Rhyme within reason: an emotion analysis approach to rhyme in a historical corpus

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Abstract:
We applied natural language processing methods to a corpus of Spanish sonnets (15th–17th centuries) to examine the semantics of rhyme words in terms of sentiment analysis (i.e. positive or negative connotation) and emotion analysis. The analyzed corpus comprises the *Corpus of Spanish Golden-Age Sonnets* and the corresponding period of the *Diachronic Spanish Sonnet Corpus*.

Sentiment and emotion analysis of rhyme words was performed to detect stylistic patterns within the work of an author and across poets. We adopted a lexicon-based approach, updating the lemmas available in the lexicons to account for morphological and orthographic specificities of the historical variant under analysis.

Our study describes trends regarding the semantic properties of rhyme in the Spanish Golden Age sonnet. The methodology can be easily adapted to other poetic forms, languages and periods, which can contribute to the debate around the semantic dimension of rhyme as a rhetorical device.

Introduction

Rhyme is a relevant structural element in many poetic forms. Besides its aesthetic and musical function, rhyme words hold a privileged position to convey meaning, and the relation created between sound and sense must not be overlooked (Houston 2016). In addition, the use of rhyme as a mnemonic device (e.g. Rubin 1997) and its role in vocabulary retrieval (e.g. Rapp and Samuel 2002) confirms that rhyme words are among the most memorable parts of a poem, which also highlights their importance.

Previous studies have proved the relevance of rhyme to answer literary questions that go beyond this device as a structural element of poetic compositions. To cite a few examples, Plecháč (2021) used rhyme to increase the accuracy of his author attribution algorithms with great success, and Ruiz Fabo and Bermúdez Sabel (2020) established intertextual relations and influences by carrying out network analysis of a corpus of rhyme words. Regarding the Spanish Golden Age sonnet specifically, Navarro-Colorado (2015; 2018) examined the interaction of rhyme with topic models, besides a variety of other features unrelated to rhyme.

As stated by Brogan and Cushman (2012, 153), "[t]he equivalence of the rhyme syllables or words on the phonic level implies a relation of likeness or difference on the

semantic level". In this contribution, we aim at exploring these semantic relations of likeness or difference from the perspective of sentiment and emotion analysis. We argue that, due to the privileged position of rhyme words, they are more likely to be emotional words, and hold a significant role in conveying the overall meaning and emotional tone of the composition. In order to explore the semantic role of rhyme words, we implemented a sentiment and emotion analysis of a corpus of sonnets spanning from the 15th to the 17th centuries (Spanish Golden Age). One of the lines of research that can be pursued through such an approach is the detection of semantic patterns among rhymes in terms of emotion association and see whether they act as a signal of the style of certain authors.

We introduce the theoretical background on sentiment and emotion analysis and their application to literary studies in section 2. Section 3 presents our methodology, and results are discussed in section 4. The paper concludes with a final evaluation and a presentation of future work.

The data and the code related to this contribution are freely available under a CC-BY license in https://github.com/pruizf/rhyme-within-reason.

Theoretical framework and state-of-the-art

Following the definitions of Kim & Klinger (2021), we understand *sentiment* as the positive or negative feeling underlying an opinion (Kim and Klinger 2021, §1), and *emotion* as "an integrated feeling state involving physiological changes, motor-preparedness, cognitions about action, and inner experiences that emerges from an appraisal of the self or situation" (Kim and Klinger 2021, §2). Thus, sentiment analysis entails the automatic classification of the positive or negative connotation of a linguistic expression, and emotion analysis tackles the automatic identification of emotions in a linguistic expression. However, we will find in the specialized literature multiple sets of emotions to consider. Kim and Klinger (2021) provide a comprehensive state-of-the-art concerning the application of sentiment and emotion analysis in Literature, including an overview related to emotion categorization.

We can divide the main proposals for emotion classification in two main groups: those based on an inventory of discrete emotion categories, and those which provide between two and four dimensions as axes along which to place a continuum of emotions.

In the psychological field, one of the most well-known classifications is Ekman's (1992) in which he considers six basic emotions: *anger*, *disgust*, *fear*, *joy*, *sadness*, and *surprise*. Another widely used taxonomy is Plutchik's (1991), which proposes eight basic emotions divided into opposite pairs: *joy vs. sadness*, *anger vs. fear*, *trust vs. disgust*, *surprise vs. anticipation*. However, literary scholars have pointed out that it would be relevant to adapt these classifications to the specific needs of literary research. In this sense, Haider et al. (2020) propose the following list: *beauty/joy*,

sadness, *uneasiness*, *vitality/energy*, *suspense*, *awe/sublime*, *humor*, *annoyance*, and *nostalgia*.

In terms of dimensional representation, different models exist. A common one is a two-dimensional model, defined by *valence* (degree of pleasure) and *arousal* (degree of activation or intensity). Other alternatives include a third dimension: *dominance*, defined as the degree of control that someone feels in relation to the situation that causes the emotion. In addition, we can find models that combine both the discrete emotion approach and the dimensional approach, providing a list of discrete categories in a dimensional space (e.g. Russell 1980).

Emotion theory is very complex. When establishing discrete categories, difficulties arise due to overlaps, the need to rely on notions that are not universal, and the issues that emerge when trying to define each category unequivocally. It is also difficult to establish all relevant dimensions when attempting to evaluate emotions. For example, besides the dimensions described above (valence, arousal, and dominance) other proposals include the notions of *certitude* or *effort* (see Smith and Ellsworth 1985). In addition, any attempt to study linguistic expressions to analyze emotions needs to tackle the tension between the linguistic expression of emotions, the emotions the person feels and the ones they want to evoke in their audience.

Even with these theoretical difficulties, emotion and sentiment analysis is a very relevant natural language processing (NLP) task for Literature, considering how emotion is an intrinsic element to literary production. There is a relation between the emotions evoked in the text and the emotions experienced during its reading that it is relevant to explore. Appeals to emotion are a classical rhetorical mode of persuasion (see Arias 2019). Moreover, the success of literary works can be analyzed from the point of view of its emotional tone scores, (see Anderson and McMaster 1986). In addition, sentiment and emotions may function as literary genre markers (e.g. Henny-Krahmer 2018), as relevant elements in the identification or description of narrative techniques (e.g. Kim and Klinger 2019) or as characterization features (e.g. Kuivalainen 2009).

In particular, the computational analysis of emotions in literature presents specific challenges. Emotional content might be evoked by implicit descriptions, inferences, and by expressions that are not lexical items, such as onomatopoeias or punctuation. As mentioned above, the inventory of discrete emotions to be identified in literary works might be different from the inventories proposed from the psychological field due to the different objectives of these disciplines. In this sense, efforts have been made to develop literature-specific emotion inventories, such as Schmidth et al. (2021) to study German theater from 1650 to 1815, or Haider et al. (2020) to analyze poetry reception.

Computational analyses of emotions in Spanish poetry have been carried out before. Barros et al. (2013) developed an automatic classifier of Quevedo's poetry by using emotion analysis. This work suggests the pertinence of emotion vocabularies to automatically distinguish poem groups according to a simple classification (in this case

there were four categories). In a more recent study, Barbado et al. (2021) identified the general affective meaning of sonnets by developing a non-supervised model created from lexicons, using affective, lexical-semantic and psychological features. An evaluation against a manually annotated corpus of 274 sonnets yielded significant results as regards the identification of affective features.

Methodology

We performed a semantic analysis of rhyme pairs by applying sentiment and emotion analysis to a corpus of sonnets from the 15th to the 17th centuries taken from the *Diachronic Spanish Sonnet Corpus* (DISCO) (Ruiz Fabo et al. 2021) and the *Corpus of Spanish Golden-Age Sonnets* (Navarro-Colorado, Ribes-Lafoz, and Sánchez 2016) which we will abbreviate as ADSO from now on.

The ADSO and DISCO corpora are encoded in TEI, but their metadata and annotations are slightly different. Although both corpora include the metrical scansion of each verse line, DISCO also contains annotations for rhyme words and rhyme-scheme. Poems are also annotated with enjambment. In terms of corpus size, ADSO focuses on canonical poets while DISCO aims at breadth. ADSO has a size of 5,077 sonnets by 53 poets while, for the selected time-span, DISCO contains 1,088 sonnets by 477 poets. There are only 17 poets represented in both corpora, with 333 sonnets in common. Sonnets duplicated across both corpora were only included once in our analyses. Our final corpus included 5,814 sonnets.[1]

A first preprocessing step consisted in annotating the rhymes of the ADSO corpus using the *rhymetagger* Python package (Plecháč 2018).[2] We also added some metadata to the TEI header of this corpus, such as the author of each sonnet (which was not included in the original XML files, only in the file names). Once the XML files contained all the relevant information, we created a dataframe in which each row corresponds to a rhyme pair, i.e. the *call* of each rhyme and its *echo*; we adopt the *appel* and *écho* terminology used in the French tradition.

There are three main strategies to implement sentiment and emotion analysis: lexicon-based methods, feature-based methods (machine learning) or representation-learning methods (deep learning). In this case, we implemented a lexicon-based approach. Thus, before carrying out the semantic analysis, it was relevant to lemmatize the rhyme words. We used the Stanza Python NLP toolkit (Qi et al. 2020), using a model trained with the AnCora treebank (Taulé, Martí, and Recasens 2008). The lemmatization accuracy of Stanza with this model is 99.20%. A test over a small sample drawn from our dataset revealed an accuracy of 92.21%. It is not surprising that the accuracy is a bit lower with our dataset, considering the specific challenges posed by historical

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1 The total number of sonnets unique to either ADSO or DISCO is 5832, however, 18 sonnets were not included in any of the analyses here due to format errors in the source files and irregularities in the automatic rhyme annotation results.
2 https://github.com/versotym/rhymetagger

varieties and poetic language for automatic lemmatization. The most common errors were due to:

- presence of lexical archaisms (e.g. *gros*, a type of coin);
- historical orthography, like the use of ‹ç› instead of current Spanish ‹c› (e.g. *exerçiçios*) or the presence of ‹y› in diphthongs instead of ‹i› (e.g. *cuytad*);
- enclisis (e.g.: *délo, cumpliólo, serviros, daros*), where clitics *lo* and *os* follow the verb, unlike in current Spanish;
- verb forms corresponding to the second person singular (P2). Considering that the training dataset for the lemmatizer is a newspaper corpus, we can assume that P2 was underrepresented;
- linguistic register and the particularities of poetic language.

We corrected some common lemmatization errors before carrying out the semantic analysis with the aid of lexicons. For sentiment, we used Stadthagen-González et al. (2017)*, ML-SentiCon* (Cruz et al. 2014), and NRC's *Valence, Arousal and Dominance Lexicon* (NRC-VAD) (Mohammad and Turney 2013). The first one has two dimensions, valence and arousal, and it contains 14,031 entries. *ML-SentiCon* contains 11,918 terms and it is based on the senses included in the WordNet lexical database (Fellbaum 1998). NRC-VAD presents the three emotion dimensions mentioned in its acronym for 20,007 words. The lexicon was originally created for English and was then automatically translated to over 100 languages, including Spanish. Table 1 presents the coverage obtained by merging these lexicons, both in terms of occurrences (80,852 rhyme words) and of vocabulary, that is, distinct lemmas (9,288). Although the coverage in terms of vocabulary might seem low (53.07%), 84.6% of the rhyme-word occurrences were covered by the lexicons.

Lexicon	Occurrences		Vocabulary	
	Rhyme words	**%**	**Rhyme words**	**%**
Stadthagen 2017	61,609	76.2	3,872	41.77
+ NRC-VAD	66,568	82.33	4,560	49.19
+ ML-SentiCon	68,488	**84.71**	4,927	**53.15**

Table 1. Coverage of the dataset obtained by joining the sentiment lexicons. Percentages of the total number of rhyme-word occurrences (80,852) or unique rhyme words (9,270).

In the case of emotion analysis, the lexicons used in our study were Stadthagen-González et al. (2018) and NRC's *Emotion Intensity Lexicon* (NRC-EIL) (Mohammad and Turney 2013). Stadthagen-González et al. (2018) contains 10,491 entries, which are classified according to five different dimensions: happiness, disgust, anger, fear and sadness. NRC-EIL contains 4,711 terms described by means of anger, anticipation, disgust, fear, joy, sadness, surprise, and trust; *joy* is equivalent to

Stadthagen-González et al.'s *happiness*. Table 1 presents the coverage obtained by merging the lexicons. The emotion lexicons are less broad than the sentiment ones, so it is not surprising to find a smaller coverage. What we can see in both Tables 1 and 2 is that both NRC-VAD and NRC-EIL complement the work by Stadthagen-González et al. As the lexica did not all use the same score range, scores were scaled to a 0-1 range, using min-max scaling.[3]

Lexicon	Occurrences		Vocabulary	
	Rhyme words	%	Rhyme words	%
Stadthagen 2018	32,805	40.57	2,559	27.61
+ NRC-EIL	50,662	62.66	3,404	36.72

Table 2. Coverage of the dataset obtained by joining emotion lexicons. Percentages of the total number of rhyme-word occurrences (80,852) or unique rhyme words (9,270).

Some of the challenges found during the automatic lemmatization process also apply to lexicon-based semantic analysis. Vocabulary specific to a historical variety is not necessarily covered in available sentiment and emotion lexicons and some words common in literary language are also absent. In addition, named-entities are not unusual as rhyme words, but they are not present in the lexicons, yet we could argue that the mention of certain named entities, such as Greco-Latin mythological characters can be used to evoke particular emotions and sentiments. These are some of the types of words that were not covered in our semantic analysis even if it would be relevant to cover them.

It should be noted that the lexicon-based approach has other well-known limitations, such as the fact that it does not deal with polysemy or homography in a satisfactory manner. Different senses of a word might evoke different degrees of the same emotion or even different emotions altogether. In our study, semantic change also needs to be considered. Although random samples of our corpus did not reveal examples of words whose connotation has changed over time and that were contained in the lexicons (and would thus receive an incorrect assessment), the possibility remains that such cases exist in our data. Another possible problem is enantiosemy, which can be roughly described as polysemic words in which one of their meanings is the reverse of another. This phenomenon has not been as thoroughly studied in Spanish (Martínez 2022; Torijano Pérez 2021) as in other languages (e.g. Karaman 2008; Shmelev 2016) and, although it does not seem likely that it affects our corpus, the possibility remains.

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3 The implementation used for min-max scaling is the scikit-learn's package: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.MinMaxScaler.html

Discussion

The sonnet is a prescribed form, thought to have appeared in southern Italy in the mid 13th century (Spiller 2004, 1). Since its origins it was used to explore different themes adopting a variety of lyric voices: a narrative speaker, dramatization via dialogue or a first-person speaker (Spiller 2004, 6–8). In the Spanish Golden Age, the topics written about are extremely diverse: Although both romantic love and heartbreak are well represented, we find the depiction of a wide range of emotions not always aroused by romantic love (e.g. those related to ascetic devotion and heroism), together with the portrayal of heterogenous subjects (religion, political and moral commentary, social and personal satire, among many others). Even if we were to limit the corpus to just love sonnets, different rhetoric-thematic classifications can be implemented (see García Berrio 1978). Thus, the thematic heterogeneity of sonnets makes their exploration through automatic semantic analyses attractive.

An important characteristic of the sonnet is its division into an initial octave (two quatrains with enclosed or alternate rhyme) and a final sestet. The final six lines can be arranged in different ways, either with two tercets or with a quatrain and a final couplet, and rhyme schemes vary. In terms of discourse organization, the sestet generally complements the octave by "making a point", deepening on the content of the octave, providing an analysis of it or a contrast. Some change is expected at the end of the octave, and a "tripartite structure of discourse—statement, development and conclusion" is distributed across the octave-sestet division (Spiller 2004, 16–19).

We first discuss trends in rhyme-word sentiment and emotion in our corpus, as measured through valence scores, at the level of single poems and per author, besides emotion scores per poem. We then introduce trends in emotion combinations within rhyme-pairs. Finally, we present ways in which sentiment and emotion analysis identifies differences between the sonnets' octave and sestet in our dataset.

Sentiment and emotion trends

We consider that a valence score equal or greater than 0.5 corresponds to positive sentiment, while a lower score is equivalent to negative sentiment. For 91.98% of the sonnets we obtained a sentiment coverage of at least 10 rhyme words. Of those, 80.53% had at least 7 rhyme words with a positive score, while only 12.21% of sonnets had at least 7 rhyme words with a negative value. This suggests a preference for rhyme words with positive connotations, but whether this means that the overall meaning of the poem is a positive one needs to be systematically analyzed. The corpus shows however some degree of negative correlation between rhyme-word valence and arousal (Pearson's r = -0.46),[4] which may suggest a slight trend for positive sentiment in the corpus rhyme-words to correspond to less strong emotions (less arousal) than negative sentiment does. A superficial inspection of the sonnets that present an accumulation of positive rhyme words (12 or more) revealed some of the themes explored in these compositions: Besides sonnets that discuss romantic love

4 All statistical tests were performed with the SciPy package (version 1.8.2)

and the description of a love interest (e.g. *Reina desotras flores, fresca rosa* by Luis Martín de la Plaza or *Si la grana del labio Celia mueve* by Lope de Vega), we also find sonnets that address the joy derived from religious devotion (e.g. *Adonde quiera que su luz aplican* by Lope de Vega) or from nature/a *locus amoenus* (e.g. *Alegre, fértil, vario, fresco prado* by Fernando de Herrera). Amongst the sonnets that present an accumulation of negative sentiment (10 or more), we find poems that focus on heartbreak and suffering caused by unrequited love, like *Lucida, que sirvió quererme tanto* by Pedro Padilla, but we also find sonnets from the political domain, like Quevedo's *Duro tirano de ambición armado* against tyrannical rulers.

In terms of rhyme pairs, valence score coverage with our combination of lexicons is 74.93%, considering cases where both elements of the pair have a valence score. As we can see in Figure 1, the least frequent combination is the association of two negative words. Although the association of two positive words is very frequent, Figure 2 shows how alternation (the combination of a positive with a negative word without taking in consideration the order) is slightly more frequent.
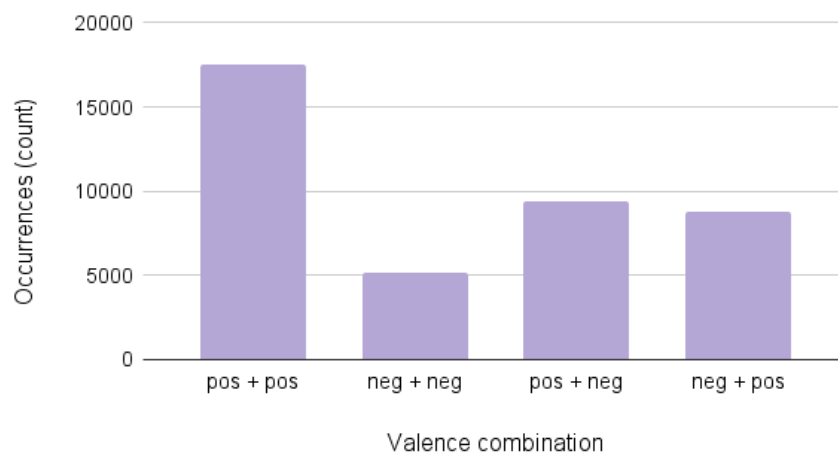

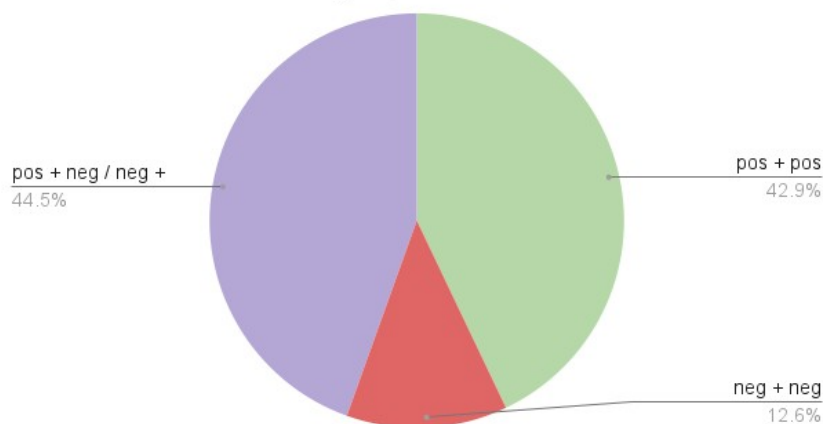Figure 1. Frequency of valence values in rhyme pairs.

Figure 2. Frequency of valence values in rhyme pairs.

By calculating the average of both the call and echo for either a single poem or the complete production of an author, we can observe trends and detect authors whose values are outliers (see Figure 3 as an example). Authors at the bottom left show an overrepresentation of negative valence. Examples of this would be Alonso Cabello and his sonnet *Memoria viva de la causa muerta*, where we find words related to the semantic fields of death (*muerta,* 'dead'), sadness (*llanto,* 'cry') and fear (*espanto,* 'fright'). Another example is work by Francisco Núñez de Velasco, which evokes sorrow (*disculpa,* 'excuse') and emotional suffering (*daño,* 'harm'; *engaño,* 'ploy'; *culpa,* 'guilt'). Authors at the upper right show an overrepresentation of positive valences, as Gonzalo de Ayala and his sonnet *Ímpetu superior, amor ardiente* that explores the semantic fields of life (*vive,* 'lives'; *alma,* 'soul'; *vida,* 'life'; *presente,* 'present') and passion (*ardiente,* 'burning'; *deseo,* 'desire'; *recreo,* 'entertainment'; *trofeo,* 'trophy'). It is interesting to find outliers like Tomás Gudiel, at around (0.62, 0.2), who presents a clear alternation of positive valences with negative ones (e.g. *mañana-ufana,* 'morning-conceited'; *quiere-muere,* 'wants-dies').
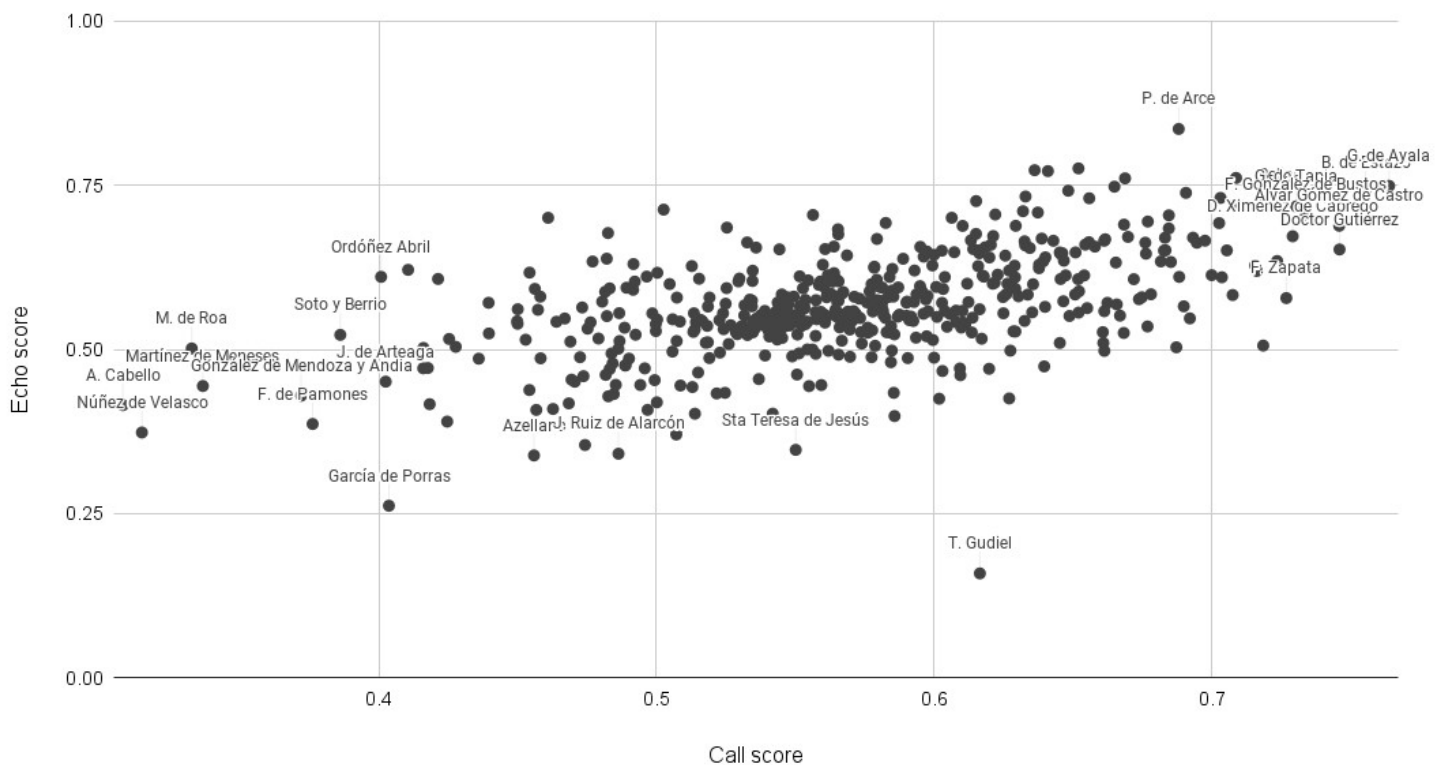

Figure 3. Scatter plot with the mean valence score by author.

One of the most immediate applications of the emotion analysis results is to annotate poems with the predominant emotion in its rhyme-word inventory. This task could be especially useful to classify, according to their emotional tone, poems that explore the same subject. The example in Box 1 presents two sonnets that address love-related suffering. However, the dominating emotion within the rhyme words of the first of them, *Dulce pasión, que en holocausto ofrece* by Joseph Delitala y Castelví, is sadness,

while on the second one, *Mucho tormento es ya para sufrido* by Luis de Ulloa y Pereira, anger prevails.

Dulce pasión, que en holocausto ofrece,	Mucho tormento es ya para sufrido,
rendir la vida en manos de un tirano,	y mucho agravio para declarado,
que mata con imperio soberano,	Lesbia, presumes mal, no se ha privado
y vence aquello mismo que apetece.	el alma de razón, se ha suspendido.
Cuanto más es mi Amor, tanto más crece,	Si verme entre las llamas encendido
su ceño, su rigor en lo inhumano,	te asegura de eterno mi cuidado,
fatal destino, pensamiento vano,	en las penas de amor el condenado,
que espera la razón, pues no enloquece.	no padece incapaz de arrepentido.
Sentir la pena, padecer el daño	Yo tiraré con ánimo tan fuerte,
sentir el golpe, conseguir el yerro,	del lazo en que mi cuello se cautiva,
llorar el mal, embarazar la dicha,	que me ahogue, o le rompa la violencia.
perder el bien, y para desengaño	Esto también por ti, que es ofenderte
habla el dolor en un cruel destierro,	ser tuyo, y ser tan vil, que torpe viva,
las ansias que me ofrece la desdicha.	infamando al amor con la paciencia.
Joseph Delitala y Castelví	Luis de Ulloa y Pereira

Box 1. Example with two sonnets of similar subjects, but with different predominant emotions in the rhyme words (sadness vs. anger).

Emotion combination in rhyme pairs

A different dimension to be examined is the semantic associations between emotions created through rhyme. Figures 4 and 5 present the most frequent emotions in combination. We considered that a certain rhyme-word is a valid representative of a given emotion if its score for that emotion is at least 0.5 in a 0 to 1 scale. Thus, the radar charts show how the emotions are distributed among the echoes when a particular emotion is predominant in the call. Given the predominance of positive + positive associations, it is not surprising to see that emotion words of joy rhyme more frequently with joy (Fig. 4). However, the strongest association takes place between surprise and fear, in relative terms. In other words, if the call is an emotion word of surprise, its echo is most likely to be an emotion word of fear, followed by surprise, anger and sadness (Fig. 5). Table 3 presents the data in tabular format. It shows the total number of rhyme pairs for which the call is a representative emotion word (i.e. with a score of at least 0.5) for each emotion. Each row also shows the percentage of each emotion as the echo for calls representing a given emotion; in other words, of all rhyme pairs in which the call represents a given emotion, what is the percentage for each emotion in the echo. The rows do not add up to 100% for two possible reasons: First, the echo word may be absent from our lexicons and thus receive no emotion score. Second, even in cases where the echo is found in the lexicons, its score may be lower than 0.5, and is thus not accepted into our analyses, as we do not consider the score strong enough to convey the emotion clearly. Examples of the second type are words

like *llevar*, 'carry', or *guiar*, 'guide', which are in the emotion lexicons but with a score lower than 0.5.

Figure 4. Radar chart with the distribution of emotion words in echos for joy, sadness, anger, and fear in the call.
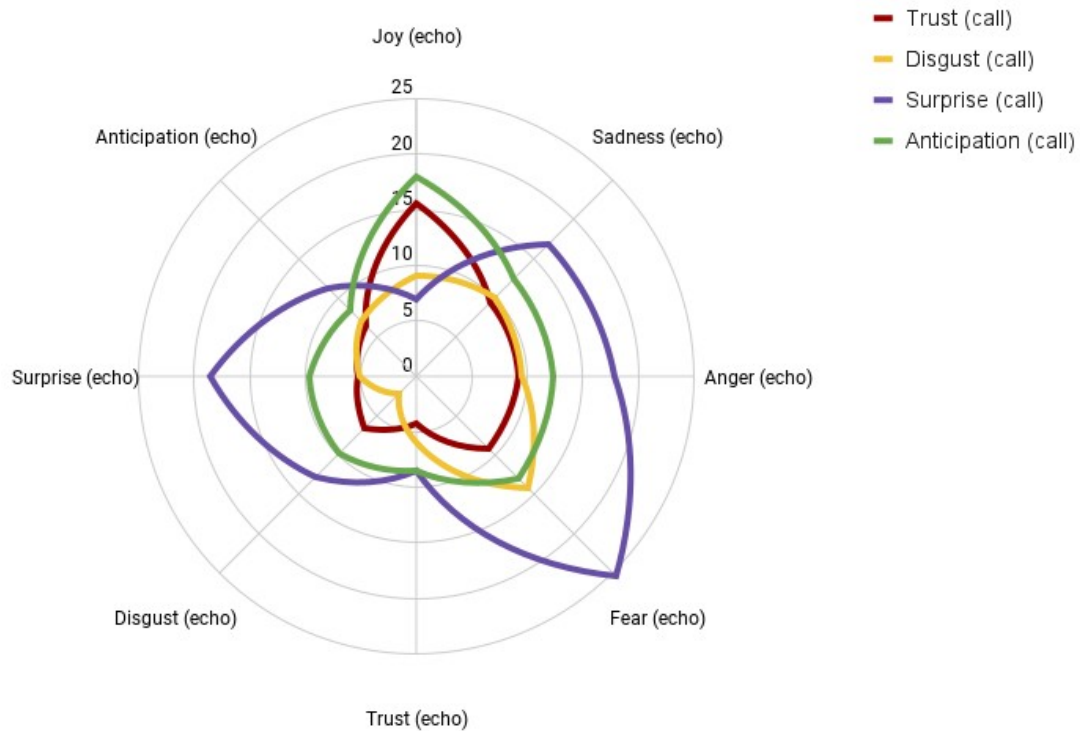

Figure 5. Radar chart with the distribution of emotion words in echos for joy, sadness, anger, and fear in the call.

Call	Rhyme pairs (nbr)	Echo							
		Joy	Sadness	Anger	Fear	Trust	Disgust	Surprise	Anticipation
Joy	7771	**19.55**	6.02	4.29	4.89	5.04	1.98	1.00	4.59
Sadness	3875	**11.23**	8.36	6.48	10.30	4.52	2.74	2.92	4.26
Anger	2792	**11.57**	9.03	5.80	9.28	5.77	3.65	4.23	5.95
Fear	3457	10.85	**11.22**	7.75	9.92	4.74	4.89	5.29	4.95
Trust	2244	**15.55**	9.49	9.27	9.14	4.28	6.55	5.26	6.51
Disgust	1591	9.06	10.06	9.50	**14.21**	5.97	2.14	5.16	6.98
Surprise	1031	6.99	16.89	17.86	**25.44**	8.54	12.91	18.54	11.17
Anticipation	1878	**18.01**	12.47	12.36	13.00	8.47	9.91	9.70	8.47

Table 3. Emotion associations between rhyme pairs (words need to have a score greater than 0.5 for a given emotion to be considered).

Taking into account the limited coverage of rhyme words in the emotion analysis task (see Table 2) we considered that our results would not allow us to detect stylistic patterns among the authors based on rhyme-word emotion, since the conclusions would be based on an overly limited proportion of the data.

Emotion and the octave-sestet divide

As mentioned, the sonnet's division into an octave and a sestet generally corresponds to a development in its discourse or rhetorical structure. As described by Spiller (2004, 4), "the second part [sestet] is structurally different from the first [octave], and almost always compels some kind of development and analysis". Another "main requirement" is providing a closure by the end of the sestet (Spiller 2004, 16); a sense of closure at the end of the octave and again at the end of the sestet are characteristic of the sonnet (Spiller 2004, 11).

Bearing this in mind, we assessed whether differences in rhyme-word attributes in the octave vs. the sestet can be used to identify sonnets presenting certain types of development between the octave and sestet. It is conceivable that a way to organize content into the octave and sestet may correspond in some sonnets to presenting a positive (or negative) emotional picture in the octave, which gets contrasted to a negative (or positive) emotional view in the sestet, driven by sentiment-bearing rhyme words, or at least aided by such rhyme words. Arousal (related to emotion intensity) may also show differences between the octave's and the sestet's rhyme-words: Since the sestet brings final closure to the poem's discourse (after the internal closure at the end of the octave), higher emotional intensity may be expected, to convey a strong

point or more forceful expression at the end of the poem. The converse strategy is also imaginable: after an octave expressing strong emotion, the sestet could provide a more calm picture.

To test these possibilities, we aggregated valence and arousal scores at octave and sestet level for each sonnet, in several ways, considering only sonnets where the number of rhyme-words covered in the lexicons reached a given threshold. In terms of valence scores, the threshold to accept a sonnet into the analyses was 6 rhyme-words covered for the octave and 5 words for the sestet. In terms of arousal scores, the threshold was 6 rhyme-words covered for the octave and 4 rhyme-words covered for the sestet. By choosing these thresholds, the number of sonnets covered by the analyses amounts to 72.86% of sonnets when working with valence scores and 77.92% of sonnets when working with arousal scores. The aggregated scores we computed, both at octave and sestet level, are as follows:

- Number of positive rhyme-words (i.e. valence >= 0.5)
- Number of negative rhyme-words (i.e. valence < 0.5)
- Average valence
- Average arousal

Based on these aggregated scores, we obtained the following measures:[5]

- *oms1*: Number of positive rhyme-words in the octave minus number of positive rhyme-words in the sestet
- *oms0*: Number of negative rhyme-words in the octave minus number of negative rhyme-words in the sestet
- *omsv*: Average valence in the octave minus average valence in the sestet
- *omsa*: Average arousal in the octave minus average arousal in the sestet

We observe that, when sorting sonnets by decreasing order of *oms1* and then by decreasing order of *omsv*, about 50% of the first 20 sonnets consistently show more negative rhyme-words in the sestet than in the octave. This need not however mean that the overall tone of the sestet is more negative than the octave's, since emotion-bearing words elsewhere in each line may not be coherent with the rhyme-word valence. Clear-cut examples, where negative rhyme-word valence does reflect an overall negative sestet, contrasting with positive rhyme-word valence in an overall positive octave, are harder to identify; one such example is in Box 2 (a). The same trend and limitations apply when we sort the corpus by *oms0* in decreasing order and then by *omsv* in ascending order and examine the first 20 sonnets. Similarly to the previous case, it is challenging to find very clear-cut cases where the sestet is clearly less negative than the octave, and the difference in negativity is borne by the rhyme words; one such example is in Box 2 (b).

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5 Other measures were also calculated but not exploited in order to query the dataset. Measure *omsa* was not used in the results discussed here, but can be used to search for sonnets where there is a difference in emotional intensity between the octave and the sestet.

Las hebras que cogía en lazos de oro
con arte vuestra blanca y tierna mano,
miraba, y el semblante altivo y llano
y la florida luz que amando adoro.

Creía en vos del sacro excelso coro
que el esplendor se unía soberano;
porque en sombra, aunque bella, y traje humano
no vio tal bien el orbe y tal tesoro.

Cuando rompiste leda el dulce espanto,
que de vos parte ausente y solo apena,
preguntando: «¿Qué fuerza me arrebata?»

Yo, que temo partirme, suelto en llanto,
digo: «Pienso que a muerte me condena
del cruel vuestro amor la saña ingrata».

Fernando de Herrera

Envuelto el cielo en confusión oscura,
lloviendo mares de su brazo airado,
Dios, que basta decir Dios, enojado
y que le ofende ya su misma hechura.

Dura el enojo y el castigo dura,
la luz está escondida, el Sol turbado,
y el hombre por los montes anegado
aumenta con llorar su desventura.

Para el Arca en Armenia, el arco asoma
coronado de paz y de alegría;
por la oriental ventana el ramo toma

de verde oliva, en que la paz venía,
Noé de aquella cándida paloma,
y el mundo de los labios de María.

Lope de Vega

Box 2. Sonnets showing a valence contrast between the rhyme-words (and general sentiment of the octave and sestet. In (a), octave sentiment is more positive than the sestet's. In (b), octave sentiment is more negative than the sestet's.

The preceding examples show that aggregated affective scores can be used to filter the corpus aiming to find sonnets showing certain characteristics. Besides their heuristic use for that purpose, we also examined whether the distribution of mean valence and arousal scores varies between the octave and the sestet. The same thresholds as above were applied (in the case of valence, at least 6 rhyme-words recognized in the octave and at least 5 in the sestet; in the case of arousal scores, at least 6 rhyme-words recognized in the octave and at least 4 in the sestet). We carried out an additional filtering, in order to keep sonnets showing a strict 8 + 6 line structure only; the filtered corpus contained 5355 sonnets (92.1% of the total).[6] The difference between average scores in the octaves vs. the sestet was found to be statistically significant for arousal scores, but not for valence scores, as assessed with the Wilcoxon signed-rank test at $p <= 0.01$.[7] Table 4 and the boxplots in figure 6 describe the distribution.

As table 4 shows, the arousal mean and standard deviations are slightly higher in sestets than in octaves, and the range of values is also wider, spreading from 0.319 to 0.86 in the sestets vs. 0.342 to 0.786 in the octaves. Although the differences are small, they may be related to increased emotional intensity in the sestet's rhyme words,

6 One of the reasons for the occurrence of sonnets where the line count is not 14 is that some Spanish sonnets may feature an additional couplet known as *estrambote* after the 14th line.
7 The SciPy package implementation (version 1.8.2) was used, omitting null values (`nan_policy='omit'`)

as a device used in the part of the poem which brings closure to its discourse. In the case of valence scores, the range and standard deviation are also slightly higher in the sestets than in the octaves, but no statistically significant difference was found.

	valence		arousal	
	octave	**sestet**	**octave**	**sestet**
N	3902		4173	
mean	0.549	0.550	0.562	0.569
std	0.089	0.103	0.067	0.077
min	0.225	0.202	0.342	0.319
25%	0.492	0.482	0.517	0.514
50%	0.554	0.556	0.559	0.567
75%	0.610	0.624	0.606	0.618
max	0.824	0.859	0.786	0.86

Table 4: Descriptive statistics for valence and arousal scores in sonnets' octaves vs. sestets.
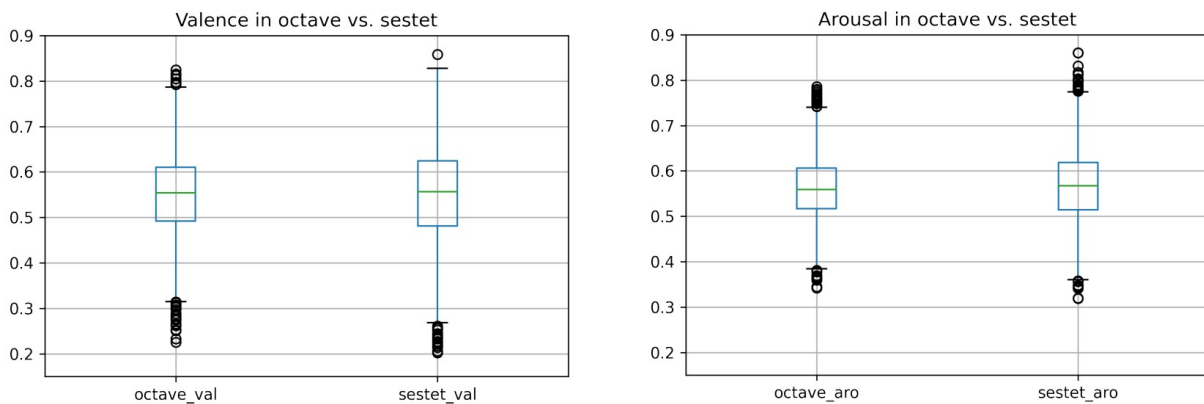

Figure 6. Boxplots showing the distribution of valence and arousal scores in octaves vs. sestets.

Conclusion and future work

This contribution presented some preliminary results derived from the application of sentiment and emotion analysis of rhyme words and rhyme pairs in a corpus of Spanish Golden Age sonnets (15th to 17th centuries). The methodology implemented presents certain limitations as discussed in section 3, but the results are nevertheless promising.

As stated by Natalie Houston, "[r]hyme connects lines of poetry through sound patterns which contribute to the tone, pace, and emotional effects of a poem" (Houston 2016, 567). In the study by Barbado et al. (2021), based on a sample of the DISCO corpus, 56% of their corpus was covered in the lexicons applied. The present work obtained a much higher coverage (84.71%, see Table 2). Barbado et al. (2021) used a wider variety of lexicons than our study, but both studies have one lexicon in common, Stadthagen-González et al. (2017). Our coverage with only that lexicon is 76.2%, which is still much higher than the total coverage obtained by Barbado et al. (2021). The results of this comparison suggest the hypothesis that rhyme words are more likely to be sentiment and emotion words. Future work will focus on testing this hypothesis by carrying out the analysis of the complete corpus minus the rhyme words following the same methodology and comparing with the results obtained here.

The semantic annotation of rhyme words in terms of sentiment and emotion has a heuristic value. It enables us to query the corpus using these semantic features, making it possible to search by specific combinations or intensity levels. Such annotations could also be used to establish rhetoric-thematic subclassifications within the literary production of an author or movement, complementing other computational semantic analyses like topic modeling.

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