador y Frauca). The discovery led Fred Abrams to believe that the town crier was in fact the Sevillian actor and author of *entremeses*, Lope de Rueda. Analyzing the thematic and stylistic similarities as well as the concordances between the little book and the plays by Lope de Rueda, the American suggested that the actor could be the wanted author (Abrams, 67). However, a later study on town criers by Jaime Sánchez Romeralo revealed that the Lope de Rueda from Toledo and the author of plays were different persons, which was considered by Rico as the final piece of evidence to stop supporting the candidacy of the playwright. Years later Alfredo Baras Escolá still defended the similarities between the works of the Sevillian Lope de Rueda and the *Lazarillo*, based on the “eleven motifs or situations usually employed by the dramatist Lope de Rueda and that happen with precision in the novel [*i.e.*, the *Lazarillo*] in the form of sequences” (“once motivos o situaciones a que suele recurrir Lope de Rueda dramaturgo y que se cumplen con exactitud en la novela incluso en forma de secuencias”) (Sánchez Romeralo, “*De Lope de Rueda*” 671-675; Baras Escolá, “*Lazarillo y su autor*” 6), but with the scholar having failed to express them clearly, no one seems to have supported the actor’s authorship ever since. Rico vehemently rejects the hypothesis: “the same alleged reasons that later on would be used in defense of this idea lead to discard them without hesitation” (“las mismas pretendidas razones que posteriormente se han querido alegar en defensa de tal idea inducen a descartarla sin vacilaciones”) (Anónimo ed. Rico, 40).

During the second part of the 20th-century other names were proposed although none of them enjoyed enough support afterwards. In 1955, based on the idea of the author being a recognized intellectual and humanist in Spain at the time, Arturo Marasso raised the possibility of the professor and latinist Pedro de Rhúa (Marasso, 74). His argument was based on an alleged aversion between Pedro de Rhúa and Friar Antonio de Guevara. In that sense, the *Lazarillo* would merely be a parody of Guevara’s style, in particular of his *Epístolas familiares* (*Family epistles*). The Argentinian also highlighted the erasmist and knowledgeable tone used by de Rhúa in his letters. The criticism against Antonio de Guevara is somewhat similar to the general indictment towards the clergy from Soria that can be found in the *Diálogos de Mercurio y Carón* (Corencia Cruz). To this respect, Fernando Calero contributed supporting the candidacy of de Rhúa as the author with a rather particular approach (Calero Calero, “Homenaje” 26):

What a sharp nose Marasso had! Because the hidden author of the Lazarillo was indeed the Bachiller Rhúa. [...] It seems highly significant that in all Spanish literature [the expression “lana caprina” (goat wool)] was only used in the Letters of Rhúa, and from there the concordance with Vives [in regards to his De concordia et discordia in humano genere] gained an incontrovertible evidential value. If we join this concordance to the other previous two, there is no shadow of a doubt that Rhúa and Vives are the same person.

(¡Qué fino olfato literario tuvo Marasso! Porque, efectivamente, el oculto autor del Lazarillo fue el Bachiller Rhúa. [...] Resulta altamente significativo que en toda la literatura española sólo sea utilizada [la expresión ‘lana caprina’] en las Cartas de Rhúa, y de ahí que la concordancia con Vives [en su De concordia et discordia in humano genere] adquiera un valor probatorio incontrovertible. Si unimos esta concordancia a las dos anteriores, no puede haber la más mínima duda de que Rhúa y Vives son la misma persona) (qtd. in Sánchez Ferrer, Los padres).

Aldo Ruffinato also found Brenes’ hypothesis to be evocative and compelling.⁶²

Unfortunately, the profile of the author drawn by Marasso lacks bibliographical support and factual certainties to rely on.

In his 1964 essay on the interpretation and attribution of *Lazarillo*, Aristide Rumeau proposed the latinist Hernán Núñez de Toledo as the author (Rumeau). His comparison between the little book and *Las trescientas del famosísimo poeta Juan de Mena con glosa* (*The three hundred of the universally known poet Juan de Mena with glosa*) by the disciple of Nebrija, relied on linguistic and tone similarities, although these were not compelling enough to raise the support of other scholars. Not a stronger candidate is Fernando de Rojas, proposed by Howard Mancing in 1976. The American researcher based his hypothesis on the ability of the alledge author of *La Celestina* to criticize the social establishment, and on his nature of *converso* (convert), which supposedly granted

⁶² In his *Introduction* of his edition of the *Lazarillo*.

him an agnostic or anti-clergy background to write the *Lazarillo* (Mancing, 47-61). The Royal Secretary Gonzalo Pérez was also proposed by Dalai Brenes Carrillo in a series of studies started in 1986. Brenes interprets that the translator of *La Vlixia de Homero* (*The Odyssey of Homer*) wrote the little book as a sort of *roman à clef* about the life in the court of Charles V, where Laázaro is a “combined anti-thesis of the young Telemachus and the astute Ulysses of the gimmicks” (“combinada antítesis del joven Telémaco y el astuto Ulises de las tretas.”) (Brenes Carrillo, “Lazarillo” 43; “Vlixia” 104). In the process, Brenes identifies the addressee of “V.M.” as “Vuestra Majestad” (Your Majesty), and establishes other parallels between characters of the little book and real ones surrounding the milieu of the Emperor (Hurtado de Mendoza, Fernando de los Cobos, Gattinara, Enciso, Sílice, etc.) (Brenes Carrillo, “¿Quién es V.M.?” 73-88).⁶³ Other minor attributions, at least in terms of supporters and evidence, include the dramatist Bartolomé Torres Naharro, author of *La Propalladia*, who, according to Alberto M. Forcadás, shares certain similarities with the *Lazarillo* (Forcadás, 48). Furthermore, suggested for the first time by Cejador (Anónimo ed. Cejador y Fracuca), Juan Maldonado was more recently supported by Clark Colahan and Alfred Rodríguez in 1995. Arguing that although the humanist and friend of Erasmo only wrote in Latin, the little book presented several thematic and stylistic correspondences, supported by the common style used by Maldonado, *i.e.*, the autobiographical monologue.⁶⁴

Almost all previous candidates were rejected in 2003 by Francisco Calero, who staunchly defended Juan Luis Vives, the illustrious Valencian pedagogue and philosopher, as the author of the little book. Despite his thorough analysis of up to 151 (sic) thematic, stylistic, and linguistic concordances, more than enough to *incontrovertibly* settle the problem once and for all –in Calero’s words–, the candidacy still does not feel sufficiently strong. Drawing on the work of other *lazarillistas*, the philologist seems to arbitrarily use the arguments that could benefit his thesis while rejecting those that do

⁶³ Curiously, in his *Un par de vueltas más*, 2011, Agulló claimed that “V.M.” was in fact referring to Gonzalo Pérez himself.

⁶⁴ See Colahan and Rodríguez (289-311), and to a lesser extent Warren Smith, Clark Colahan, and Alfred Rodríguez (160-234).

not, *e.g.*, “[Américo Castro] previously defended the Jew origin of Luis Vives. It is true that he did not propose him as the author of the *Lazarillo*, but it is also true that he was in the right direction” (“Al igual que en los casos citados, también acertó en este A. Castro, quien con anterioridad había defendido el origen judío de Luis Vives. Es cierto que no llegó a postularlo como autor del *Lazarillo*, pero también lo es que estaba en la dirección correcta”) (Calero, “Luis Vives”; *Juan Luis Vives, autor* 46). Besides the concordances, Calero’s arguments rely on the conviction that the erasmist also wrote in the Castilian language, although Vives was known and laureated for his Latin works in several and complex matters such as hunger, poverty, charity, mercy, spirituality, or morality. In order to further support his claims, Calero builds on Ricapito’s arguments to sustain Alfonso de Valdés’ authorship and twisted them to favour his candidate (Calero, “Homenaje” 65). Likewise, he supports Navarro Durán’s thesis in one important aspect: the author of the *Diálogo de las cosas acaecidas en Roma* and *Diálogo de Mercurio y Carón* must be the author of the *Lazarillo*. Coincidentally, Calero has published several works that allegedly demonstrate that the *Diálogos*, together with other important works of the time, were all written by Juan Luis Vives. In his zeal, the philologist passes over the inquisitorial documental proof referred to by Bataillon that attributes both the *Diálogos* to Alfonso de Valdés. And while we acknowledge the similarities between the *Diálogos* and the *Lazarillo*, the topics and expressions alluded by Calero to defend his thesis as unequivocal were actually platitudes among the intellectual circles at the time. The early death of the forefather of modern psychology in 1540 does not help in either case. More recently the attribution to Vives was supported by Marco Antonio Coronel Ramos in 2012, without really adding much (81), and criticized again in 2014 in a review of Calero’s theory by Encarna Podadera, editor of a critical edition of the second part of the little book (13-24).

The 21st Century also brought the first authorship attributions complemented and supported by computational means. In order to delimit the profile of the author, in 2003 José Luis Madrigal drew his attention to the circle of intellectuals surrounding Alejo de

Venegas.⁶⁵ The grammarian from Toledo wrote *Las diferencias de libros que ay en el Universo* (*The different books existing in the Universe*) in which the “libro racional” (“rational book”) covers the topic of poverty with influences from Erasmo’s *Moria* and a general tone inspired by Apuleyo’s *Asno de oro* (*The Golden Ass*). The evident erasmist point of view inspired Madrigal to conclude that the author of the little book had to be a disciple of Venegas, and if not from Toledo at least a great connoisseur of the place. After discarding other authors of the same environment, Madrigal found in Francisco Cervantes de Salazar the candidate that fitted the profile (“Estudio de atribución” 9-13; “Cervantes de Salazar” 3). Translator of Juan Luis Vives, Fernán Pérez de Oliva, and Luis Mejía among others, Cervantes de Salazar moved to Mexico possibly inspired by the opportunity to found the Pontifical University of Mexico. There he started to sign his works with the Latin version of his name, *Franciscus Cervantes Salazarus*, in which Madrigal believed to find an anagram with the name Lázaro (*saLAZARUS ~ LAZARO*) that would prove the authorship, albeit recognizing himself that “attributions based in possible anagrams usually have the same credibility that the prophecies of Nostradamus” (“Las atribuciones basadas en posibles anagramas suelen tener normalmente la misma credibilidad que las profecías de Nostradamus”) (Madrigal, *Autor del Lazarillo*). To further support his candidate and his circumstantial evidence, Madrigal tried to identify what he called the *modus scribendi* of the author, a sort of fingerprint that comprises the set of features that supposedly defines the style of an author univocally. From the electronic versions of texts available in repositories such as CORDE,⁶⁶ and using as discriminator the coincidences between the *Lazarillo* and Cervantes de Salazar’s *Crónica de Nueva España* (*Chronicle of New Spain*), Madrigal built a method upon four opinionated levels of similarity (groups of words, idioms, peculiar syntactic turns, and other complex syntactic constructions). After applying his technique to other contemporary works to see which ones kept the highest number of similarities, Cervantes de Salazar’s works were stylistically closer to the *Lazarillo* than any other work. During the process Madrigal acknowledged he had not used more modern and current

⁶⁵ Vaguely proposed as well by Ruffinatto (“Lázaro González Pérez” 3).

⁶⁶ Banco de datos (CORDE), 2007, October 30 2015 <<http://www.rae.es>>.

approaches to authorship attribution, which weakens the credibility of his proposal although not of his methodology. In fact, five years later, with more evidence and slightly improved methods, Madrigal was forced to abandon the candidacy of the Toledan and welcome the jurist Juan Arce de Otálora, author of the *Coloquios de Palatino y Pinciano* (*Colloquia of Palatino and Pinciano*) (Madrigal, “Notas” 137-236). The palinode, strongly criticized by scholars such as Francisco Calero (“Los Coloquios” 65), downplayed the issue arguing that during the research, the corpus he had access to was limited, and that he realized that the author did not necessarily need to be a member of the chosen corpus—a problem usually referred to as the *open-set problem* and that characterizes the attribution of the *Lazarillo*. Nevertheless, Madrigal continued to employ keywords in context (KWIC) concordances to further support Arce de Otálora’s candidacy, insisting as well on another anagram he found (“LAZARO DE TOR(M) (E)S ARZE DE OTALOR”), and the suggestive coincidence between Lázaro’s surnames (González Pérez) and Arce de Otálora’s grandparents surnames (Fernand González and Juan Pérez).⁶⁷ In the same year of 2010, Alfredo Rodríguez López-Vázquez supported and rejected the candidacy of the author of the *Coloquios*, to later propose Friar Juan de Pineda (“El Tractado” 259-72; “Una refutación” 313-34). His theory was based on the same statistical methods and biographical similarities used by Madrigal, and followed the lead left by José Luis Ocasar, who edited the *Coloquios* some years before and in a later study did not confirm nor deny Arce de Otálora as the author (Ocasar, 873-888).

Inspired by Madrigal and Rodríguez López-Vázquez, and by means of his genetic-literary approach,⁶⁸ Ocasar mentioned a possible collaboration in the little book by Friar Juan de Pineda. The editor of Otálora’s *Coloquios* highlighted that way the alleged important role of the multiple authorship around the mid 16th-century, previous to the strict rules imposed by the Church in terms of the signing of books, and raised the possibility of *Lazarillo* being the product of the collaboration between several authors. Although the

⁶⁷ In the Hispanic tradition is habitual that people have two surnames, the first coming from the first surname of the father, and the second from the first of the mother (Madrigal, “De nombres y lugares” 89-118).

⁶⁸ Roughly, a genetic-literary analysis is the study of the differences and similarities between the editions of a text.

analysis of multiple authorship may be increasing in importance and interest in recent years it was once considered a sort of joke, as gathered by Francisco Rico in relation to Francisco de Avellaneda's 1675 famous *Loa por papeles* (*Loa for the papers*):⁶⁹

*I do not ignore that Thou knows,
as [Thou] nothing ignores,
that the Lazarillo de Tormes
six lads, just like that,
wrote in two days,
as that is the utter count.*

*(No ignoro que Vos sabéis,
puesto que nada ignoráis,
que al Lazarillo de Tormes
seis mozos, sin más ni más,
escribieron en dos días,
que esta es la cuenta cabal).*

At this side of the spectrum at which the author is belittled in favour of the many interpretations and meanings that the anonymity has to offer, some scholars such as Robert Fiore consider the authorship of the little book vital for its understanding: “the author, who undoubtedly wished to remain anonymous, has had his wishes fulfilled. Not only does the author remain unknown today, but his narrator is obscured, and his point of view is so shrouded by irony that it is not obvious to readers and critics” (Anónimo ed. Fiore, 714). In the same line, Américo Castro suggests that the anonymity of the *Lazarillo* is an essential part of the text itself:⁷⁰

We should realize, however, that this anonymity is not an accident, nor an omission, but an essential aspect of the literary reality of the book. If we take the

⁶⁹ Rico's *Lazarillo* (115-128), where he also gathers the attribution made by Dr. Locker, Dean of Peterborough, to a group of Spanish bishops traveling to the Council of Trent.

⁷⁰ See Américo Castro's introduction in Williams Harry Franklin and Hesse Everett Wesley.

fact of this anonymity as a point of departure, we may penetrate the book more deeply and enjoy it better than through mere appeasement of our curiosity about the author's name.

In his latest edition of the *Lazarillo* to date, and after thoroughly discrediting all other candidates, Francisco Rico takes for certain that the author was indeed a man named “Lázaro de Tormes”. In order to argue in favor of the apocryphal character of the book, Rico maintains that the game-changer aspect of the *Lazarillo* was a new kind of fiction, one that the audience was not yet ready to experience: “readers faced the book as pure ‘truth’ and ended up finding a ‘lie’ that established an admirably new genre of ‘fiction’” (“los lectores acometían el libro como pura ‘verdad’ y acababan encontrando una ‘mentira’ que instauraba un género de ‘ficción’ admirablemente nuevo”) (Anónimo ed. Rico, 115-128). According to Rico, not all readers were capable or in a position to decipher the fictionality introduced in the *Lazarillo*. This same complexity, together with the structural necessity of the author for anonymity, also led Fernando Rodríguez Mansilla to think about the author as an undercover moralist, not as a professional writer, who only wrote one little book in his entire life (Rodríguez Mansilla 235). We have a precedence in Fernando de Rojas’ *La Celestina*. If this were true, as Rico points out, any internal analysis of the little book would have been futile. Therefore, we will work from the assumption that its true author, as slippery and elusive as he may seem, wrote more than only one book, even if that were a masterpiece such as the *Lazarillo*.

According to the aforementioned list of the most frequently proposed authors, we have created a table that summarizes the candidates in terms of support by scholars and sorted by year of contribution (see table 1), as well as a chronology of the candidates, when they were proposed, by whom, who criticized them, and when they were criticized (see also table S1 in the supplementary materials, henceforth: SM).⁷¹

⁷¹ Good summaries can be found in Rico’s 2011 edition, and Joaquín Corencia Cruz. Rico’s 2011 edition is not included in this table as he basically discredited all the authors ever proposed. He stays neutral while the same edition reads “«Lázaro de Tormes»” as the author.

Table 4-1: List of plausible candidates as mentioned in this study, by year of proposal. For each author a chronological list of scholars supporting and rejecting the hypothesis is shown.

| | Supported by | Year | Criticized by |
|--------------------------|-------------------------|------|------------------------|
| Juan de Ortega | José de Sigüenza | 1605 | |
| | | 1624 | Tomás Tamayo de Vargas |
| | Marcel Bataillon | 1954 | |
| | Claudio Guillén | 1966 | |
| | " | 1988 | |
| | Antonio Alatorre | 2002 | |
| Diego Hurtado de Mendoza | Valerio Andrés Taxandro | 1607 | |
| | Andrés Schott | 1608 | |
| | Tomás Tamayo de Vargas | 1624 | |
| | Nicolás Antonio | 1873 | |
| | | 1888 | Alfred Morel-Fatio |
| | Ángel González Palencia | 1943 | |
| | Eugenio Mele | " | |
| | Erika Spivakovsky | 1961 | |
| | Olivia Crouch | 1963 | |
| | Charles Vincent Aubrun | 1969 | |
| | Erika Spivakovsky | 1970 | |

| | | | |
|----------------------|--------------------------|------|------------------------|
| | Mercedes Agulló | 2010 | Javier Blasco |
| | Jauralde Pou | " | Rosa Navarro Durán |
| | | " | José Luis Madrigal |
| | | " | Rodríguez Mansilla |
| | Mercedes Agulló | 2011 | |
| | Reyes Coll-Tellechea | " | |
| | Joaquín Corencia Cruz | 2014 | |
| Sebastián de Horozco | José María Asensio | 1867 | |
| | Julio Cejador y Frauca | 1914 | |
| | | 1915 | Emilio Cotarelo |
| | F. Márquez Villanueva | 1957 | |
| | José Gómez-Menor Fuentes | 1973 | |
| | Jaime Sánchez Romeralo | 1978 | |
| | Fernando González Ollé | 1980 | |
| | | 1987 | Francisco Rico |
| Juan de Valdés | Alfred Morel-Fatio | 1888 | |
| | | 1914 | Julio Cejador y Frauca |
| | Manuel J. Asensio | 1959 | Erika Spivakovsky |
| | | " | 1960 |
| | | " | 1992 |

| | | | | |
|---------------------|--------------------------------|------------------------|------------------------|---|
| Lope de Rueda | Fonger de Haan | 1901 | | |
| | | 1914 | Julio Cejador y Frauca | |
| | Fred Abrams | 1964 | | |
| | | 1980 | Jaime Sánchez Romeralo | |
| | | 1987 | Francisco Rico | |
| | Alfredo Baras Escolá | 2003 | | |
| | | 2006 | Francisco Calero | |
| Pedro de Rhúa | Arturo Marasso | 1955 | | |
| | Francisco Calero ⁷² | 2008 | | |
| Hernán Núñez Toledo | Aristides Rumeu | 1964 | | |
| | | 1987 | Francisco Rico | |
| Alfonso de Valdés | Joseph V. Ricapito | 1976 | | |
| | Rosa Navarro Durán | 2002 | Antonio Alatorre | |
| | | " | 2003 | " |
| | Juan Goytisolo | " | Félix Carrasco | |
| | | 2004 | " | |
| | | " | F. Márquez Villanueva | |
| | " | Valentín Pérez Venzalá | | |

⁷² Francisco Calero does not properly support the authorship of Pedro de Rhúa *per se*, but him being the same person than Juan Luis Vives ("Homenaje" 26).

| | | | |
|--------------------------------|--------------------------|------|--------------------------|
| | Rosa Navarro Durán | 2006 | M. Antonio Ramírez López |
| | | 2007 | Pablo Martín Baños |
| | Rosa Navarro Durán | 2010 | |
| | Joseph V. Ricapito | " | |
| Francisco Cervantes de Salazar | José Luis Madrigal | 2003 | |
| | | 2008 | José Luis Madrigal |
| Juan Luis Vives | Francisco Calero | 2006 | |
| | M. Antonio Coronel Ramos | 2012 | |
| | | 2014 | Encarna Podadera |
| Juan Arce de Otálora | José Luis Madrigal | 2008 | |
| | Rodríguez López-Vázquez | 2010 | Rodríguez López-Vázquez |
| | | 2011 | Francisco Calero |
| | José Luis Madrigal | 2014 | |
| Juan de Pineda | Rodríguez López-Vázquez | 2010 | |

4.3 Beyond Concordances

The analysis of texts sits at the core of the humanities. Identifying writing styles and the authors of anonymous or wrongly attributed texts has been of interest to scholars at least since the invention of the printing press, when the availability of and access to texts fostered comparative studies.⁷³ Text attribution studies fall into two different categories

⁷³ See an introduction to the topic by Harold Love.

attending to the nature of the evidence used. Internal analysis deals with the ways in which language is employed, from syntactic occurrences to the use of expressions that are characteristic of a specific author, or stemmatics based on Lachmannian textual criticism. The purpose of the internal analysis is to find the fingerprints of the author, and in the process it assumes that each author maintains a *modus scribendi* –as Madrigal called it– that is characteristic of each author. On the other hand, external analysis focuses on the circumstances of the author and how they are reflected in the text. It tries to create a profile of the anonymous writer by looking into readings that influenced the text, the kind of content expressed, and even by tracing parallels between events told in the text and the real life events of the author. Historiography, hermeneutics and rhetorics are big parts of the external analysis. Most non-traditional authorship attribution studies, in opposition to those run by the domain experts, rely on the internal analysis of the texts in hand, and therefore assume some existence of a quantifiable individual’s writing style.

Although authorship studies and their quantitative approaches predate computing, the introduction of computers made it easier and more affordable to analyze internal characteristics of texts and whole corpora (Love; Lord, 282; Mendenhall, 97-105). The successful attribution made by Frederick Mosteller and David Wallace of the essays in *The Federalist* marked the start of modern authorship techniques powered by computers. Their method was based on the statistical analysis of a set of predefined characteristics – usually a list of words– known as style markers: features outside the conscious control of the writer that were supposed to quantify the writing style. Over time other features were added, such as sentence length, vocabulary richness, *magic* indices (such as the widely used Yule’s Characteristic or Simpson’s Index), hapaxes, character frequencies, and all sort of ratios.⁷⁴ However, the case of the *The Federalist* has been considered not to be a good representative of the larger problem of non-traditional authorship studies: Mosteller and Wallace had a very well delimited problem with a clear set of possible candidates and certainty about one of them being indeed the author. Criticism started to flourish after a period of popularity during which the results of authorship attribution techniques were

⁷⁴ All these *old* techniques are very well explained in David I. Holmes (“Authorship attribution” 87-106).

even accepted at courts as experts' evidence.⁷⁵ Richard Bailey was the first to identify the necessary circumstances for authorship attribution in a forensic setting (1-20). More recently Efstathios Stamatatos considered (and extended) those as limitations of the techniques when faced with real life authorship attribution cases: long textual data of possibly very dissimilar styles, small candidate sets with 2 or 3 members, corpora not controlled by topic, and lack of objective evaluation criteria or benchmark data to assess the goodness of the methods ("A survey" 56). These flaws would be mostly overcome from the 1990s onwards, when electronic texts became pervasive and machines started to be powerful enough to process large volumes of data. In turn, these advances made possible the development and maturation of disciplines such as information retrieval, machine learning, and natural language processing (NLP), from where authorship studies have borrowed and applied some of the methods (Stamatatos, "A survey" 56).

Other aspects also affect the credibility and accuracy of computer-based methods. There is evidence of language affecting the reliability of these techniques, mostly focused in English texts since its beginning, although some language-independent methods of attribution have later appeared as part of computational linguistics (Peng et al., 267-274). Efforts in the field have been put in place to test methods in language-specific corpora and cross-language settings with encouraging results (Stamatatos et al. "Overview"). Javier Blasco and Cristina Ruiz Urbón highlighted the importance of the language and the proper choice of features when applied to Spanish texts. Albeit their study focused on modern Spanish texts extracted from online newspapers and blogs, they still mention the controversy surrounding the *Lazarillo* and noted the peculiarities of dealing with Spanish Golden Age works.

In general terms, modern authorship attribution problems fall in different categories depending on the desired outcome and the corpus. The process of discovering how alike two given texts are and finding their similarities is usually known as plagiarism detection (Stein, Lipka, and Prettenhofer, 63-82; Stein and zu Eissen; Zu Eissen and Benno Stein,

⁷⁵ Such is the case for CUSUM (QSUM) by Andrew Morton and Sidney Michaelson, strongly criticized by David Holmes and Fiona Tweedie (19-47).

565-569).⁷⁶ When the corpus is not available, researchers try to cluster authors, a technique that divides up the texts into parts that maintain the same style in order to discern authorship in collaborative works, which makes it possible to show the evolution of an author's style over time (Collins et al. 15-36; Graham, Hirst, and Marthi, 397-415). In some cases, it is even possible to characterize the profile of authors in terms of age, education, etc. by means of their writing (Koppel, Argamon, and Shimoni; Rangel et al.). While these approaches might some day be useful when applied to the *Lazarillo*, unfortunately they are still in their infancy. On the other hand, authorship identification counts with a more solid and dilated history, both in terms of research published and success cases. It is defined generally as the task of determining the unknown author of a given text from a set of candidates whose texts' authorships are generally accepted. Unlike closed-set attribution identification problems where the authors involved are known and the only task remaining is to identify who wrote what, *Lazarillo* turns out to be an open-set problem, where new authors are still being added to the pool of candidates. Open-set problems are considered much more difficult to dilucidate as there is no guarantee that the true author is part of the pool of candidates, especially when its size is small (Koppel, Schler, and Argamon, 83-94). Author verification, the problem of authorship identification with a set of one only candidate, is even more challenging since the task is to determine if the candidate is the author or not (Koppel and Schler). Among the different approaches for authorship identification, some scholars treat the problem as a set of instances of author verification, one per each author in the candidate set (Craig).

According to Hugh Craig, non-traditional authorship attribution studies lay their foundation on the idea of writers being constrained by their own cognitive faculties, resulting in a finite and statistically analyzable set of variation patterns that form their style (Craig). As it appears, authors cannot escape their style, not even when writing in different genres since "much of language production is done by parts of the brain which act in such swift and complex ways that they can be called a true linguistic

⁷⁶ An interesting introduction and approach can be found in Marilyn Randall.

unconscious.”⁷⁷ As tenable as they seem, style markers do not convey the power of conviction that traditional humanities scholars consider sufficient. The black-box, or yes-or-no approaches most computer-based authorship studies follow do not provide the stylistic explanation expected by the experts. Computational approaches to authorship attribution, and thus to authorship identification and verification, are not considered sufficient evidence to state the final truth in the dispute of anonymous texts. However, as we demonstrate in this study, using automatic authorship attribution might help reduce the pool of candidates and contribute evidence to further support a specific possible author or set of authors.

4.4 Materials

One big problem of computational methods is that they usually require the availability of digital editions of the texts, and it has been proven that some of the methods work better when their extensions are at the level of entire books. These kinds of collections exist but they do not usually grant access to the whole text;⁷⁸ therefore, in order to carry out our study, we were forced to collect our own corpus. We decided our corpus to comprise works in a period of 90 years surrounding the publication of the first known edition of the *Lazarillo*. All the major aforementioned candidates for the authorship of the little book are included, as well as some authors who had not been considered previously. The inclusion of these other authors is not coincidental: they add robustness to our method and establish a framework to assess its effectivity. We consider the period from 1499 to 1589 to be comprehensive enough to cover the nuances of all possible publication dates, lifespans and active period of authors. This span is even more generous if we take for granted the genetic-literary analysis by Ocasar (*La atribución*), who allegedly found the first citation to the *Lazarillo* in the early editions of *Coloquios de Palatino y Pinciano*, published in 1550.⁷⁹

⁷⁷ Citing from Craig, in relation to Mary Thomas Crane.

⁷⁸ CORDE, for example, only allows counting frequencies.

⁷⁹ Fernando Calero dates these *Coloquios* even sooner, around 1539 (Calero, *Los Coloquios*).

Collecting a dataset of the kind described was not an easy task. Some of the works are still in manuscript form and lack normalization, modernization, and digitized text, which makes the task even more monstrous. Digitization of original Spanish Golden Age manuscripts also presented some challenges, which we solved by building and using our own crowdsourcing OCR reviewing tool, *i.e.*, Festos.⁸⁰ Object character recognition (OCR) is the process of transforming an image of a text into its digital version readable by both people and machines. We built Festos upon DocumentCloud,⁸¹ a platform for journalists to collaboratively share and annotate documents, and Tesseract (Smith, 629-633), a state-of-the-art OCR tool open sourced by Google. While Tesseract is pluggable (Smith, Antonova, and Lee), it still lacks a good understanding of manuscript typefaces and old Spanish. These limitations were overcome by adding a reviewing tool in Festos that allowed collaborators to correct and proofread the results of the automatic recognition. This reviewing feature sped up the process of getting the digital texts ready as compared to the approach of transcriptions from scratch.

Unfortunately, although some works were already in digital form and others had modern usable editions, due to resources and time constraints we were unable to collect works from all the authors proposed and mentioned in this study as possible fathers of the *Lazarillo*. Pedro de Rhúa and Hernán Núñez de Toledo are among the authors without representation in our list of works, although this might not pose a great burden on our study since they were arguably the weakest of the candidates: not supported ever since they were first proposed in 1955 and 1964, respectively. Friars Juan de Pineda and Juan de Ortega, the first and last candidates to date to be proposed, are the other two authors not present in our corpus. The former has not been backed up yet by any other scholar, the latter does not count with any known work that could be used. The final list of works by authors in the pool of candidates analyzed is detailed below:⁸²

⁸⁰ Festos. October 30, 2015. <<http://festos.cultureplex.ca>>.

⁸¹ DocumentCloud. October 30, 2015. <<https://www.documentcloud.org/>>.

⁸² Dates consigned are publication dates or around the date of death of the author if posthumously published.

- Alfonso de Valdés: *Diálogo de las cosas acaecidas en Roma* (1527), *Diálogo de Mercurio y Carón* (1528)
- Diego Hurtado de Mendoza: *De la Guerra de Granada* (~1573)
- Francisco Cervantes de Salazar: *Crónica de la Nueva España* (1575)
- Juan Arce de Otálora: *Coloquios de Palatino y Pinciano* (1550)
- Juan de Valdés: *Consideraciones* (1575), *Diálogo de la Lengua* (1535), *Trataditos* (1545)
- Juan Luis Vives: *Ejercicios de lengua latina (Diálogos)* (1539), *El Alma y la Vida* (1538), *Sobre el socorro de los pobres o Sobre las necesidades humanas* (1525), *Sobre la Concordia y la Discordia* (1529), *Instrucción De La Mujer Cristiana* (1523), *La Sabiduría* (1544), *Las Dimensiones de Europa y del Estado* (1526), *Las Disciplinas* (1531), *Los Deberes del Marido* (1528)
- Lope de Rueda: *Armelina* (~1565), *Auto de Naval y de Abigail* (~1565), *Coloquio de Camila* (~1565), *Coloquio de Tymbria* (~1565), *Discordia* (~1565), *El Deleitoso* (~1565), *Eufemia* (~1565), *Farsa del Sordo* (1549), *Los Desposorios de Moisés* (~1565), *Los Engañados* (1560), *Registro de Representantes* (~1565), *Medora* (~1565), *Prendas del Amor* (~1565)
- Sebastián de Horozco: *La famosa historia de Ruth* (~1570), *Relaciones Históricas Toledanas* (~1570)

Furthermore, we added works from coetaneous authors of *Lazarillo*'s: some with evident connections to the circumstance of the little book (Pedro Mejía, Pérez de Oliva), others with no connection whatsoever (Torquemada, Juan de Malara), and a few minor or discarded attributions (Fernando de Rojas).

- Antonio de Torquemada: *Don Olivante de Laura* (1564)
- Cristóbal de Villalón: *El Crotalón de Christophoro Gnophoso* (1552)

- Gaspar Gil Polo: *Diana enamorada* (1564)
- Gonzalo Argote de Molina: *Discurso sobre la Poesía Castellana* (1575)
- Fadrique de Zúñiga y Sotomayor: *Libro de Cetrería* (1565)
- Fernán Pérez de Oliva: *Diálogo de la Dignidad del Hombre* (1586)
- Fernando de Rojas: *La Celestina* (1499)
- Francisco Delicado: *La Lozana Andaluza* (1528)
- Juan de Malara: *Descripción de la Galera Real del Sermo. Sr. D. Juan de Austria* (~1570)
- Pedro Mejía: *Carlos V* (1530), *Coloquios del Convite* (1547), *Coloquio del Porfiado* (1547), *Coloquio del Sol* (1547), *Dialogo de la Tierra* (1547), *Diálogo de los Médicos* (1547), *Diálogo Natural* (1547), *Silva de Varia Lección* (1540)
- Sebastián Fernández: *Tragedia Policiana* (1547)

The corpus counts a total of 50 works by different authors of different genres, styles, and extensions.⁸³ Regarding *Lazarillo* itself, we used the edition of the Centro Virtual Cervantes, which is a digital edition based on those published in 1554 in Burgos (Spain) by Juan de Junta, Alcalá de Henares (Spain) by Salzedo, Antwerp (Belgium) by Martín Nucio, and Medina del Campo (Spain) by Mateo and Francisco del Canto. The edition, also collated with the critical works by Alberto Blecua, José M. Caso González, and Francisco Rico (Anónimo ed. Blecua; Anónimo ed. Caso González; Anónimo ed. Rico), marks visually the interpolations that the edition of Alcalá added. There is some controversy around deciding whether those additions should be considered as apocryphal, or as coming from the same author and therefore part of the *princeps*. In this context, and aiming to improve the accuracy of our method by only having works written by the same

⁸³ Gonzalo Argote de Molina's *Poesías Castellanas* was later discarded as its extension was too short to support any statement about authorship.

author, we segmented the little book and assigned different anonymous authors to each separate part. For purposes of completeness, we also added the second part, *La segunda parte de Lazarillo de Tormes y de sus fortunas y adversidades* (*Second part of the Lazarillo de Tormes and of his fortunes and adversities*), published in 1555 in Antwerp by the printer Martín Nucio. Digitally edited by Centro Virtual Cervantes, it takes into account the editions by Buenaventura Carlos Aribau (Anónimo ed. Carlos Aribau), and the one by Pedro Manuel Piñero Ramírez (Anónimo ed. Piñero). The final list looks as follows:⁸⁴

- Anonymous +: *La vida de Lazarillo de tormes y de sus fortunas y adversidades* (1554) (with interpolations)
- Anonymous -: *La vida de Lazarillo de tormes y de sus fortunas y adversidades* (1554) (without interpolations)
- Anonymous S: *La segunda parte de Lazarillo de Tormes y de sus fortunas y adversidades* (1555)

4.5 Methods

In the presentation of their automated tool (JGAAP) Patrick Juola, John Sofko, and Patrick Brennan stated that “all known human languages can be described as an unbounded sequence chosen from a finite space of possible events.” These events might range from the different words of a language such as Spanish, to the letters of a specific alphabet, or the different phonemes in the spoken inventory; as such, any written book meets the definition. They also considered that, generally, almost any non-traditional authorship attribution analysis –and, thus, author identification– can be seen as a three-phases pipeline, each of which must be tailored to the specific needs of the corpus and task at hand (Juola, Sofko, and Brennan). We adopted their framework for its broad and comprehensive view and redefined the steps for our purposes. The first one,

⁸⁴ Unfortunately, the interpolations are not long enough to be included in the authorship attribution study. Possible workarounds for this issue are discussed in the conclusions and further research of this study.

canonicalization,⁸⁵ is the process of standardizing the events in the text in order to reduce the complexity and thus the number of different symbols and words to handle. The rules we followed for regularizing the spelling of old Spanish were borrowed from Ocasar's system in his edition of the *Coloquios de Palatino y Pinciano* by Arce de Otálora (Ocasar, *La atribución*), to which we added some of our own. Specifically, we removed margin annotations and footnotes; removed page headers, footers, and numbers; removed any Latin or Greek citations; joined split words; removed spurious characters; removed duplicated punctuation marks; converted all possible hyphens into one; removed numbers in text as they usually add little to the style; expanded abbreviations such as “Ð” into the canonical form “DE;” and removed starting and ending marks of chapters, volumes, parts, scenes, and books. For plays, we also removed names of speakers. Then the event set had to be determined, which includes the partitioning of the works in the corpus into nonoverlapping events, such as paragraphs, sentences or words. The last step was the application of different kinds of statistical inferences to said events, from basic frequencies and distance-based measures to machine learning and pattern-based techniques. The specific features to be extracted depend on the statistical analysis to be carried out. This process can be seen as a transformation of the text into numbers, an ultimate quantification that produces vectors from stories attending to a variety of criteria: a corpus is now transformed into a more general and abstract dataset. The main goal of any feature extraction step is to maximize the discriminative power of the feature set selected, that may contain different kinds of features. Efstathios Stamatatos classifies the features in 5 groups, according to their nature and role in the text, and each requiring different mechanisms for their obtention (see table 2). Lexical and character features are historically the first ones to be used, and deal with the text at the word and letter levels, respectively. Frequency distributions of words or characters (bag of words), or ordered sets of them of different lengths (n-grams) are among the most used lexical features and the ones that provide best results. Although they are very useful since they can be applied regardless of the language, the extraction of lexical features might require the use of advanced techniques from natural language processing in order to segment the text into

⁸⁵ “Canonicization” in the original text.

sentences or words –tokenizers, stemmers, and lemmatizers may come in handy. Extraction of semantic and syntactic features involves an even more sophisticated analysis of the texts, as it uses layers of knowledge that are not revealed in the text itself. These abstract constructs such as parts of speech, polysemy, or phrase structure, are related to a specific role of parts of the text. In practice, the extraction of this kind of features can be thought of as a two-step process: first, the text is transformed according to the function of its parts, and second, the same mechanism of counting the lexical features can then be used.

Furthermore, Stamatatos also makes a distinction according to how the different methods of attribution treat the corpus. Profile-based approaches operate on a per-author basis, concatenating all texts by the same author and extracting the features cumulatively, ignoring in fact the possible existence of differences amongst their texts. Instance-based methods, on the other hand, treat each text individually and try to produce most accurate attribution models by considering the individual contributions that each of the texts makes to the authorial style. Generally, as a manner to artificially increase the number of texts available in the corpus, chunking the works into parts of equal sizes in terms of number of paragraphs, sentences, or words is a widely employed technique. Finally, there is a third approach that would combine both profile and instance-based methods. Regardless of the technique of attribution used, the selection of features and their size or dimensionality still remains a rather arbitrary and domain specific task.

Table 4-2: Summary of features by category following Stamatatos’ classification and adding some from Argamon and Juola’s overview (Argamon and Juola, “Overview”).

| Category | Features |
|----------|---|
| Lexical | Token-based (word length, sentence length, etc.) Vocabulary richness Word frequencies Word n-grams Errors |

| | |
|----------------------|---|
| | Function words |
| | Pronouns |
| | Modal verbs |
| | Contractions/abbreviations |
| Character | Character types (letters, digits, etc.) |
| | Character n-grams (fixed-length) |
| | Character n-grams (variable-length) |
| | Compression methods |
| | Punctuation |
| | Suffixes |
| Syntactic | Part-of-Speech |
| | Chunks |
| | Sentence and phrase structure |
| | Rewrite rules frequencies |
| Semantic | Synonyms |
| | Semantic dependencies |
| | Semantic parser |
| | Named entity types |
| | Polysemy / specificity |
| Application-specific | Structural |
| | Content-specific |
| | Language-specific |

4.5.1 Comprehension and Compression

When faced with many features, dimensionality reduction and feature selection techniques can be applied (Forman), although they might fail to capture authors' styles and therefore result in features too genre- or topic-dependent (Brank et al.). John Burrows, after experimenting with techniques based on multivariate analysis to reduce the dimensionality of the feature space, came up with an approach that fits perfectly in

Juola’s broad definition of an authorship attribution method: the ‘Delta’ method (Burrows, “Delta” 267-287; “Attribution and Beyond”). From a frequency distribution of the 150 most frequent words in a corpus, the method starts by estimating the mean frequency of the word and its variance, the so called z-distribution. Burrows’ ‘Delta’ (which he insisted it to be named ‘ Δ ’ where possible, although his claims were unheard) is then built as “the mean of the absolute differences between the z-scores for a set of word-variables in a given text-group and the z-scores for the same set of word-variables in a target text.” Which means that the smaller the Delta, the more similar the texts are. This profile-based method turned out to be the most robust single measure and it is now used as a baseline for other methods since it usually produces useful results across genres and languages. Some improvements have been proposed based on explanations of the underlying mathematics involved, but Burrows’ ‘Delta’ has proven over and over to perform better than its modifications despite lacking a solid theoretical background (Stein and Argamon, “A mathematical explanation” 207-209; Rybicki and Eder, “Deeper Delta” fqr031).

Table 4-3: Best Deltas for our corpus. Each row shows a different setting for culling and most frequent words, the best performing Delta in each case, and the difference of means as defined by Jannidis as a proxy for best measure.

| Most frequent words | Culling | Delta | Difference of means |
|---------------------|---------|-------------|---------------------|
| 100 | 50% | Eders Delta | 1.50 |
| 100 | 70% | Eders Delta | 1.50 |
| 2500 | 0% | Cosine | 1.49 |
| 100 | 90% | Euclidean | 1.49 |
| 500 | 90% | Eders Delta | 1.48 |
| 1000 | 90% | Eders Delta | 1.48 |
| 2500 | 90% | Eders Delta | 1.48 |

| | | | |
|------|-----|-------------|------|
| 500 | 70% | Eders Delta | 1.46 |
| 1000 | 70% | Eders Delta | 1.46 |
| 2500 | 70% | Eders Delta | 1.46 |
| 500 | 50% | Eders Delta | 1.46 |
| 100 | 0% | Canberra | 1.45 |
| 100 | 30% | Canberra | 1.45 |
| 1000 | 50% | Eders Delta | 1.44 |
| 2500 | 50% | Eders Delta | 1.44 |
| 2500 | 30% | Cosine | 1.42 |
| 500 | 30% | Eders Delta | 1.41 |
| 1000 | 0% | Cosine | 1.41 |
| 1000 | 30% | Eders Delta | 1.40 |
| 500 | 0% | Eders Delta | 1.39 |

Fotis Jannidis recently proposed a framework based on a simple difference of means to evaluate and assess the ‘Delta’ method and its variations. The measure “showed the best correlation with the clustering error measure” when doing ingroup and outgroup comparisons –ingroup refers to distances between texts written by the same author, and outgroup by different authors. The larger the difference, the better the measure performs. They also published the code used to carry out their analysis –a practice that we believe should become more common–, which we used with slight modifications over our corpus of *Lazarillo* (Jannidis, et al.; Evert et al.). We executed several runs changing the number of most frequent words to consider (150, 500, 1000, 2500), and also applied different

culling factors (30%, 50%, 70%, 90%) based on David Hoover’s extensive analysis and variations over the original ‘Delta’ method.⁸⁶ We obtained that Maciej Eder variation, a variant derived from the Canberra measure of similarity (Rybicki and Eder, *Deeper Delta*), performed sensibly better than baseline and than more sophisticated Deltas such as cosine-based or simpler ones such as the Euclidean (see table 3 for a summary of the executions). This might be explained by the fact that Eder’s Delta seems to provide better results for highly inflected languages, and although only tested for French, it might work as well for Spanish (Eder and Rybicki, “Birds of a feather” fqs036; Eder, “Does size matter?” 132-135).

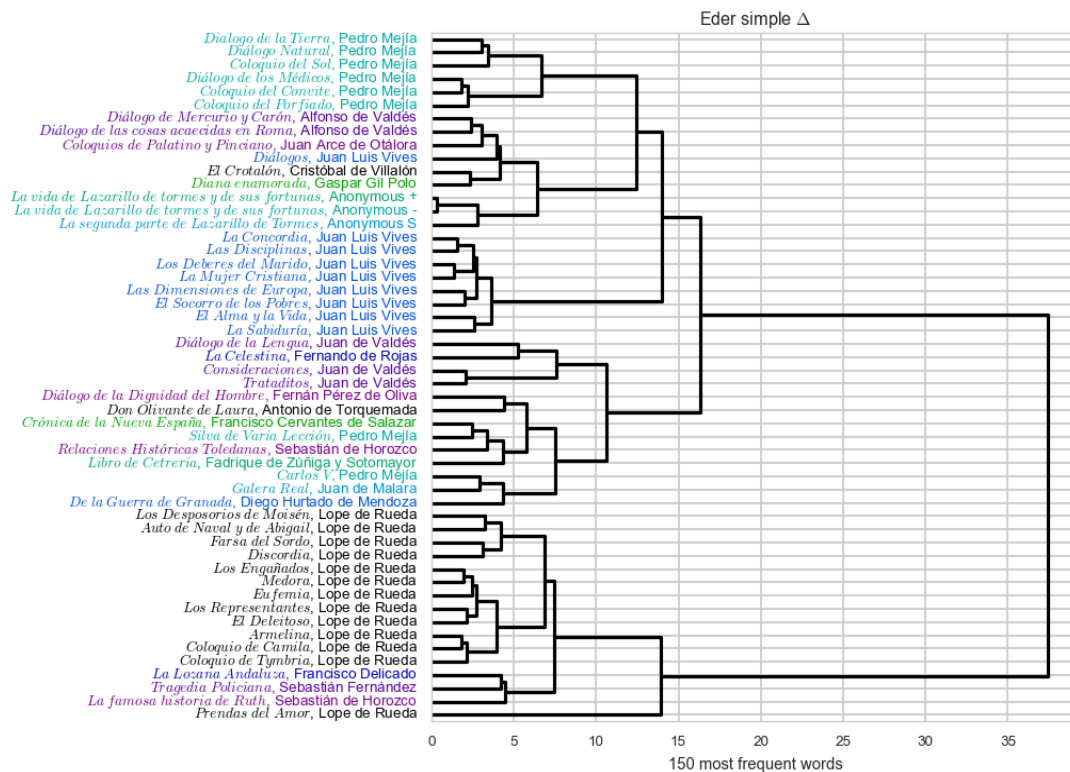


Figure 4-2: Dendrograms for Eder simple Delta. Jannidis’ algorithm performs an arborean grouping by similarity measured by the chosen Delta distance. Eder simple Delta is calculated with 0% of culling and for the 150 most frequent words. Same authors are assigned the same color.

⁸⁶ Culling is the percentage of documents a word must appear in to be retained in the corpus (Hoover, “Delta prime?” 477-495; “Testing Burrows’s delta” 453-475).

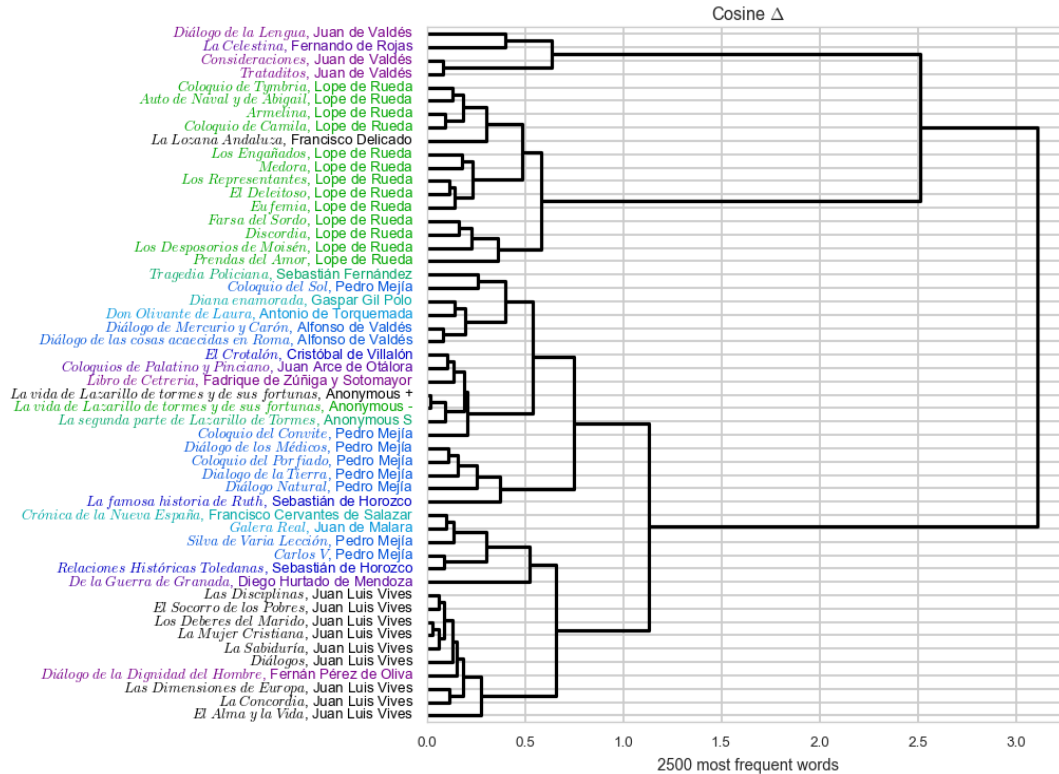


Figure 4-3: Dendrograms for Cosine Delta. Cosine Delta is calculated for the 2500 most frequent words and with 0% of culling. Same authors are assigned the same color.

Figures 2 and 3 show dendrograms that put into a hierarchy the works in our corpus by means of the Delta measure. Works in leaves with the same parent are closer to each other than to those works in leaves accessible only by traversing the tree. Following the arboreal structure Jannidis' algorithm produces, it is easy to see how some of the candidates just stay out of the branch that reaches to the *Lazarillo*. The method consistently leaves authors such as Fernán Pérez de Oliva, Fernando de Rojas, Francisco Delicado, or Juan de Malara far from our wanted anonymous author. As a first approach it goes with our intuitions as they were *impostors* in our corpus. However, authors with strong candidacies are also grouped differently than the *Lazarillo*, as it is the case of Juan Luis Vives, Diego Hurtado de Mendoza, Juan Valdés or even Lope de Rueda. Among the ones more closely related to the author of the *Lazarillo*, with or without *interpolaciones*, we find Juan Arce de Otálora and Alfonso de Valdés, but unexpected authors such as

Cristóbal de Villalón or Pedro Mejía. The second part of the adventure of Lázaro de Tormes is also placed together with the first two. According to the inventor of the Delta method, this result suggests that we should focus on these last group of authors and reinterpret the authorship of the little book as a closed-set problem. In relation to the dependence of the method on probabilities, Hoover observed that with specific cases of corpora “false attributions are a serious possibility” (Hoover, *Testing*), and Burrows also noted that “the system for distinguishing between insiders and outsiders is not foolproof” (Burrows, ‘Delta’). The problem worsens when dealing with either texts of different lengths, or with a different number of texts by author –the class imbalance problem–, as it is our case.⁸⁷ Therefore, before making a hasty decision, we had better explore other methods for authorship to further support this initial findings.

Another set of distance-based methods borrows some concepts from the principles that make regular file compression applications work. Their functioning is similar to other probabilistic distance measures such as those based on Markov models (Khmelev and Tweedie, “Using Markov” 299-307; Kukushkina, Polikarpov, and Khmelev, “Using literal” 172-84),⁸⁸ but avoids the combinatorial explosion problem when facing huge vocabulary sizes. In general, as compression methods are usually, but not necessarily, profile-based approaches, the first step is to concatenate all the works by an author to later compress them into individual files. The anonymous text is then added to the concatenated files and they are compressed again. The bitwise difference between the concatenated text files with and without the anonymous text is a measure of the similarity of both texts and can be used as a proxy for authorship attribution. Technically, from an information theory perspective, compression methods calculate the cross-entropy or Kullback-Leibler divergence of the texts as a measure of closeness.⁸⁹ Fortunately, despite

⁸⁷ Other distance-based methods, such as Common n-Grams (CNG) approach by Keselj et al. are also known to perform poorly under such circumstances (Kešelj et al.; Stamatatos, “Author identification” 237-241).

⁸⁸ A good introduction to the topic with applications and examples can be found in Ming Li and Paul Vitnyi.

⁸⁹ Joula referred to the method as the “linguistic cross-entropy” (“What can we do” 1; “Cross-entropy” 141-149).

the mathematical complexity of this measure, the underlying idea is so easy to grasp that we could bypass the formulas by using virtually any compression tool available. In this scenario, the RAR compression format has shown to outperform any other, specially dictionary-based compression such as LZMA or GZIP (Khmelev and Teahan, “A repetition” 104-110; Marton, Wu, and Hellerstein, 300-314).

In this context we used a technique implemented in 2005 by Rudi Cilibrasi and Paul Vitanyi around BZIP2, another very popular, free, and open source compression format (45). Let $C(x)$ be the bitwise size of the compression of a text file x , and let denote concatenation of files x and y as $x+y$. Cilibrasi and Vitanyi built upon the concept of Kolmogorov complexity and defined their normalized compression distance (NCD) between the files x and y as follows:⁹⁰

$$NCD(x, y) = \frac{C(x+y) - \min(C(x), C(y))}{\max(C(x), C(y))} \quad (1)$$

Broadly defined, Kolmogorov complexity “is a measure of the computational resources needed to specify an object” in an universal descriptive language (Burgin). In our case the object is a text, understood as a digital string of characters, and the computational resources can be specified as the length of the shortest computer program –written in any prefixed programming language– able to produce such an output.

The researchers reported excellent results for Russian texts, and even for their machine-translated English versions, as well as in other fields such as music and genomics. Other have reported that the technique might be noise-robust, that is resistant to noise (Cebrián, Alfonseca, and Ortega, 1895-900), which despite our efforts manually curating is still a reality in our corpus. Inspired by the alleged efficacy we applied Cilibrasi and Vitanyi’s method virtually unchanged by using a library they released and containerized for others to use: the CompLearn Toolkit (Cilibrasi, *CompLearn*). Once the distances between each pair of texts (or concatenated texts per author) are calculated, NCD provides us with a

⁹⁰ Defined as the “length of the smallest computer program that converts one string into another ... authorship can [therefore] be assigned to the training document that would require the least ‘work’ to convert to the test document” (Juola, *Authorship*).

tool to cluster them by their similarity and represent them using a hierarchy. The result is an unrooted binary tree in which leaves in the same level have closer small distances. Figures 3 and 4 show our results for two different runs: first using an instance-based approach, and second a profile-based one. When texts are grouped by author (figure 3),⁹¹ NCD shows that the first and second part of the *Lazarillo* cluster pretty closely together, followed by Fernán Pérez de Oliva, Francisco Cervantes de Salazar, and Francisco Delicado. Out of these last three, two are part of the impostors section of our corpus and the third, Cervantes de Salazar, although supported by Madrigal using computational means, was later rejected. In the next level we find a mix of impostors and genuine candidates: Sebastián Fernández, Hurtado de Mendoza (linked to Juan de Malara), Gaspar Gil Polo, Fernando de Rojas, and Alfonso de Valdés. The furthest positions belong to Juan Arce de Otálora and Pedro Mejía. By all means, these results practically contradict Delta's. We believe that the incomprehensive groupings performed in the clustering provided by the NCD tool must be sensible to the class imbalance problem, as there seem to be a slight relation between the length of the concatenated texts and the closeness at which authors are clustered. On the other hand, results for the instance-based approach (see figure 4)⁹² make more sense as works belonging to Lope de Rueda are

⁹¹ Anonymous + as "A", Anonymous S as "AS", Juan Arce de Otálora as "JAO", Francisco Cervantes de Salazar as "FCS", Francisco Delicado as "FD", Sebastián Fernández as "SF", Gaspar Gil Polo as "GGP", Sebastián de Horozco as "SH", Diego Hurtado de Mendoza as "DHM", Juan de Malara as "JM", Pedro Mejía as "PM", Fernán Pérez de Oliva as "FPO", Fernando de Rojas as "FR", Lope de Rueda as "LR", Antonio de Torquemada as "AT", Alfonso de Valdés as "AV", Juan de Valdés as "JV", Cristóbal de Villalón as "CV", Juan Luis Vives as "JLV", and Fadrique de Zúñiga y Sotomayor as "FZS."

⁹² *La vida de Lazarillo de tormes y de sus fortunas y adversidades* as "A,Lazarillo", *La segunda parte de Lazarillo de Tormes* as "AS,Lazarillo", *Coloquios de Palatino y Pinciano* as "JAO,Coloquios", *Crónica de la Nueva España* as "FCS,Crónica", *La Lozana Andaluza* as "FD,Lozana", *Tragedia Policiana* as "SF,Tragedia", *Diana enamorada* as "GGP,Diana", *La famosa historia de Ruth* as "SH,Ruth", *Relaciones Históricas Toledanas* as "SH,Relaciones", *De la Guerra de Granada* as "DHM,Guerra", *Galera Real* as "JM,Galera", *Carlos V* as "PM,Carlos", *Coloquio del Convite* as "PM,Convite", *Coloquio del Porfiado* as "PM,Porfiado", *Coloquio del Sol* as "PM,Sol", *Dialogo de la Tierra* as "PM,Tierra", *Diálogo de los Médicos* as "PM,Médicos", *Diálogo Natural* as "PM,Natural", *Silva de Varia Lección* as "PM,Silva", *Diálogo de la Dignidad del Hombre* as "FPO,Dignidad", *La Celestina* as "FR,Celestina", *Armelinea* as "LR,Armelinea", *Auto de Naval y de Abigail* as "LR,Naval", *Coloquio de Camila* as "LR,Camila", *Coloquio de Tymbria* as "LR,Tymbria", *Discordia* as "LR,Discordia", *El Deleitoso* as "LR,Deleitoso", *Eufemia* as "LR,Eufemia", *Farsa del Sordo* as "LR,Sordo", *Los Desposorios de Moisés* as "LR,Moisés", *Los Engañados* as "LR,Engañados", *Los Representantes* as "LR,Representantes", *Medora* as "LR,Medora", *Prendas del Amor* as "LR,Amor", *Don Olivante de Laura* as "AT,Olivante", *Diálogo de las cosas acaecidas en Roma* as "AV,Roma", *Diálogo de Mercurio y Carón* as "AV,Mercurio", *Consideraciones* as "JV,Consideraciones", *Diálogo de la Lengua* as "JV,Lengua", *Trataditos* as "JV,Trataditos", *El Crotalón*

clustered together, as it happens to a lesser extent to those by Juan Luis Vives and those by Pedro Mejía. This provides a more solid foundation to interpret the rest of the tree as the method seems to be capturing stylistic similarities rather than text lengths. The *Lazarillo*, with and without interpolations, is first placed close to *La Sabiduría* (*The Wisdom*) by Vives, and in a second level to his *Las Dimensiones de Europa* (*Dimensions of Europe*), the second part of the little book, and to *Diálogo de las cosas acaecidas en Roma* by Alfonso de Valdés. Further levels show heterogeneity of authors and their works with some smaller clusters. Although the instance-based approach shows some signs of coherence, it still lacks credibility. In order to further test the method we decided to implement our own approach with more solid compression formats other than BZIP2, specially PPM and RAR.

Markov-based methods have been reported to produce good results in text. Prediction by partial matching (PPM) is one of that kind: a probabilistic compression technique – achieving lossless compression in text – that creates a model with the likelihood of each letter appearing after each other. Unfortunately, although Cilibrasi and Vitanyi claimed that their tool was able to work with other compression formats, we were unable to put PPM to work with the NCD tool, so we built our own NCD implementation in Python based on the Debian package `ppmd` by Dmitry Shkarin and added support for RAR by Alexander Roshal (Shkarin, 202-211). For representing the results, and due to the lack of the NCD semi-automated output that included the result of the clustering process, we calculated the correlation matrix for all pairs of instances and profiles and plotted them into a heatmap and a dendrogram (clustermap).⁹³ The color map indicates closer similarities with darker colors whereas light colors denote more distance.

as “CV,Crotalón”, *Diálogos* as “JLV,Diálogos”, *El Alma y la Vida* as “JLV,Alma”, *El Socorro de los Pobres* as “JLV,Pobres”, *La Concordia* as “JLV,Concordia”, *La Mujer Cristiana* as “JLV,Mujer”, *La Sabiduría* as “JLV,Sabiduría”, *Las Dimensiones de Europa* as “JLV,Europa”, *Las Disciplinas* as “JLV,Disciplinas”, *Los Deberes del Marido* as “JLV,Marido”, *Libro de Cetreria* as “FZS,Cetreria.”

⁹³ Spearman rank correlations and Kendall Tau correlation coefficients produced very similar results.

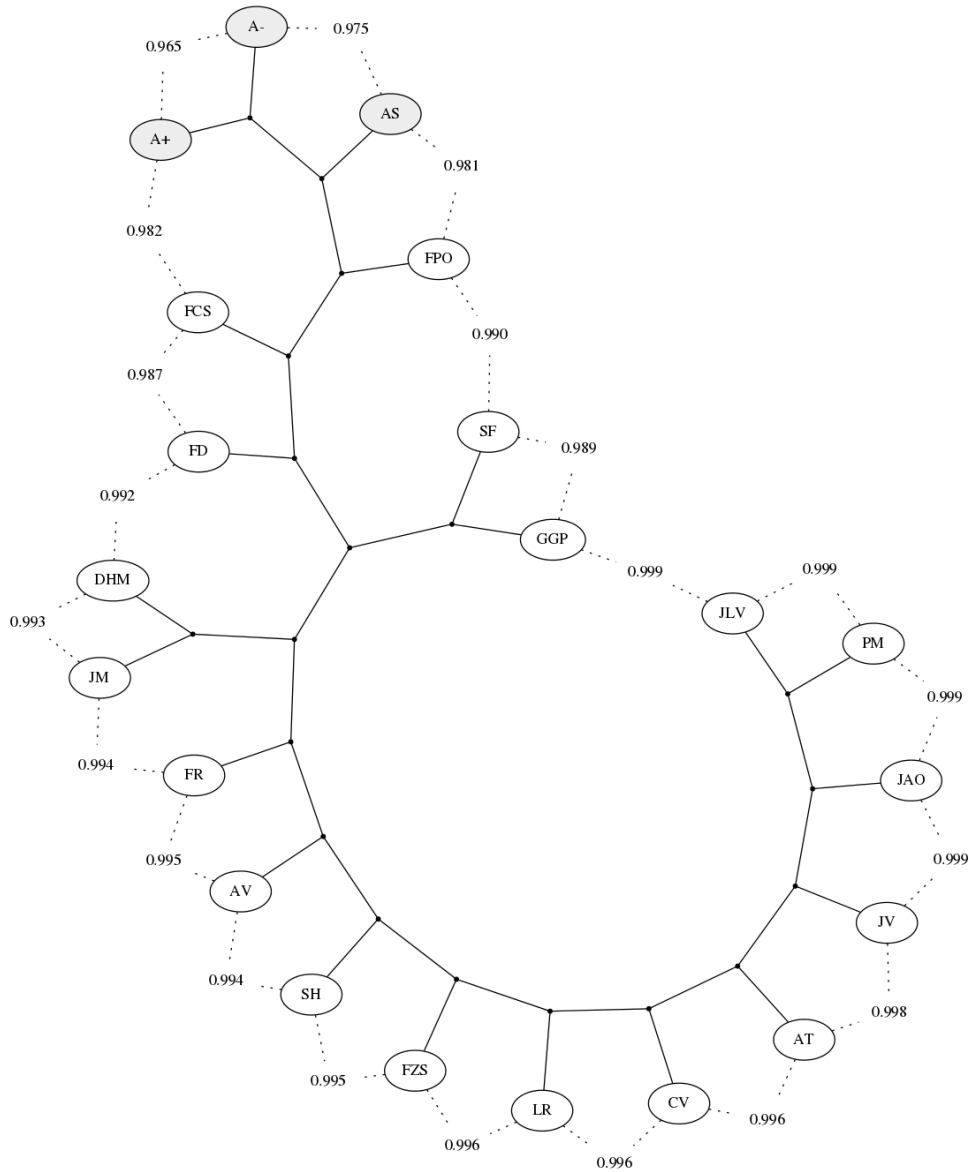


Figure 4-4: Unrooted binary tree from a matrix of normalized compression distances (profile-based). Some of the distances are included as returned by the NCD tool. Author names have been shortened to avoid overlapping in the graph.

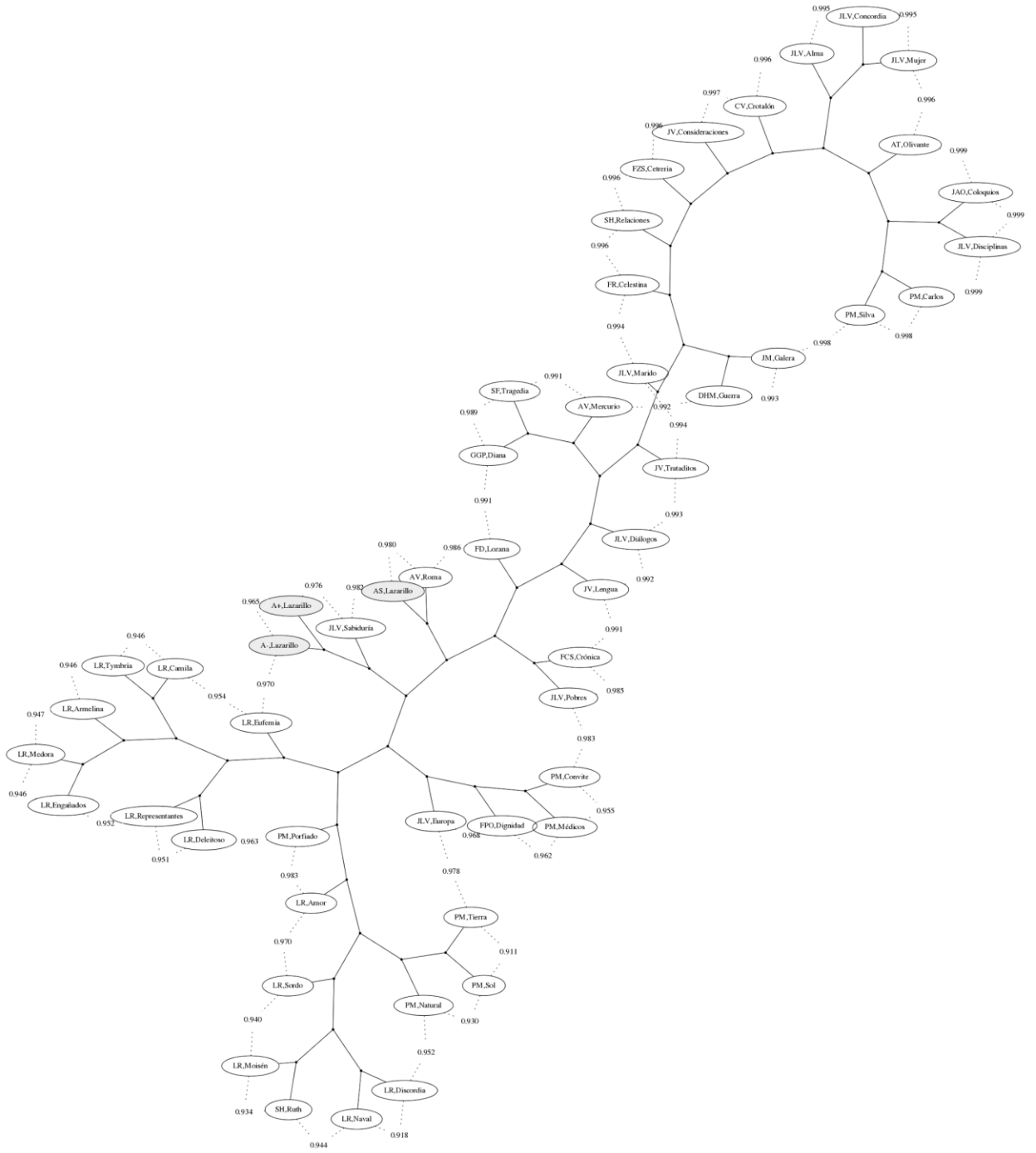


Figure 4-5: Unrooted binary tree from a matrix of normalized compression distances (instance-based). Leaf labels follow same author codes used in figure 2, whereas work titles are shortened but recognizable.



Figure 4-6: Instance-based heatmaps and dendrograms for RAR (top) and PPM (bottom) compression formats

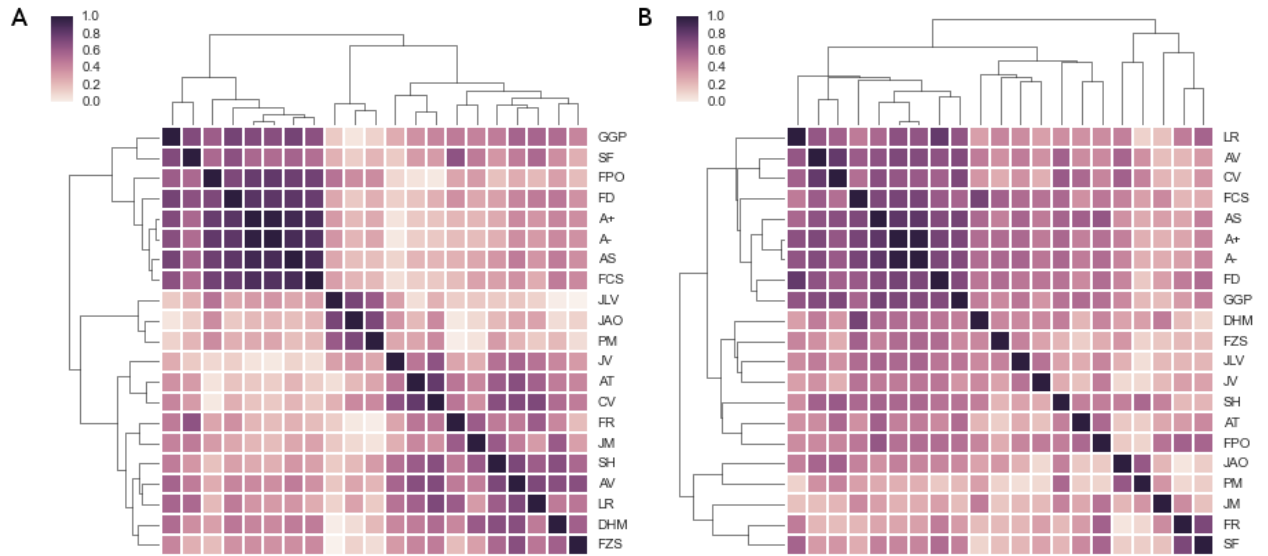


Figure 4-7: Profile-based plots for RAR and PPM compression formats. Heatmap and dendrogram for the profile-based approach using our own implementation of NCD combined with the (A) RAR and (B) PPM compression formats.

As seen in figure 7 no significant difference is noted between BZIP2, PPM, and RAR for the profile-based approach:⁹⁴ the three methods report different groupings of authors. Despite some clusters, otherwise irrelevant for our current study, that seem to remain together such as Juan Arce de Otálora’s *Coloquios de Palatino y Pinciano* and Pedro Mejía’s *Silva de varia lección (A Miscellany of Several Lessons)*, the only ones in common among the different methods are Francisco Delicado and Gaspar Gil Polo. In this regard it should be recalled that Navarro Durán insisted in the influx that works such as Francisco Delicado’s *La Lozana Andaluza* –that accounts for a reference to a such “Lazarillo”– had in the little book. While huge in Italy, the diffusion of *La Lozana Andaluza* in Spain was small compared to other alleged readings –according to Navarro Durán– made by the author of the *Lazarillo* such as *La Celestina* by Fernando de Rojas. In his critique against Navarro Durán’s proposal in favour of Alfonso de Valdés (Pérez Venzalá, *El Lazarillo*), Pérez Venzalá grants that Delicados’ work was still influential to the posterior 16th-century Spanish prose, but that the fact by itself is not enough to argue

⁹⁴ BZIP2 and RAR NCD performed almost identically.

in favour of the candidacy of the Andalusian. Others were even less inclined to recognize such influence in the *Lazarillo* (Wardropper, 88; Carilla, 97-116). Regarding Gaspar Gil Polo there is simply no mention whatsoever of his implication in the little book; the notary wrote mostly pastoral romances of a very cult tone.

The instance-based approach, however, shows more coherent results. Overall, PPM and RAR clusters are more consistent between approaches, same authors tend to be found regardless. The groups for PPM and RAR share several pairs of (author, work) closely related to the *Lazarillo* and its second part: *Diálogo de los Médicos* (*Dialogue of the Physicians*) and *Coloquio del Convite* (*Colloquia of the banquet*) by Pedro Mejía, and Fernán Pérez de Oliva's *Diálogo de la Dignidad del Hombre* (*Dialogue of the Dignity of Men*). Unfortunately, the only evidence we have about both the Sevillian humanist Mejía and the translator of the classics Pérez de Oliva in relation to the *Lazarillo* is that they moved in the same circles that surrounded the true author.

Notwithstanding, there are some facts that need to be accounted for in relation to the personal information of Pedro Mejía. Born in Seville in 1497, spent his days as a student in Salamanca and cultivated the friendship of important figures of his time such as Erasmus of Rotterdam and Juan Luis Vives. Mejía held several relevant positions in Seville before becoming the official chronicler of Charles V in 1548 after Antonio de Guevara's death. By then he had already written his hugely popular *Silva de varia lección*, that was translated to several languages and circulated all over Europe with tremendous success. Other works of his were published in Antwerp at his death in 1551. In the literary aspect, some lexical coincidences with the little book have been reported, such as “fasta” or “home,”⁹⁵ although their effect might have been minimized in our corpus due to the normalization process applied. Nevertheless, more inscrutable aspects of his writing style might have been brought into relevance by our analysis. Pedro Mejía seems to be a figure that demands a more thorough analysis.

⁹⁵ Concordance of “home” for “hombre” (“man”) documented by Diego Clemencín (58), and “fasta” for “hasta” (“until”) by Rodríguez López-Vázquez (*El 'Tractado'*).

4.5.2 Decomposing the *Lazarillo*

Despite the turn to the abstractness, there is enough evidence to sustain that more convoluted and less intuitive features carry more discriminative power than arbitrary distributions of words or expressions or over simplistic reduction of writing styles to single measures or distances (Argamon and Juola, “*Overview*”). Simple relative or standardized frequencies of words, although presenting both advantages and disadvantages (Forsyth and Holmes, 163-174), are usually preferred in traditional studies since they convey understandable meaning otherwise hidden in unfathomable statistical variables. In their 1988 pioneer study, before embracing his ‘Delta’ method, John Burrows and Anthony Hassall solved a disputed authorship based on what they called eigenvectors of the correlation matrix from different authors’ function words (usually the most common in a language; also called “stop words” in information retrieval studies) (Burrows and Hassall, 427-453). Posterior studies confirmed the separation ability of the “eigenanalysis” under a variety of cases, both in terms of the features used (function words, syntactic tags, etc.) and the works to analyze. The technique was later renamed to its proper and original statistical name: Principal Components Analysis (PCA) (Smith, “Attribution by statistics” 233-251; “The authorship” 508; “Edmund Ironside” 202-205; Binongo, “Incongruity” 477-511; “Joaquin’s” 267-279; Binongo and Smith, “The application” 445-466). As a general technique for multivariate analysis, the goal of PCA is to reduce the dimensionality of the vector of features, *i.e.*, transform a frequency distribution of the most frequent 300 words of a text into a pair of values, by summarizing them into new uncorrelated vectors, the so-called principal components, that account for the maximal amount of information that can be attributed to them (variance). Principal components are sorted by the power to retain the variation of the original vectors, and as such, the first two or three components are usually used, as they can also be represented graphically, avoiding the hassle of understanding huge correlation matrices.

We used Burrows’ approach and ran a PCA on our corpus mimicking his same setup. As the text of the *Lazarillo* itself is not considered very long when compared to other candidates’ works, the segmentation of the works in chunks of 150, 300, or 500 words

did not have much effect in the results.⁹⁶ Nor did the inclusion of the *interpolaciones*, nor the number of stop words used; we tried with 25, 50, 150, and 300 with similar outcomes. As shown in figure 6, in the best case we achieved components that accounted in average for less than 10% of the variance. Nevertheless, basic PCA still remains a useful first step in order to get a glance of a dataset. It is easy to identify visually how some of our random candidates in the corpus stand out as the representation of their chunks in the general plot are easily distinguishable from those of the little book. The clearer the clusters, the less the authors have in common. As such, the authors who exhibit a more similar use of function words are Juan Arce de Otálora, Gaspar Gil Polo, Alfonso de Valdés, Cristóbal de Villalón, and to a lesser extent, Pedro Mejía and Juan Luis Vives, names that are already mentioned in our previous analysis. The rest form more or less easily identifiable clusters, thus being the use of stop words different between them. We found no difference for the second part of the *Lazarillo* or taking out the interpolations.

Table 4-4: Winner feature sets as extracted from different competitions on authorship problems

| Features | Description |
|------------------------|---|
| stopwords | Distribution of functions words |
| bow | Distribution of the 300 most common words (bag of words) |
| cng | Distribution of the 3000 most common character 3-grams (Kešelj et al.; Kourtis and Stamatatos) |
| lexical punctuation | Average sentence length, sentence length variation, sentence lexical diversity, ⁹⁷ and distribution of punctuation signs |

⁹⁶ The list of function words was extracted from the Python package for natural language processing NLTK, which includes the lists of stopwords for 11 languages compiled by Martin F. Porter in his work with stemmers (130-137; Bird, Klein, and Loper). All the analysis and rendering in this study were made in Python with the use of several packages: numpy, scipy, scikit-learn, Pandas, matplotlib, IPython, and Jupyter are among the most important ones (Pedregosa et al.; Oliphant; McKinney; Jones, Oliphant, and Peterson; Perez; Ragan-Kelley et al.).

⁹⁷ Vocabulary richness, defined as the ratio between the number of different words and the number of total words per sentence.

| | |
|-----------------------|---|
| lexical + punctuation | |
| pos | Distribution of the 30 most common parts of speech |
| words n-grams | Term frequency-inverse document frequency (tf-idf) ⁹⁸ for a maximum of 1000 word bi- and tri-grams |
| characters n-grams | Term frequency-inverse document frequency for a maximum of 1000 character n-grams of length between 2 and 4 |
| total | All above features combined into one single vector |

⁹⁸ The tf-idf measure aims to reflect how important a word is to a text in a given corpus. It was introduced by Gerard Salton and Michael McGill as the ratio of two previous measures, the frequency of a word (tf) and the frequency of that word in the whole corpus (idf). It has been very widely used and applied in information retrieval studies ever since (Salton and McGill).



Figure 4-8: PCA of function words in our corpus. Charts represent the 2 principal components vectors of the frequency distribution of 300 stop words in the *Lazarillo* (blue) and the combined works of each of the possible candidates in the corpus (red). Only 600 random chunks of 300 words are represented, although all were taken into account during the analysis. Variance is shown as axes labels.



Figure 4-9: LDA of the 150 most common words in each pair from our corpus. Charts represent the 2 dimensions extracted by linear discriminant analysis of the frequency distribution of the 150 most common words in each pair of *Lazarillo* (blue) and the combined works of each of the possible candidates in the corpus (red). Only 600 random chunks of 300 words are represented, although all were taken into account during the analysis. Matthew's correlation coefficient (MCC) is added between parentheses.

Moreover, the naive feature set used by Burrows is not the only possible choice. Based on recent competitions for authorship attribution and author identification and verification (Argamon and Juola, Overview; Stamatatos et al., Overview), we extracted the features used by the winners (see table 4) and tested PCA under them for 2, 3, 5, 10, and 15 principal components, using the top 25, 50, 150, and 300 top words for vocabulary-based features. As the number of works per author is pretty limited in our corpus, making an instance-based analysis virtually impossible, we also segmented the texts in chunks of 300 words without breaking sentences, although only 600 chunks are represented in the charts for clarity reasons. After analyzing all possible combinations of this new setup in the search for a set of parameters that maximized the variance, a process usually known as grid search in the machine learning literature, we found that punctuation marks features, regardless of the number of words per chunk, provided the best result accounting for a variance of almost 48%. However, when plotted (see figure S1 in SM) there is no obvious way to separate the chunks of the *Lazarillo* and those belonging to the rest of authors. With the exception of perhaps Fernando de Rojas, the remainder turned out to be unusable in terms of identification of a possible author. Incrementing the number of components had a positive effect on the variance captured by the PCA, although we had to reach a balance between the number of principal components and the number of dimensions that can be represented in a chart and still be useful. By using 5 components we achieved a variance of around 80% with punctuation marks features, and after plotting the first 3 principal components, Sebastián Fernández, Diego Hurtado de Mendoza, Fernando de Rojas, and Lope de Rueda seem to be clustering separate from the *Lazarillo* (see figure S2 in SM). Higher number of PCs reported higher variance but were unsuitable for graphical representation.

Although revealing under certain circumstances, this capturing of the variance performed by PCA is not well suited for authorship attribution nor the general task of automatic classification (Juola, “Authorship attribution” 233-334). As seen in our experiments, the dimensions that carry the most information does not necessarily have to be the ones that allow for an easier identification of the different clusters at game. An alternative

technique that alleviates this limitation is the Linear Discriminant Analysis (LDA),⁹⁹ first formulated by Ronald A. Fisher in 1936 as a 2-class problem and later generalized for the multiclass scenario (Fisher, 179-188; Rao, 159-203). LDA is closely related to the analysis of variance (ANOVA, as applied by Holmes and Forsyth to the *Federalist*) and PCA, but in addition to finding the axes that maximize the variance, also finds the axes that maximize the separation between different groups.¹⁰⁰ Recently LDA has been applied successfully to authorship attribution studies, although related literature on the topic is scarce (Stamatatos, Fakotakis, and Kokkinakis, 471-95). We tested LDA as a dimensionality reduction method under the same settings used for PCA. Our results show that LDA might convey more discriminatory power than PCA while capturing similar levels of variance. Figure 7 shows clearly separated clusters for all the authors but a few. This might suggest that the only viable candidates might be Pedro Mejía, Alfonso de Valdés, Juan Arce de Otálora, and to a lesser extent Juan Luis Vives and Cristóbal de Villalón. Other discriminant methods exist: the family of *neighbors* methods take advantage of the visual representation, and group together elements based on the center of the cluster, the distance, and other parameters. A version known as nearest shrunken centroid has been reported to produce really good results in authorship attribution problems (Jockers, Witten, Criddle, 465-491; Schaalje et al., 71-88).

⁹⁹ This analysis should not be confused with Latent Dirichlet Allocation (LDA), a technique formally presented in 2003 (although introduced in 2002) by David Blei, Andrew Ng, and Michael I. Jordan for topic modelling. It built on a series of improvements over previous techniques (specially from latent semantic analysis and its probabilistic version, LSI and pLSI), overcoming some of their limitations such as allowing its embedding into other methods. As proposed by its authors, LDA can be seen “as a dimensionality reduction technique, in the spirit of LSI, but with proper underlying generative probabilistic semantics that make sense for the type of data that it models,” specially when that data is a corpus of texts. The specific formulation of LDA is beyond the scope of this study, but generally it models each work from a corpus as a mixture of various topics, which are organized following a Dirichlet distribution. Since its conception, the technique has been successfully applied in a variety of subjects ranging from history to genomics. One recent area of application is precisely authorship attribution studies where LDA is usually combined with other methods and achieving good results. Unfortunately, we have not covered Latent Dirichlet Allocation in this study (Blei, Ng, and Jordan; Deerwester et al.; Papadimitriou et al.; Hofmann; Seroussi, Zukerman, and Bohnert; Savoy)

¹⁰⁰ In doing so, it makes the assumption that the feature set (independent variables) is normally distributed

4.5.3 The Rise of the Learning Machines

Variance and educated guesses over reduced dimensions of a feature set in a plot are generally accepted as (exploratory) authorship analysis and as indicators for further study. In order to properly assess their efficacy, we recur to the standard framework of machine learning measures. Machine learning is a subfield of computer science fed by pattern recognition, artificial intelligence, and computational statistics. At its core, it tries to construct algorithms that are able to learn from an input of known data (training samples) and make predictions or decisions on unseen data. Depending on how much we know about the training samples we talk about supervised learning, if the samples are labeled as belonging to classes, or about unsupervised learning when those classes are still to be determined, either their number, membership, or both. PCA can be seen as an instance of unsupervised learning whereas LDA is supervised learning since it needs the labels of the training data to work. In fact, some machine learning methods are able to handle big feature sets without applying dimensionality reduction, *i.e.*, Support Vector Machines (SVM).¹⁰¹ Regarding authorship attribution, a single training sample would be a text from a specific author, either in the instance- or profile-based mode, that is transformed into a numerical feature vector in a process of feature extraction; a labeled training sample would be the same text annotated with its author. In our context, classes would represent the authors of our corpus, and unsupervised methods try to find the clusters that better group the works of a same author together; while supervised learning methods learn by the examples in order to classify an anonymous into one or more of the classes. When categorized by the kind of output machine learning methods produce, classification and clustering are among the most relevant in authorship attribution studies. Other forms of machine learning include dimensionality reduction, that can also be of help, and regression or density estimation, specifically applied to continuum streams of data rather than discrete, as it is our case with authors.

¹⁰¹ For an introduction to the topic from the perspective of authorship attribution, we recommend Juola (*Authorship*).

Defining authorship attribution problems in the general context of machine learning allows us to apply its measures to the case under examination. Despite the existing debate around the authorship of some of the works considered in this study –*Diálogos* by Valdés–, we made the arguable initial assumption that our corpus only contains works of undisputed authorship, which places this study under the umbrella of supervised learning with a close-set corpus. The process goes as follows: first, training data (works labeled with their authors) is used to train or learn a model that can be binary if there are only two classes to decide, as in the work written by an author or the rest, or multiclass if the algorithm is able to deal with more than two, classifying each work to its author. Once the model is fitted with the training data a score is extracted to test the adequacy of the model. If the performance is good enough,¹⁰² the model is asked to predict the label (author) of the unseen data (the *Lazarillo*). One way to assess this score is by holding out part of the training data and using it later in the prediction step for validation. Cross-validation might improve the results and reduce the problem of model overfitting –a model that predicts perfectly the training data but fails with new data– by randomly segmenting the training set several times (folds), fitting a model for each fold, and averaging the score following defined strategies that will be detailed later. Since held-out data is labeled (ground truth) we can calculate different measures based on the number of correct and wrong predictions. In classification tasks some commonly used measures are accuracy, precision, recall, and F-score (F_1). Given a class as an author and a data entry as a chunk of a work, accuracy is defined as the ratio of chunks correctly assigned to their true author (hits) divided by the total number of chunks by each author; precision as the ratio between one author hits divided by the total number of chunks correctly or incorrectly assigned to that author; recall or sensitivity as the ratio between one author hits and the total number of chunks existing by that same author; and F-score as the harmonic or weighted mean of precision and recall. In the context of binary classification, as it is the case in our LDA analysis, one class is considered “positive” and the other “negative,” leading to the definition of the measures in terms of true and false, positive and negative rates. These measures go from 0 to 1, where values closer to 1 are

¹⁰² This actually depends on the field of study, the model, and the scoring method.

preferred. Another useful measure that arises in the 2-class problem is the Matthews correlation coefficient (MCC) that is well suited for tasks where the classes are of different sizes, as it is our case with only one work for the anonymous and sometimes several or lengthy works for the candidate authors (Powers). MCC is a measure of correlation that comprises true and false positive and negative rates (the confusion matrix), and it is considered one of the best measures for binary classification. Values of MCC range from -1, meaning a total disadjustment between ground truth and prediction, to +1, perfect prediction – a value of 0 would mean no better prediction power than a random prediction.¹⁰³ Figure 7 includes values of MCC between parenthesis for the binary classification task performed by LDA for each author against the author of the *Lazarillo*. In authorship verification problems, high precision is usually easier to achieve than high recall. In the LDA run and after a 10-fold cross-validation, Alfonso de Valdés accounted for the lowest values of recall (0.95) and accuracy (0.98), a result that would suggest that none of the authors in our corpus would be the true author. In addition to the high values obtained for the lowest recall and accuracy, the Matthews correlation coefficient reported over 0.85 for all authors but Juan Arce de Otálora, Pedro Mejía, and Juan Luis Vives, which give us a quite dubious threshold to start considering them plausible candidates for the authorship. Furthermore, this method has been reported to perform poorly for authorship attribution even with models much more complex (Koppel, Schler, and Bonchek-Dokow, 1261-1276). The use of LDA as a discriminant by itself may produce misleading results since it might be affected by factors other than style. We must, therefore, further support such findings before making any hurried statement about a possible true author.

Fortunately, once we settle on using general machine learning approaches to authorship attribution, a whole range of possibilities opens up. Identifying the most likely author of the *Lazarillo* can be tackled from different angles. We can train a model for every pair of authors and assess the accuracy of the method by cross-validation. This approach is

¹⁰³ It is sometimes compared to the area under the receiver operating characteristic (ROC) curve that results from plotting the true positive rate (recall) against the false positive rate, but it performs better with unbalanced classes.

usually referred to in the literature as *one-versus-one*, as opposed to *one-versus-all*, where the models learn to distinguish an author against the rest. Classification then happens by a winner-takes-all strategy in one-versus-one, where the classifier with the best performance gets to decide the class, and by a max-wins strategy in the one-versus-all case, in which each classifier adds a vote to a class based on its results, being the class with more votes the class that assigns the classification.

In order to test for the multiclass problem, we extracted the features defined in table 4 considering the whole corpus when vocabularies of words or characters were needed to be taken into account. Our first test using basic regression methods in a supervised fashion had very exciting results. We employed linear regression, Bayesian, and discriminant (neighbors) classification methods.¹⁰⁴ A profile-based version of the corpus was built with the texts segmented in chunks of at least 300 words without breaking paragraphs. Scores were averaged using a 10-fold cross-validation. Table 5 shows the 10 most performant algorithms (Ridge, Bernoulli, multinomial, and nearest centroid) and features sorted by their accuracy. Common n-grams, and bag-of-words are the features that report better results in our corpus, although our total feature set, a combination of all the features, behaves slightly better in every case. However, the increase in dimensionality that it involves might not be justified by the gain in precision, that barely adds up to a 0.12% in the worst case.

¹⁰⁴ Ridge classification is based on linear least squares; Bernoulli and Multinomial are specific cases of Naive Bayes classifiers; and nearest centroid can be related to discriminant analysis. Other classifiers tested with poorer results include Gaussian, Perceptron, k-nearest neighbors, radius neighbors, and nearest shrunken centroid.

Table 4-5: Top 10 algorithms and features pairs ranked by precision, recall and F-score.

| Algorithm | Features | Precision | Recall | F-score |
|------------------|----------|-----------|--------|---------|
| Ridge | total | 0.9718 | 0.9696 | 0.9701 |
| Ridge | cng | 0.9706 | 0.9675 | 0.9682 |
| Bernoulli | total | 0.9450 | 0.9273 | 0.9296 |
| Bernoulli | cng | 0.9429 | 0.9176 | 0.9215 |
| Multinomial | total | 0.9418 | 0.9273 | 0.9295 |
| Multinomial | cng | 0.9341 | 0.9078 | 0.9116 |
| Nearest centroid | cng | 0.9312 | 0.9067 | 0.9111 |
| Nearest centroid | total | 0.9211 | 0.9067 | 0.9092 |
| Bernoulli | bow | 0.9170 | 0.9078 | 0.9058 |
| Ridge | bow | 0.9287 | 0.8872 | 0.9032 |

In order to determine the most plausible author we used a max-wins strategy and also the average number of chunks assigned to each candidate. In this settings, Juan Arce de Otálora, who was assigned the most number of chunks most of the times, seems to be the winning author in both cases, with an important difference over the second ones in both the win and the average strategies, being those Gaspar Gil Polo and Alfonso de Valdés, respectively (see table 6). Interestingly, the result holds with or without *interpolaciones* and also for the second part of the little book –in which case Cristóbal de Villalón is also added. It is worth noting that the algorithm that reported the best performance grants the second position to Pedro Mejía instead of Gaspar Gil Polo. There seems to be an effect of the total number of chunks per author in the corpus over the predictions. The class imbalance problem is known to affect drastically the effectiveness of vector space models. Several approaches have been proposed in the last years to tackle this situation

regarding authorship attribution (Stamatatos, “Author identification” 790-799).

Segmenting or resampling the texts (reusing some parts of the text) in order to re-balance the number of samples per author is one of the methods proposed by Stamatatos for the instance-based approach. To alleviate the situation in the profile-based approach, we used a cut-off sampling approach by randomly removing the number of chunks that are over a fraction of the average number of chunks per author in the corpus, while resampling author texts whose number of chunks are said fraction below the average –we used a chunk fraction of 10%. We then averaged results over several general machine learning methods using 10-fold cross-validation.

Table 4-6: Top authors with the most chunks of the Lazarillo assigned to them for the different methods and features. Number of pairs algorithm and feature set wins, and the average number of chunks assigned for each author are included in the last two columns.

| | Ridge | | | Bernoulli | | | Multinomial | | N. Centroid | | Wins | Avg. |
|-----|-------|-----|-----|-----------|-----|-----|-------------|-----|-------------|-------|------|-------|
| | total | cng | bow | total | cng | bow | total | cng | cng | total | | |
| JAO | 34 | 47 | 37 | 42 | 54 | 18 | 48 | 60 | 46 | 39 | 9 | 42.50 |
| AV | 7 | 3 | 7 | 12 | 6 | 18 | 11 | 5 | 5 | 10 | 0 | 8.40 |
| GGP | 2 | 1 | 4 | 10 | 2 | 21 | 12 | 4 | 9 | 14 | 1 | 7.90 |
| PM | 22 | 17 | 16 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 5.9 |
| LR | 2 | 3 | 1 | 8 | 11 | 6 | 1 | 4 | 6 | 1 | 0 | 4.30 |
| CV | 1 | 0 | 3 | 1 | 0 | 7 | 1 | 0 | 5 | 8 | 0 | 2.60 |

Support Vector Machines (SVMs) are binary classifiers in nature and as such they recur to ensemble techniques to generalize to the multiclass version. They are intended to work with high-order feature vectors by finding a hyperplane (vector) that allows (supports) the division of the feature space in two spaces, while maximizing the average of the distances from the features vectors to such hyperplane. In a way, they automatize the visual inspecting task we performed for exploring the results of the LDA. Used in combination with bag-of-words or character n-grams, SVMs are a solid choice for authorship attribution, from newspaper articles, to e-mails or 19th-century English literature. Their most important characteristic, and the reason why they became so popular, is that they can handle several thousands of features without resulting in overfitting or needing preprocessing steps (Teng et al., 1204-1207; Sanderson and Guenter, 482-491; Joachims). Other models that have reported good results in authorship attribution problems include neural networks, decision trees, maximum entropy, memory-based learners, and ensemble learning methods.¹⁰⁵ Faced with the impossibility of testing every single existing method, we resorted once again to the winners of several authorship attribution competitions editions that included Spanish corpora, and when suitable, according to the specifics of our corpus, we tested some of the best performing methods with the feature sets we defined in table 4 (Argamon and Juola, Overview; Juola, “An Overview”; Rangel et al; Stamatatos et al., “Overview”; Stamatatos et al., “PAN 2015”). Specifically, we tested linear and nonlinear SVMs;¹⁰⁶ maximum entropy learning (MaxEnt), a type of logistic regression method (not to be confused with linear regression) that measures the relationship between features and their assigned author using a logistic function for estimating the probabilities (Nigam, Lafferty, and McCallum, 61-67); and random forests, an ensemble technique that reduces the overfitting problem in decision trees by building a number of them and classifying unseen samples as the most repeatedly assigned label (the statistical mode) (Maitra, Ghosh, and Das; Pacheco, Fernandes, and

¹⁰⁵ Especially promising is the application of biologically inspired neural networks, such as recurrent and convolutional neural nets, that have reported results that outperform state-of-art for the Spanish case (Bagnall).

¹⁰⁶ Nonlinear SVMs use transformations of the feature space, specifically we used a gaussian kernel (RBF). For an introduction to kernel-based methods in machine learning in general we recommend Nello Cristianini and John Shawe-Taylor.

Porco). We also included other less performant algorithms that showed some good results for the Spanish case: stochastic gradient descent classification (SGD), an optimization-based method that can operate with large datasets since only takes one sample at a time, and although it might not find the optimum, most of the times it finds a reasonably good approximation (Caurcel Díaz and Gómez Hidalgo); and bagging, an ensemble classifier that trains decision trees, although other learners can be used, on random subsets of the features and combines their prediction by voting (Giraud and Artières). When suitable we normalized the feature vectors and reduced their dimensionality up to 100 components prior cross-validation.¹⁰⁷ Figure 7 shows the 10 best performing algorithms with their respective feature sets. They all performed extremely well, especially maximum entropy and linear SVMs, and the only difference is the feature set: common characters 3-grams and our total fusion of features are again dominating.

We then used the most performant models to classify the chunks of the *Lazarillo* to one of the candidates finding that Juan Arce de Otálora beat the rest of the authors in both the max-wins –9 over 1– and the average criteria –almost 37 out of the 73 chunks of the *Lazarillo* are always assigned to Otálora regardless of the method.¹⁰⁸ Second positions correspond to Alfonso de Valdés in max-wins and Pedro de Mejía in chunk average. This results strongly points out at solid similarities between the writing style of the little book and the work by Juan Arce de Otálora. We believe that despite the limitations in our corpus and the candidates chosen to represent the debate around the possible author, an average of half the chunks assigned to Otálora –ranging from 33% under a SGD learner with precision of 94% and bag-of-words features to more than 86% of the chunks under a nonlinear SVM with precision of 96% using common 3-grams–, is a strong and data-based argument in favour of the candidacy of the jurist.

¹⁰⁷ In fact, we tested with and without dimensionality reduction, and with PCA and LDA, and even after the fact that supervised decomposition as the one performed by LDA might bias cross-validation, with obtained very similar results and a general speedup when applied.

¹⁰⁸ Results hold with or without interpolations, although for the second part of the little book Cristóbal de Villalón seems to be slightly stronger than Otálora.

Table 4-7: Top 10 supervised algorithms and features pairs ranked by precision, recall and F-score without using dimensionality reduction

| Algorithm | Features | Precision | Recall | F-score |
|------------|----------|-----------|--------|---------|
| Max Ent | total | 0.9762 | 0.9740 | 0.9745 |
| Max Ent | cng | 0.9723 | 0.9707 | 0.9712 |
| Linear SVM | total | 0.9700 | 0.9685 | 0.9689 |
| Linear SVM | cng | 0.9682 | 0.9664 | 0.9668 |
| SVM | cng | 0.9558 | 0.9458 | 0.9480 |
| SVM | total | 0.9563 | 0.9447 | 0.9474 |
| SGD | total | 0.9512 | 0.9382 | 0.9406 |
| Max Ent | bow | 0.9438 | 0.9382 | 0.9397 |
| SGD | bow | 0.9375 | 0.9273 | 0.9302 |
| SGD | cng | 0.9430 | 0.9262 | 0.9000 |

Table 4-8: Top authors with the most chunks of the Lazarillo assigned to them for the different methods and features. Number of pairs algorithm and feature set wins, and the average number of chunks assigned to each author are included in the last two columns.

| | MaxEnt | | | LinearSVM | | SVM | SGD | | | Wins | Avg. | |
|-----|--------|-----|-----|-----------|-----|-----|-------|-------|-----|------|------|-------|
| | total | cng | bow | total | cng | cng | total | total | bow | | | cng |
| JAO | 39 | 42 | 15 | 34 | 40 | 63 | 58 | 37 | 24 | 44 | 9 | 36.82 |
| PM | 14 | 14 | 7 | 16 | 15 | 9 | 8 | 12 | 14 | 12 | 0 | 11.00 |
| AV | 13 | 8 | 25 | 13 | 6 | 0 | 4 | 4 | 10 | 0 | 1 | 7.64 |
| GGP | 4 | 5 | 17 | 5 | 6 | 0 | 0 | 0 | 19 | 0 | 0 | 5.09 |
| JLV | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 20 | 3 | 17 | 0 | 3.82 |
| CV | 1 | 1 | 5 | 1 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 1.18 |
| LR | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 1.00 |

4.5.4 Unmasking the Author of the *Lazarillo*

At the beginning of our study we did our best effort to collect a set of works that would sufficiently represent the stronger candidates in the debate about the authorship of the *Lazarillo*. The reason behind was to allow the use of statistical methods in order to analyze the problem as a closed-set task. However, our best set of classifiers, even when not overfitting, would always assign chunks of any given book to the authors that have been trained on. That is the fundamental flaw of the closed vs open-set problem. We believe that a consistent prediction of more than half the chunks to Juan Arce de Otálora

is not casual, but when asked with the task of classifying an unseen work, the regular supervised methods we employed lack a foundation to decide “none of the above” as the right answer. In 2004 Moshe Koppel and Jonathan Schler proposed –and improved in successive years– a new ensemble method to tackle this issue (Koppel and Schler, “*Authorship verification*”; Koppel, Schler, and Argamon, *Authorship*; Koppel, Schler, and Bonchek-Dokow, *Measuring*). We used their method, based on feature elimination,¹⁰⁹ in an attempt to dispel the last doubts about the author of the *Lazarillo*, considering now the problem of its authorship as open-set.

Ensemble learning techniques usually provide better results and predictive power than their algorithms would separately. Koppel and Schler *unmasking* method is one of the best-known techniques of its kind, albeit having numerous subtleties that need to be fine tuned corpus-wise. A defining characteristic of their technique is the ability to decide not only whether an anonymous text is written by one of the authors in the candidate set, but also if the text has not been written by any of them. In its general form it conceives the authorship problem as a one-class classification task built upon linear SVMs. Although the specifics of its implementation, which we had to develop in Python in the lack of reference source code, are out of the scope of this study, the main idea remains rather intuitive. Given a set of features for a pair of works the method iteratively removes “those features that are most useful for distinguishing between [them]” and “gauge the speed with which cross-validation accuracy degrades as more features are removed.” Koppel and Schler hypothesize that if two works are written by the same author then “whatever differences there are between them will be reflected in only a relatively small number of features, despite possible differences in theme, genre and the like.”¹¹⁰ For each pair <work, candidate’s works> in the corpus,¹¹¹ a linear SVM is built to distinguish between

¹⁰⁹ It has been noted and we agree on certain similarities between the unmasking method and a technique known as feature elimination used in cancer classification (Guyon et al., 389-422; Huang and Kecman, 185-194).

¹¹⁰ The efficacy of the method in a cross-genre setup was later confirmed by Mike Kestemont et al. (340-356).

¹¹¹ If for a certain pair, the work in question is by the candidate, we remove said work from the candidate’s works for that pair.

them. The feature set is bag-of-words-like, with the n most frequent words calculated as the average of the frequency in the work and the candidate's works for a given pair. In a number of steps m , the top k most and least informative features are removed and the accuracy of the SVM is measured using a 10-fold cross-validation. These n values of accuracy that define the degradation curve are used to build a vector of "essential features" that is labeled *same-author* if the work was in fact written by the candidate author in the pair, and *different-author* otherwise. Figure 8 shows an example of degradation curves for the work *Las Disciplinas* by Juan Luis Vives against the rest of the candidate authors with default parameters as defined by Koppel and Schler ($n=250$, $k=6$, $m=8$). The method assumes that these two types of curves are different and easy to identify. A linear SVM is then trained to distinguish between *same-author* and *different-author* curves. When asked to decide on an unseen work, degradation curves are built for each of the candidate authors in the corpus, and then the SVM decides if any of the unseen work degradation curves are classified as *same-author*, and in that case return for which one. The method does not guarantee that an author will be returned and it does not prevent more than one author from being the result. Using Matthew's correlation coefficient, we obtained a classification score 0.98.

Due to the computationally expensive nature of the method, it is usually a good idea to reduce the number of authors and works in the corpus, although it is proven that the unmasking behaves better with lengthy texts such as books (Sanderson and Guenter, *Short text*). Building upon our previous results, we can now shrink the pool of candidates to those that have shown to be likely authors in the previous methods along this study. Nonetheless, it is worth noting that some of the candidates that we thought to be mere impostors are now among the most plausible ones, *i.e.*, Pedro Mejía. We must interpret this as part of the *Lazarillo* sharing stylistic similarities with the works of others, and consequently when reducing our pool of candidates to reduce execution time, we must get rid of those authors who were assigned in average less than one chunk of the little book. The final list of authors considered for unmasking includes Juan Arce de Otálora, Pedro Mejía, Alfonso de Valdés, Gaspar Gil Polo, Lope de Rueda, and Juan Luis Vives. Just an ironic coincidence that, as the Avellaneda's song goes, 6 can be the most likely authors of the little book. Moreover, we must highlight the recurrent apparition in our

analysis of Cristóbal de Villalón, not only among the possible authors but as the most assigned author of the second part of the *Lazarillo*; thus we included him as well. We calculated all the curves and essential feature vectors for the *Lazarillo* against the candidates in our corpus, and the trend shown in figure 9 seems to confirm that Juan Arce de Otálora shares the most stylistic similarities with the little book, followed closely once again by Alfonso de Valdés, as their drop in accuracy per iteration is larger than for the rest of the authors. Unfortunately, we cannot state with enough certainty that either Arce de Otálora or Valdés is the true author, since the SVM that distinguished between *same-* and *different-author* curves did not assign a clear winner; it returned *different-author* for all the authors. Nevertheless, this last result is the last of a series of methods applied along this study that support Juan Arce de Otálora as the most likely author. The result, however, demands more fine tuning of the parameters of the unmasking method.

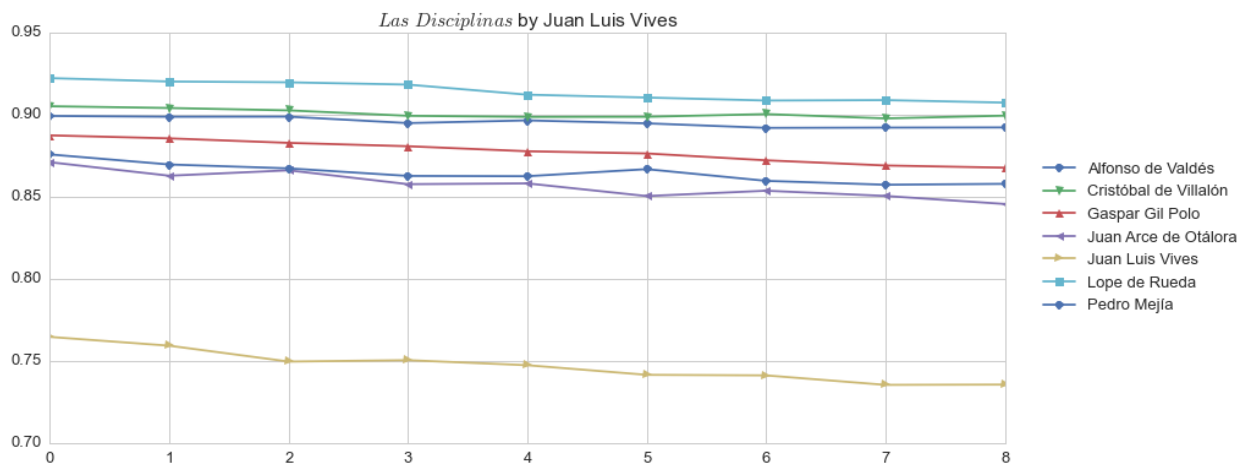


Figure 4-10: Unmasking *Las Disciplinas* by Juan Luis Vives against each of 6 authors ($n=250$, $k=3$). The curve below all the authors is that of Juan Luis Vives, the actual author.

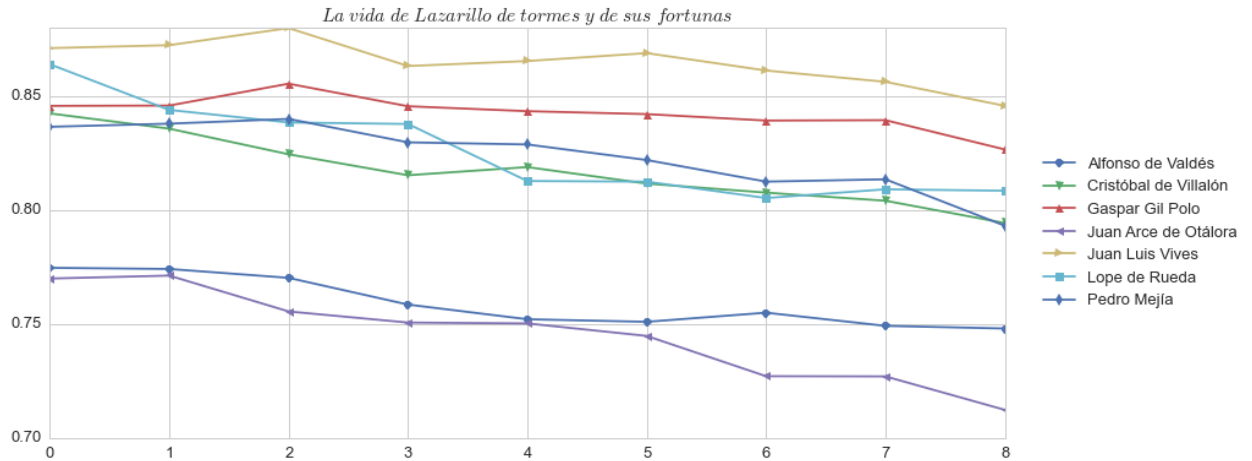


Figure 4-11: Unmasking *Lazarillo* against each of 6 authors ($n=250$, $k=3$). The curve below all the authors is that of Juan Arce de Otálora, the most likely author, followed by that of Alfonso de Valdés.

4.6 Discussion

Coinciding with the statistical approach carried out by Madrigal, Juan Arce Otálora has been consistently assigned high positions in the analysis of the authorship of the *Lazarillo*, but if we are to accept the result by Burrows's Delta and Koppel and Schler unmasking method, the evidence is not enough to support him being the true author: both methods agree on the prominent similarity between Arce de Otálora and Alfonso de Valdés' writing styles, but suggest that any of them is in fact the author. We add, nevertheless, that the candidacy for Arce de Otálora has been strongly supported. Deficiencies are in general attributable to the corpus rather than the methodology. Diego Hurtado de Mendoza, on the other hand, one the most documented candidates of all and possibly the one towards whom we felt more confident, turned out not to be a strong player in our analysis. We believe that one of the reasons is the lack of representation of his works in our corpus. Hurtado's *De la Guerra de Granada* might not be the best work to put on play against *Lazarillo*, or at least not the only one, as the linguistic registry is very different in both cases. As Ángel González Palencia pointed out, Hurtado de Mendoza's informal style expressed in his personal letters would account for a better representation in the corpus, but he also considers that style of writing not to be precisely descriptive of Mendoza's, as letters had to be usually written with haste. That is, if the

style of *Lazarillo* were to be similar to Mendoza's, it would have to be similar to a style which he never would use to write prose, unless it was written as a joke for a then young prince, as Agulló argues.

In either case, as the study advanced, we tried to minimize the effect of the class imbalance problem, and when critical for certain methods, it turned out not to be such an obstacle. Alfonso de Valdés, whose works were not precisely the longest ones, still had been consistently given as one likely author. This study might sustain Valdés' candidacy in relation to the internal evidence when compared to the little book, oftentimes the reason of the criticism to Navarro Durán's candidate.

Juan Luis Vives, the candidate with the longest corpus and brought to the discussion in the initial exploration methods, was ultimately not sufficiently supported by any of the supervised learning techniques. A similar case is Lope de Rueda, who showed in the methods affected by the imbalanced-class problem but disappeared later. Other authors such as Fernán Pérez de Oliva or Fernando Delicado were soon removed from the debate. For those that were not part of the impostors we believe that this study is proof enough to reject their candidacies. And for the impostors that in the end resulted to share stylistic similarities with the little book, we believe there is a demand for further research in their cases, as for Pedro Mejía as a possible contributor of the *Lazarillo*, or even Cristóbal de Villalón for the second part, which deserves its own study. The hypothesis of a multiple authorship might also be backed up if we only consider the style markers evidence brought up by our study, and although not accountable or usable by literary critics as the features sets that carried the most discriminative power were undecipherable in a human context, we provide with stylistic proof that might support the idea.

4.7 Conclusions

This study started with an overview of the status of the question of the authorship of the *Lazarillo*, which allowed us to establish a baseline corpus of candidates to work with. The subsequent exploratory analysis employing distance-based measures and methods from unsupervised learning started to give the first hints. Juan Arce de Otálora and Alfonso de Valdés were then highlighted and soon supported by the use of more

sophisticated methods. The majority of the statistical evidence seem to point out in the direction of Arce de Otálora by a wider margin with regards to Valdés, and while our corpus is not as comprehensive as the one used by Madrigal, the jurist is still chosen by the learning methods as the most likely author. It seems as if all statistical techniques agree on Arce de Otálora, which supports the hypothesis of Madrigal, but it might not be the ultimate proof the authorship needs. Open-set methods suggest that none of the authors wrote the little book. After all, if, as Francisco Rico mentions in his 2011 edition (Anónimo ed. Rico, 128), the *Lazarillo* was the only work written by his author, any method, computational or not, based on the comparison of styles, mentions, idioms, or fingerprints, turns out to be useless. Under such assumption and due to the lack of other texts used as clues, the traditional historiographic profile-based research stands out as our only chance to find the author.

The Erasmian answer to the question of the authorship is recursively based on the principle of authority: it is important to unmask the anonymous of a work if the writer is in fact an important author. In recent times, the author might not ever be of interest at all, as the Barthesian conception of the death of the author considers. Others, however, agree on that knowing the author of a work “changes its meaning by changing its context [...] certain kinds of meaning are conferred by its membership and position in the book or oeuvre” (Love, *Attributing*, 46). Paraphrasing Love, *Lazarillo* by Diego Hurtado de Mendoza, with its life parallels and allusions, is a different story that *Lazarillo* by Friar Juan de Ortega or Pedro Mejía. While this study helps to dispel doubts around some of the most often cited authors for the little book, we still believe that the authorship of the *Lazarillo* plays an important role in the work. Unlike Américo Castro, we do not give much importance to the fact of the anonymity itself but to the actual 400 year-old debate about who the author might be. Discovering new authors and arguing in favor or against them injects with life the adventures of such Lázaro de Tormes. Every time a new author is proposed, a new reading is found in the *Lazarillo*. Because of this, part of us hopes nobody ever finds the definitive factual proof to prove the authorship, as that would take away all the fun from it.

4.8 Further Research

Much is still to be done regarding computational approaches for the resolution of the anonymity of the *Lazarillo*. Forensic linguistics also includes problems related to author plagiarism and author clustering, which could help to identify, for example, the legitimacy of the *interpolaciones* as part of the text of the *Lazarillo*, or to discern whether different hands intervened in the creation of the little book. Debates in this context, however, can also be enriched by the use of modern techniques such as those of the social network analysis. Previous studies in different areas have proven to be useful in shedding some light and contributing to the discussion of similar questions by the study of the graph structure of the actors involved (Suárez, Sancho, and de la Rosa, 281-285; Suárez et al., fqt050; Suárez, Sancho Caparrini, and de la Rosa; Suárez, McArthur, and Soto-Corominas, 45-50). While the use of this technique for authorship attribution would hardly result in a final answer, it configures an interesting path worth exploring in further research.

Compiling a better corpus to test authorship verification for each of the authors is another important future direction for investigation. Adding more authors and more works to the corpus could only benefit the study of the authorship of the little book. If both individual and institutional efforts were to be combined, the anonymity of the little book could be solved once and for all. Hundreds of mathematicians were able to altruistically combine their efforts to solve century-old problems (Gowers and Nielsen, 879-81; Cranshaw and Kittur, 1865-1874), therefore we believe that literary experts could do so as well for the *Lazarillo*. Having access to the digital editions that presumably RAE's CORDE handles as its core, or agreements with the editors of critical editions of Spanish Golden Age literature in order to use the same normalization rules for the old Spanish language, are only a couple of suggestions that could skyrocket the research on the topic. Moreover, proper coordination and agile communication channels to share early discoveries would be key factors to take into account. Traditional and nontraditional studies need to handshake and start a path together if we aim to find that elusive author of the masterpiece that is *The Life of Lazarillo de Tormes and of His Fortunes and Adversities*.

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4.9 Supplementary Materials

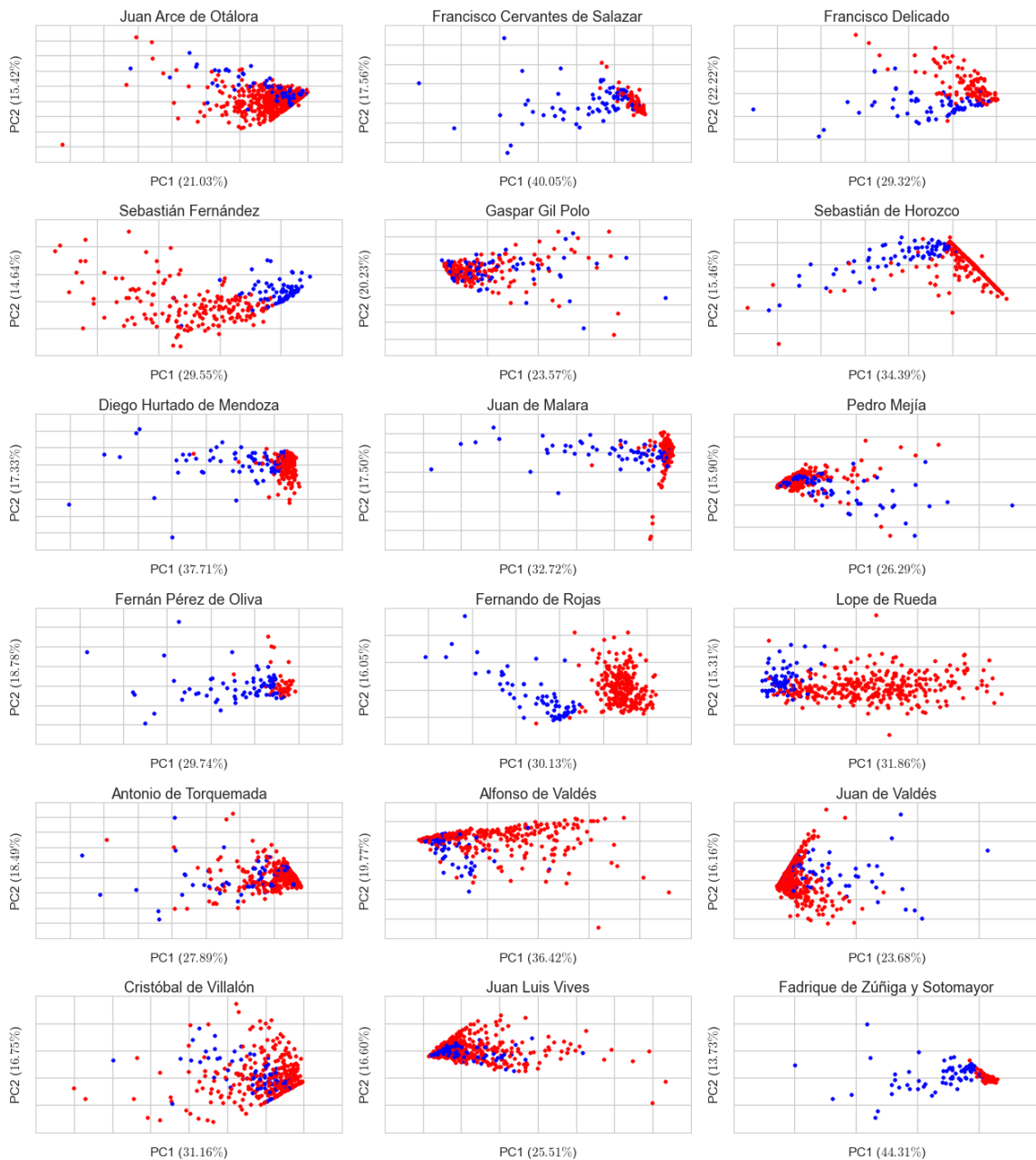


Figure 4-12, S1: PCA of punctuation marks in our corpus. Charts represent the 2 principal components vectors of the frequency distribution all Spanish punctuation marks in the *Lazarillo* (blue) and the combined works of each of the possible candidates in the corpus (red). Only 600 random chunks of 300 words are represented, although all were taken into account during the analysis. Variance is shown as axes labels.

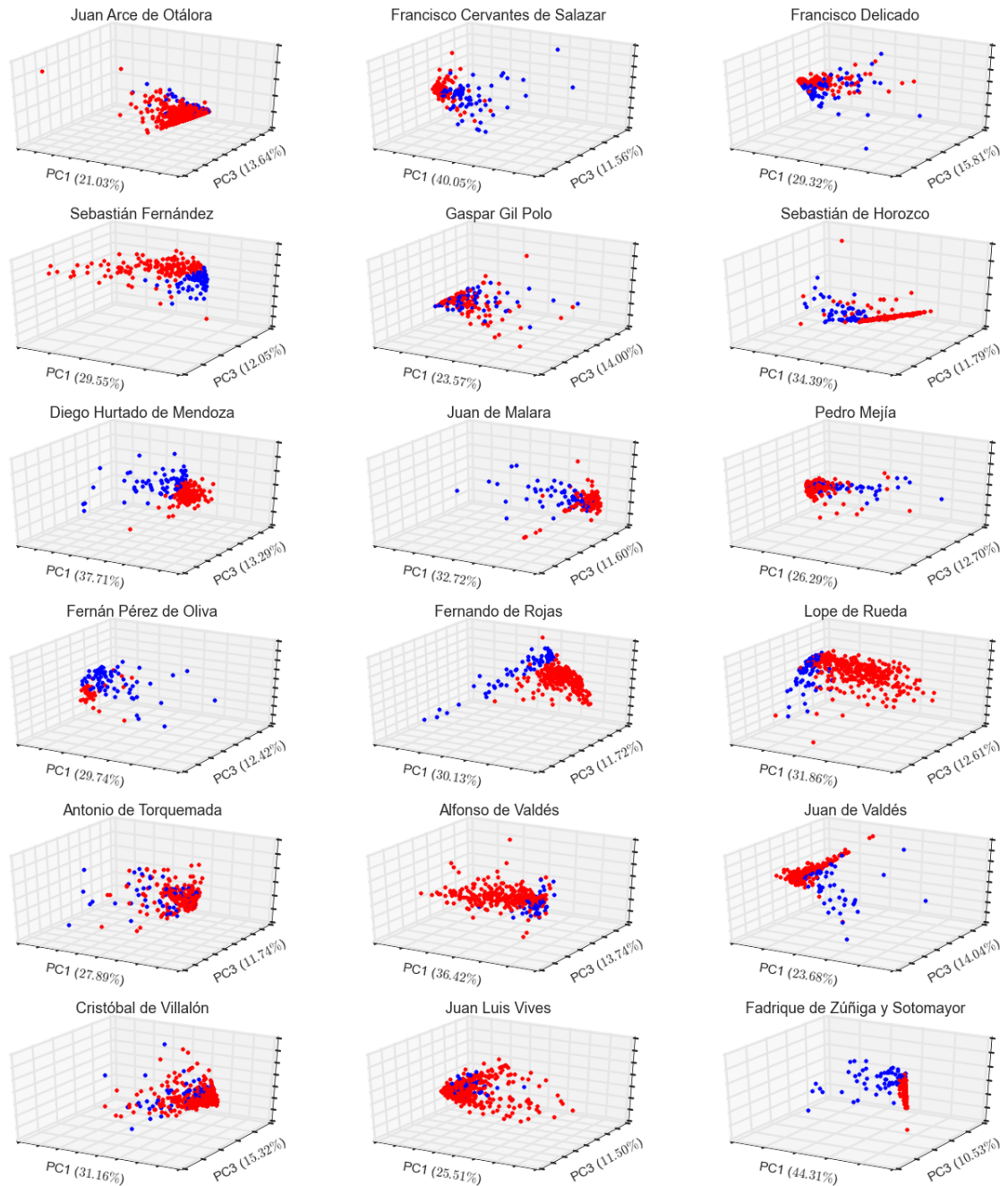


Figure 4-13, S2: PCA of punctuation marks in our corpus. Charts represent the first 3 principal components of a 5 PCA of all Spanish punctuation marks in the *Lazarillo* (blue) and the combined works of each of the possible candidates in the corpus (red). Only 600 random chunks of 300 words are represented, although all were taken into account during the analysis. Variance is shown as axes labels.

Table 4-9, S1: Timetable of attributions. Chronology of the candidates for the authorship of the *Lazarillo*, their support and their criticism. A dagger (†) besides the name of a possible author refers to him being proposed for the first time.

| Year | Author | Supported by | Criticized by |
|------|---------------------------------------|-------------------------|------------------------|
| 1605 | Juan de Ortega [†] | José de Sigüenza | |
| 1607 | Diego Hurtado de Mendoza [†] | Valerio Andrés Taxandro | |
| 1608 | Diego Hurtado de Mendoza | Andrés Schott | |
| 1624 | Juan de Ortega | | Tomás Tamayo de Vargas |
| | Diego Hurtado de Mendoza | Tomás Tamayo de Vargas | |
| 1867 | Sebastián de Horozco [†] | José María Asensio | |
| 1873 | Diego Hurtado de Mendoza | Nicolás Antonio | |
| 1888 | Diego Hurtado de Mendoza | | Alfred Morel-Fatio |
| | Juan de Valdés [†] | Alfred Morel-Fatio | |
| 1901 | Lope de Rueda [†] | Fonger de Haan | |
| 1914 | Juan de Valdés | | Julio Cejador y Frauca |
| | Lope de Rueda | | Julio Cejador y Frauca |
| | Sebastián de Horozco ¹¹² | Julio Cejador y Frauca | |
| 1915 | Sebastián de Horozco | | Emilio Cotarelo |
| 1943 | Diego Hurtado de Mendoza | Ángel González Palencia | |

¹¹² Although José María Asensio was the first to suggest Sebastián de Horozco, the attribution owns much more to Julio Cejador y Frauca.

| | | | |
|------|-------------------------------------|------------------------------|-------------------|
| | Diego Hurtado de Mendoza | Eugenio Mele | |
| 1954 | Juan de Ortega | Marcel Bataillon | |
| 1955 | Pedro de Rhúa [†] | Arturo Marasso | |
| 1957 | Sebastián de Horozco | Francisco Márquez Villanueva | |
| 1959 | Juan de Valdés | Manuel J. Asensio | |
| | Juan de Valdés | | Erika Spivakovsky |
| 1960 | Juan de Valdés | Manuel J. Asensio | |
| 1961 | Diego Hurtado de Mendoza | Erika Spivakovsky | |
| 1963 | Diego Hurtado de Mendoza | Olivia Crouch | |
| 1964 | Hernán Núñez de Toledo [†] | Aristides Rumeu | |
| | Lope de Rueda | Fred Abrams | |
| 1966 | Juan de Ortega | Claudio Guillén | |
| 1969 | Diego Hurtado de Mendoza | Charles Vincent Aubrun | |
| 1970 | Diego Hurtado de Mendoza | Erika Spivakovsky | |
| 1973 | Sebastián de Horozco | José Gómez-Menor Fuentes | |
| 1976 | Alfonso de Valdés [†] | Joseph V. Ricapito | |
| 1978 | Sebastián de Horozco | Jaime Sánchez Romeralo | |
| 1980 | Lope de Rueda | Jaime Sánchez Romeralo | |
| | Sebastián de Horozco | Fernando González Ollé | |
| 1987 | Lope de Rueda | | Francisco Rico |

| | | | |
|------|---|----------------------|--------------------------|
| | Sebastián de Horozco | | Francisco Rico |
| | Hernán Núñez de Toledo | | Francisco Rico |
| 1988 | Juan de Ortega | Claudio Guillén | |
| 1992 | Juan de Valdés | Manuel J. Asensio | |
| 2002 | Alfonso de Valdés | Rosa Navarro Durán | |
| | Alfonso de Valdés | | Antonio Alatorre |
| | Juan de Ortega | Antonio Alatorre | |
| 2003 | Lope de Rueda | Alfredo Baras Escolá | |
| | Alfonso de Valdés | Rosa Navarro Durán | |
| | Alfonso de Valdés | Juan Goytisolo | |
| | Francisco Cervantes de Salazar [†] | José Luis Madrigal | |
| | Alfonso de Valdés | | Antonio Alatorre |
| | Alfonso de Valdés | | Félix Carrasco |
| 2004 | Alfonso de Valdés | | Félix Carrasco |
| | Alfonso de Valdés | | F. Márquez Villanueva |
| | Alfonso de Valdés | | Valentín Pérez Venzalá |
| 2006 | Alfonso de Valdés | Rosa Navarro Durán | |
| | Alfonso de Valdés | | M. Antonio Ramírez López |
| | Alfonso de Valdés | | Francisco Calero |
| | Lope de Rueda | | Francisco Calero |

| | | | |
|------|-----------------------------------|---------------------------------|-------------------------|
| | Juan Luis Vives [†] | Francisco Calero | |
| 2007 | Alfonso de Valdés | | Pablo Martín Baños |
| 2008 | Pedro de Rhúa | Francisco Calero ¹¹³ | |
| | Francisco Cervantes de Salazar | | José Luis Madrigal |
| | Juan Arce de Otálora [†] | José Luis Madrigal | |
| 2010 | Diego Hurtado de Mendoza | Mercedes Agulló | |
| | Diego Hurtado de Mendoza | Jauralde Pou | |
| | Diego Hurtado de Mendoza | | Javier Blasco |
| | Alfonso de Valdés | Rosa Navarro Durán | |
| | Alfonso de Valdés | Joseph V. Rikapito | |
| | Diego Hurtado de Mendoza | | José Luis Madrigal |
| | Diego Hurtado de Mendoza | | Rodríguez Mansilla |
| | Juan Arce de Otálora | Rodríguez López-Vázquez | |
| | Juan Arce de Otálora | | Rodríguez López-Vázquez |
| | Juan de Pineda [†] | Rodríguez López-Vázquez | |
| 2011 | Juan Arce de Otálora | | Francisco Calero |
| | Diego Hurtado de Mendoza | Mercedes Agulló | |
| | Diego Hurtado de Mendoza | Reyes Coll-Tellechea | |

¹¹³ As explained before, Francisco Calero suggests that Pedro de Rhúa and Juan Luis Vives were in fact the same person.

| | | | |
|------|--------------------------|--------------------------|------------------|
| 2012 | Juan Luis Vives | M. Antonio Coronel Ramos | |
| 2014 | Juan Luis Vives | | Encarna Podadera |
| | Diego Hurtado de Mendoza | Joaquín Corencia Cruz | |
| | Juan Arce de Otálora | José Luis Madrigal | |

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Conclusions

At the beginning of this dissertation we defended how properly informed questions of humanistic tradition can be formulated, enriched, and answered by computational means. In this respect, we covered three different case studies to illustrate each. The analysis of more than 120,000 pictures of paintings is a task that would demand a lifetime to be achieved. A “distant reading” approach might reduce that time to several months, at the expense of losing the existing theoretically-constructed criticism, but fostering the need of new frameworks to overcome this limitation. It is not sufficient to defend the legitimacy of the older instance-based studies when technology enables us to raise new questions and engages us in them. Both approaches must work together and harmonize, reconcile, and coordinate efforts. Our second study built upon the notion of empathy, an apparently intractable subject for machines. However, by using sentiment analysis as a proxy, we further supported the mischievous nature of Calderón de la Barca when trying to reach different audiences in his massively popular *autos sacramentales*. In this case, we just confirmed an existing debatable argument of the Baroque through different and more objective means. Finally, we tackled one of the biggest mysteries of Hispanic literature, namely the author of the *Lazarillo*. Non-traditional authorship studies have been long constructing upon internal analysis their arguments to solve this “problem”, and in the process had to deal with learning computational tools and statistics. It has been surprising to find the scarcity of such approaches in Spanish Golden Age literature. While given the evidence found, we must not state who the author was, the consistent appearance of Juan Arce de Otálora and Alfonso de Valdés might engage new scholars into looking for further evidence, outside of the internal realms of the works. Of course, as in all data-based research endeavors, the better the dataset the better the conclusions we can infer from our analysis.

Computers do not think (yet), but they are outperforming humans in several specific tasks: recognizing and identifying faces, analyzing sentence structure and coherence, summarizing texts, calculating frequencies, generalizing and extracting polarity expressed, etc. Humanists should not miss this opportunity, where all the manual work can be made faster and in greater volumes. This puts the scholar in an arguably

uncomfortable position. On one hand, humanists can now study wider and larger periods of time, more works, plays, or films, as they are being digitized or just born digital. On the other hand, it requires a new methodological and theoretical framework to validate their findings, an exercise that, unfortunately, not everyone is willing to undergo. However, results must continue to be analytically studied, not in the sense of quantifiable statistics, but in addition to the proper humanistic inquiry that the results demand. The type of research that computers aid has not been yet assimilated or comprehended by the traditional practitioners. Computational algorithms bring new possibilities of inquiry. Some still lack the critical apparatus that has been in development for the rest of humanities for decades, but this unfair advantage is precisely the reason that makes digital humanities and cultural analytics so appealing to novel and old scholars alike. Some questions, simply, could not be answered by traditional means. Critique against the computational turn tries furiously to delegitimize the use of machines in humanities endeavours, arguing that the lack of a solid critical foundation makes their insights unbearable and ultimately unnecessary or irrelevant –*i.e.*, they add nothing. We agree that technological advancements and the use of computers without a proper research question fall into the category of didactic exercises, *just for fun*. But ignoring, or worse, attacking the potential of technology and its applications is a mistake of historical perspective. The theoretical framework that could put digital humanities in a relevant, not fashionable, position might yet remain to be developed but that is a path worth exploring.

Accusations of the shortsighted view of digital humanities only denote a fear of the pre-established position that at the moment detents the power. Arguing that the hermeneutical limitations of computers can only lead to misguided results is unfounded and detrimental for the advancement of the disciplines and knowledge of the human being and its condition. What remains clear is that questions about what makes us human are more relevant than ever and that cultural analytics, and its application of big data analysis to the behaviour of human beings in their context, will play a key role in helping understand what is human in an age of change.

In the context of beauty, exact measurements such as averageness and symmetry help us better understand the various ways in which human faces have been depicted throughout

the history of painting. As attested by art historians through traditional scholarship, these representations have not always remained constant, as different artistic styles have attempted their own ways of capturing facial beauty. After our analysis, we can conclude that there have been variations in the form in which faces have been represented over time, and that these variations can be measured and tracked accurately. While there is a clear trend conforming to features of classical representation of the human face from the 15th to the 18th centuries, both the 13th-century –Gothic style– and contemporary art have shown clear deviations from the classical paradigm. Especially interesting is the data from 20th-century artistic styles, which shows low levels of both symmetry and averageness as well as a reduced proportion of total faces captured when compared to previous centuries.

These results conform to the views of art historians regarding the aesthetic and methodological disruptions that occurred after the vanguards. There has arguably been a change in the concept of art itself, as well as in the theories that explain and criticize it. Nowadays, it is accepted that the representation of the human does not necessarily attempt to represent beauty. This shift in thought is clear in the data analysis and opens the door to a second phase of the investigation. By contrasting the aesthetic theories of specific periods and artists against the data, we would be able to establish their levels of conformity to and deviation from the objective measures of beauty. This would allow us to complement the qualitative and conceptual analysis of art history with the study of quantitative data. Combining these two levels appropriately should be one of the methodological aims of any culturomics science.

The separation from the classical mode of representing the human being in contemporary art also serves as a reminder of the bias that we imposed on the analysis of perceived beauty by employing such accurate measuring systems. This bias also shows the interestingly close relationship between classic ideas of beauty and art in Western cultures, and mathematical notions that support data-driven methods of research. While it is evident that the examples in Picasso's, Duchamp's, and Pollock's works show deviations from painting styles which depict faces that conform better to measures of symmetry and averageness, the judgment of whether these human faces are more (or less)

beautiful than previous cases remains an aesthetic one. The contingency of aesthetic values is subject to fads, trends, reactions, and public opinion (Dutton). Better algorithms can help us be more precise in the measurement of objective elements, although it has to be noted that the discipline that studies how social movements get started, become important, and disappear, remains in its infancy (Pentland). Once we have improved the way to measure and analyze both the internal features of art works and the dynamics of social movements that create judgments about those works, we will be able to approach these types of problems in a more accurate manner.

Another relevant factor to take into account is the sampling we used for the study and how representative it is. While we are certain about the validity of the used set as related to art history, it is impossible to ascertain how representative these faces are of the real populations living in the various historical periods. However, we have observed that there is a correlation between the production of various types of media and the size of the human population in various countries throughout time. The more people there are, the more media is produced. This correlation remains true for paintings.

Although not explicitly discussed in our analysis of paintings, we also verified that age, gender and face orientation, along with symmetry and averageness in the representation of human faces in paintings, can become a complementary and objective way to identify and characterize styles and movements. Along with the exhaustive tagging for techniques, materials, and the analysis and recording of chemical products used in art production, this could become the basis for the culturomics of art history (Michel et al., 176-182).³ Nevertheless –and although this does not contradict our findings– it is clear that there is also a variety of complex social, aesthetic, and evolutionary elements that influence our judgment of beauty. Capturing these constructs into proper algorithms has not resulted (yet) in perfect solutions to account for changes in perceived beauty. As we have previously stated, this has to do in part with the close relation between classic ideas and mathematical models that biased the analysis towards certain ideas of beauty. It is also important to note that many of these variations are due to the pressure that culture exerts in the short term on the adoption of different traits, and the deviations that this provokes from well-established, long-term genetic features related to beauty,

reproduction, and social acceptance and belonging (Suárez, Sancho, and de la Rosa, 281-281). Thus, it is important that any approach to the culturomics of art history and beauty also take into account cultural evolution and cultural history as forces that shape the results we find in the data, and that have to contribute to the explanation of these results.

Alongside our second study, we analysed almost 37,000 sentences constructed from verses in dramatic and allegorical plays. Since our main objective was to demonstrate whether Calderón could be considered a mass influencer or not and what artefacts he used in order to become one, we built an automated classifier to annotate all the sentences in his works. Afterwards, we tagged all the sentences and characters of the plays and discovered the predominance of characters of allegorical and biblical dimension in the social spheres of nobility, laymen, and theological abstractions, which clearly compose the intended audience of the *autos* as these were staged in public spaces and free of charge for the entire population of Madrid.

Women seemed to be slightly underrepresented as compared to men, which could be considered normal taking into account the different social and historic context of when the plays were written. On the other hand, female members of the lay population, clergy, nobility, and supernatural spheres had more sentences classified as positive, which left men as an authority on moral and soul-related affairs, as far as our typology of characters is concerned.

We concluded by saying that the architecture of sentiments in Calderón's *autos* is as complex as the dramatic structure of baroque plays, and that the various metaphysical and rhetorical interconnected levels of baroque technologies of speech make it difficult to draw firm conclusions about the empathy of the characters and the machination of the messages by baroque authors. Data, however, can be contradictory sometimes. For example, according to our methodology, the villains' speeches were classified as positive, which is in line with the notion of the *engaño* (deceit) practised in the Baroque, but villains were not the ones with the highest values of positive messages –philistines, muslims, and jews presented even higher values. In other cases, it is hard to decide whether Calderón was using characters' speeches to send clear religious messages or just

as devices to fool the audience and play with the public. Be that as it may, the twisted nature of the Baroque was once again brought to light.

The last study, concerning the authorship of *Lazarillo*, started with an overview of the possible authors, which allowed us to establish a baseline corpus of candidates to work with. The subsequent exploratory analysis employing distance-based measures and methods from unsupervised learning started to give the first hints. Juan Arce de Otálora and Alfonso de Valdés were then highlighted and soon supported by the use of more sophisticated methods. The majority of the statistical evidence seems to point at the direction of Arce de Otálora by a wider margin with regards to Valdés, and while our corpus is not as comprehensive as the one used by Madrigal, Arce de Otálora is still chosen by the learning methods as the most likely author. It seems that all statistical techniques agree on Arce de Otálora, which supports the hypothesis of Madrigal, but might not be the ultimate proof the authorship needs. Open-set methods suggest that none of the authors wrote the little book. After all, if, as Francisco Rico mentions in his 2011 edition (Anónimo ed. Rico), *Lazarillo* was the only work written by his author, whoever that might be, any method, computational or not, based on the comparison of styles, mentions, idioms, or fingerprints, turns out to be useless. Under such an assumption and due to the lack of other texts used as clues, the traditional historiographic profile-based research stands out as our only chance to find the author.

The Erasmian answer to the question of authorship is recursively based on the principle of authority: it is important to unmask the anonymous author of a work if the writer is in fact an important author. In recent times, the author might not even be of interest at all, as the Barthesian conception of the death of the author considers. Others, however, agree that knowing the author of a work “changes its meaning by changing its context ... certain kinds of meaning are conferred by its membership and position in the book or oeuvre” (Love). Paraphrasing Love, *Lazarillo* by Diego Hurtado de Mendoza, with its life parallels and allusions, is a different story than *Lazarillo* by Friar Juan de Ortega or Pedro Mejía. While this study helps to dispel doubts around some of the most often cited authors for the little book, we still believe that the authorship of the *Lazarillo* plays an important role in the work. Unlike Américo Castro, we do not give much importance to

the fact of the anonymity itself but to the actual 400 year-old debate about who the author might be. Discovering new authors and arguing in favor of or against them injects with life the adventures of Lázaro de Tormes. Every time a new author is proposed, a new reading is found in the *Lazarillo*. Because of this, part of us hopes nobody ever finds the definitive factual proof to prove the authorship, as that would take away all the fun from it.

All previous examples follow the same pattern. There exists, first, an intellectual challenge. Solutions to research questions are attempted by traditional means, and later, by incorporating technology into the equation. Due to the lack of methodologies that suit the specific needs, the only possible path is to expand and to adapt the available techniques. In some cases, it will be a matter of writing new algorithms as an ensemble of machine learning methods. Others will require creating customized corpora to improve accuracy in predictions. Finally, there will be cases where combining computer science with knowledge from other fields –such as neuroscience– is one possible way to achieve the research goals. In either case, throughout these examples, we believe that the complementary nature of the research in computer science with regards to digital humanities has been successfully defended and that our knowledge of the three cases studied has been expanded.

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Appendices

Appendix A: Ethics Approval



Research Ethics

Western University Non-Medical Research Ethics Board NMREB Delegated Initial Approval Notice

Principal Investigator: Juan Suarez
Department & Institution: Arts and Humanities/Modern Languages & Literatures, Western University

NMREB File Number: 107103
Study Title: Sentiments in the Spanish Golden Age Calderón's Autos Sacramentales
Sponsor:

NMREB Initial Approval Date: September 18, 2015
NMREB Expiry Date: September 16, 2016

Documents Approved and/or Received for Information:

| Document Name | Comments | Version Date |
|---|--|--------------|
| Instruments | This is an example of what participant will see when they assess a sentence. | 2015/08/19 |
| Instruments | This is the initial survey that participants will fill in before starting to assess sentences. | 2015/08/19 |
| Recruitment Items | This is the poster that will be posted on the department of Modern Languages and Literatures. | 2015/08/19 |
| Revised Western University Protocol | | 2015/09/10 |
| Instruments | Revised instruments | 2015/09/10 |
| Revised Letter of Information & Consent | Modern Languages and Literatures. | 2015/09/10 |
| Revised Letter of Information & Consent | Amazon Mechanical Turk. | 2015/09/10 |

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the above named study, as of the NMREB Initial Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario.

Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Ethics Officer, on behalf of Hilary Hinson, NMREB Chair or delegated board member

Ethics Officer to Contact for Further Information

| | | | |
|---------------------------------------|---|---------------------------------------|-------------------------------------|
| <input type="checkbox"/> Erika Basile | <input checked="" type="checkbox"/> Grace Kelly | <input type="checkbox"/> Mina Mekhail | <input type="checkbox"/> Vikki Tran |
|---------------------------------------|---|---------------------------------------|-------------------------------------|

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“Decline of Perceived Beauty: Facial Representations between the 18th and 20th century in Western Art.” With Natalia Caldas, Nandita Dutta, and Juan Luis Suárez. 4th Global Conference on Beauty, 2014.

“SylvaDB: A Polyglot and Multi-Backend Graph Database Management System.” With Juan-Luis Suárez, and Fernando Sancho-Caparrini. In *DATA*, pp. 285-292. 2013.