

## RHETORICAL ANALYSIS TECHNIQUES IN DANTE ALIGHIERI'S DIVINE COMEDY

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### Abstract

The diversity of languages of the digital real has led to the creation of new communication models which incorporate formal, synthetic, and approved-by-areas codes for smart communication. The emblem of our society is the Mood virtual communicator: this replaces words and sentences with algorithms and acronyms. Our course of direction is heading inexorably towards digital codes that transmit pre-established semantics generated by a fixed sentence. Thus, it makes sense to discuss communication styles. And what does education consist of? Although we can take sides with fixed and standardized synthetic communication, we also call for respect for traditional and cultural values in individual societies. Still, we call into question the methodologies of study and reference models, which are currently used for virtual communication. The disciplines of theoretical linguistics, computational linguistics, mathematics, quantum physics, sociology, psychology, pedagogical theories, and other related subjects are all included in Social Sciences and Digital Media. This work aims to present an unwavering logical progression that transitions from normative grammar to formal grammar to then examine the features of a poetic text, such as Dante Alighieri's Divine Comedy, from several perspectives.

**Keywords:** digital codes, communication models, theoretical linguistics, computational linguistics, virtual communication.

## TÉCNICAS DE ANÁLISIS RETÓRICO EN LA DIVINA COMEDIA DE DANTE ALIGHIERI

### Resumen

La diversidad de lenguas del universo digital ha llevado a la creación de nuevos modelos de comunicación que incorporan códigos formales para la comunicación inteligente, que son sintéticos y homologados. El emblema de nuestra sociedad es el comunicador de Modo virtual, que reemplaza las palabras y las oraciones con algoritmos y acrónimos. Nuestra orientación inexorable es hacia códigos digitales que transmiten semánticas preestablecidas generadas por una oración fija. Por lo tanto, tiene sentido preguntar acerca de los estilos de comunicación. ¿Y en qué consiste la educación? Abogamos por una comunicación sintética fija y estandarizada, a la vez que pedimos el respeto de los valores tradicionales y culturales en las sociedades individuales. Hoy nos preguntamos por las metodologías de estudio y los modelos de referencia para la comunicación virtual. Las disciplinas de lingüística teórica, lingüística computacional, matemáticas, física cuántica, sociología, psicología, teorías pedagógicas, están incluidas en Ciencias Sociales y Medios Digitales. Este trabajo pretende presentar una progresión lógica inquebrantable que transita de la gramática normativa a la gramática formal y poner en práctica las características del texto poético, como la Divina Comedia de Dante Alighieri, a través de múltiples etapas.

**Palabras clave:** códigos digitales, modelos de comunicación, lingüística teórica, lingüística computacional, comunicación virtual.

## 1. Introduction

This work is included in the project "Literary and linguistic computing, digital and public humanities" in collaboration with IRIS lux in artibus scriptionibus, SIDELMED SPA, and the scientific collaboration of University of Salerno Dipsum dir. Rosa Maria Grillo and Nicoletta Gagliardi. This work also summarizes the efforts of researchers worldwide who provide their contributions in real-time through a continuous and fruitful reciprocal collaboration. Conducting research that is made up of comparisons, debates, individual studies, and collaboration among people who assume or share their language is almost a utopian concept, i.e., ethics, values, traditions, and cultures. The disciplinary field of origin is made possible by each researcher's specific contribution, which makes it possible to create an osmotic thought, as seen in the plurality of aspects such as linguistic L1 L2, i.e., computer, mathematical, physical, psychological, and pedagogical features to understand simultaneously and with common techniques, the production of a scientifically validated model. Accordingly, the research is supported by experts such as Max Silberztein at the Université de Franche-Comté. Michel Planat, Institut FEMTO-ST Besançon. Ali Hussein Hazem, University of Al-Hamdaniya. Karen Alkoby, Gallaudet University. Rosalee Wolfe, DePaul University, Chicago. Samuela Franceschini, University of Venice. Giulia Savarese, University of Salerno. Roberto Capone, University of Bari Aldo Moro. Ritamaria Bucciarelli, University of Venice. Francesco Terrone, University of Naples Federico II. FS Tortoriello, University of Salerno; Marianna Greco, MIUR. Raffaele Marcone, University of Salerno; Andrea Fernanda Rodrigo, Rosario National University. Ilaria Veronesi, University of Salerno. Javier Julian Enriquez, Polytechnic University of Valencia. Linguists have conducted over ten years of work to create the scientific collaboration with the University of Salerno in collaboration with other research centers and the Laboratory of Automatics and Linguistics (CNRS, Paris 7). The study of the Lexicon Grammar of the Italian Language (LGLI) was the starting point for the research studies. The theoretical reference model is represented by the grammar-based "on operators and arguments" (Harris, 1957, 1970). Mathematical language can provide a justification for the evolution of language through a long series of historical and cultural events. The basis of our approach is scientific, that is, it grounded on seeing natural languages as an object and describing them using a mathematical method in the same way as other sciences such as physics or biology would with their objects of study. (De Bueris and Langella, 2019).

Reference models have been taken as a guide to our research when describing the poetry of such a style- master of the craft as Dante Alighieri to then translate his verses into formal codes. For detecting linguistic mechanisms, we will use descriptive grammars (lexicon-grammar) and perform linguistic environment calculations and analysis to generate sentences in NooJ, a linguistic development environment created by Max Silberztein. Still, there are a series of prerequisites to be met to achieve the necessary results: thorough comprehension of the work, proficiency in rhetorical analysis techniques, morpho-syntactic stylistics, critical abilities, and evaluation of prosodic facts. In this context, the team shall proceed as follows:

Phase I: 1.1 Analysis of the poetic text (in compliance with the typology) to detect the most common rhetorical and metric figures in the traits under analysis. 1.2 Substitutional and distributional linguistic mechanisms, which are highlighted in the text and traits. 1.3 Study of the triplet case in Cantos XXXIII and XXIII from Paradiso and Canto VI from Inferno, with the production of statistical data.

Phase II: Study of formal mechanisms and validations in NooJ using distribution and transformational analysis, which are presented in graphs and included in Peco tables. 2.1. Scientific validation, quantum theories, and application of verses in highlighting emotional traits in the Fano Plane. 2.2. The implementation of digital intelligence W. Tool.

## 2. Phase a: stylistics between rhetoric and linguistics

*The style is comparable to the "enchanted castle" of Ariosto's memory, with a thousand rooms in which mock characters roam. The rhetoric has been and continues to be a "map" to travel within this ideal castle (Silvestri, 1996).*

The initial research, on one hand, points out certain fundamental concepts, such as rhetoric that generates fixed models and excludes the free, creative, and, above all, individual aspects of style; linguistics. On the other hand, it focuses on the detection of analytical facts in a linguistics that does not prescribe but is able to describe the phenomena of style in an exhaustive, coherent, and simple manner and can also attempt to circumscribe its essence.

Thus, it was decided to investigate rhetorical phenomena such as phonic style, which deals with the stylistic relevance of the sounds of literary language and specifically the poetic one. That is, phonic recursion with the technique of repetition and a series of phenomena attributable to rhythmic metrics. More evident syntactic mechanisms of the traits studied are the manipulations of the fixed verse and the characterizing of the dislocation of phenomena of locative deictic, verbal, and nominal ellipsis. The first section of the study is Canto XXIII from *Paradiso*. A great Russian linguist (Jakobson, 2009) recognizes in the two fundamental "figures" of rhetoric, metaphor, and similitude, two basic conditions of language. Since the metaphor appears with reference to the paradigmatic axis or similarity, similarity appears with reference to the syntagmatic axis or contiguity. We will, then, consider a case of similitude; see Canto XXIII from *Paradiso* v25–27 (Alighieri, 1979):

*In the serene full moons, Trivia laughs among the eternal nymphs, who paint the sky for all breasts. I saw above thousands of lamps a sun that all of them light up, as ours do the supernal views; similitude, which in the serene full moons metaphor (such) I saw over thousands of lamps.*

In the first sentence, a linguistic operation consisting of a similarity and, therefore, substitution is carried out. The phenomenon of phonic recursiveness is present in these verses in the repetition of homophonic consonants with a stylistic deviation from the normal language based on the recursiveness and the consequent pragmatically vectored sounds:

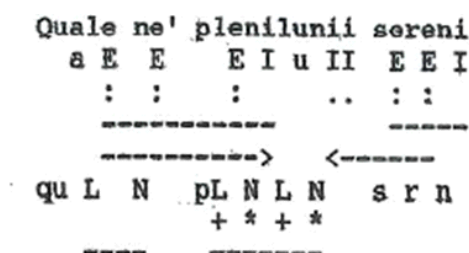


Fig. 1. Linguistic operation through similitude and substitution.

In this first verse, there is already a phenomenon of sequential vowels (seven out of eleven locations). From the point of view of the diaphragmatic place, there is an iteration of homotypic vowels (EEE, IIEE). The same vowels are involved in a pervasive parallelism (EEE... EEI) and in an even stronger specularity (EEEI.IIEE), realized in a phenomenon of sequential dominance of strong evocative power. The sequential consonant is evident in the iteration (LNLN), strengthened by the homophonic parallelism LNLNLN with an evident anagrammatic effect (LuNa), which is a reminder of the star, not mentioned but evoked in the verse. Comparative analysis of vowel sequential aspects in *Horatius Flaccus (Horace), De Arte Poetica*, (Flaccus et al., 1989) *hoc amet, hoc spernat promissi carminis auctor. In verbis etiam tenuis cautusque serendis, dixeris, egregie, notum si callida verbum reddiderit iunctura novum. Si forte necesse est indicais monstrare recentibus abdita rerum.* The phonic recursion and the linguistic manipulation of traits are analyzed in St. Bernard's prayer to the Virgin in Canto XXXIII from *Paradiso* ((Alighieri, 1979, pp. 19–21): *In te misericordia, in te pietate, in te magnificenza, in te s'aduna.* There is also phonetic sequencing, with the phenomenon of recursion, of sequential figures, etc. Again, in Canto III from *Inferno* VI-III (Alighieri, 1979), *for me, you go into the sorrowful city; for me, you go into eternal pain; for me, you go among the lost people.* Dante Alighieri, as a master of style, has well-conceived these triplets, which today are the emblem of Christianity. Finally, we include the simile that contains phonetic mechanisms and, at the same time, has fixed elements in the sentence. Phonetic sequencing serves to create an evocation because it is an artifice of sounds. The same effects exist.

*The phonetic sequencing mechanism is already present in the endothetic joints of the Divine Comedy. The three "cantiches" (Inferno, Purgatorio, and Paradiso) are made up of an equal number of "songs" (33 x 3 = 99).*

For this reason, they are sequenced according to a simple trimester iteration with homophonic effects. The syntactic mechanisms highlighted in the traits are *in te (s'aduna)* with dislocation of the verbal operator. However, the most evident phenomenon is the substitutive pronominal manipulation present in the tercets:

*in your mercy, in your pity, in your magnificence, in you it gathers, and again, for me, you go to the sorrowful city, for me, you go into eternal pain, and for me, you go among the lost people.*

The locative function represents the semantic description of praise to the Virgin in Canto XXIII (Paradiso) and Canto III (Inferno) (Alighieri, 1979), a sense of perplexity for the passage in a place of punishment.

*For Dante, the numerology in the Divine Comedy makes sense. The relationship between numerology, the non-random choice of the recurrence of certain numbers, and the Divine Comedy is evident throughout the work, both structurally and narratively. It is the origin of all things; it represents perfection and absolute divinity. Symbol of monotheism, it is an expression of fullness of God the Creator... refers to the Christian Trinity, to perfection and knowledge.*

This phase ends with an elementary calculation to detect the percentages present of the phenomena mentioned above as among the most important phonic sequencing mechanisms validated in the numerical value that the poet observes. The most evident is the value of the number "3" with specific semantics, that is, the canticles, the verses in the triplets, and the deontology of Christian values such as faith, hopes, and charity. The most convincing hypothesis is the observation about the mean of the verses. However, as is often the case with justifications of standard deviations with respect to the number of verses and in the scansion of a precession of the equinoxes, a paradigm for the structure of the poem can be derived from the data presented in Table 1:

**Table 1.** Mean of verses and number of tercets

Title	Mean of verses	Numbers of triplets
Inferno	138,9090909	46
Purgatorio	144,0909091	48
Paradiso	144,1818182	48

$$\sigma = \sqrt{\frac{(x_1 - M)^2 + (x_2 - M)^2 + \dots + (x_n - M)^2}{n}}$$

$$\sigma = \sqrt{\{[(x_1 - M)^2 + (x_2 - M)^2 + \dots + (x_n - M)^2]/n\}}$$

With a standard average: Hell: 9.735; Purgatory 6,934; Paradiso 5,422

### 3. Lexical-algebraic grammar in NooJ environment

To proceed with validation in a linguistic environment or the formal coding of a new formal grammar and dictionary and implement co-occurrence texts, we will move on to the realization of

transformational and distributional analysis of the sentences examined in the chosen traits with a local grammar and an electronic dictionary using NooJ.

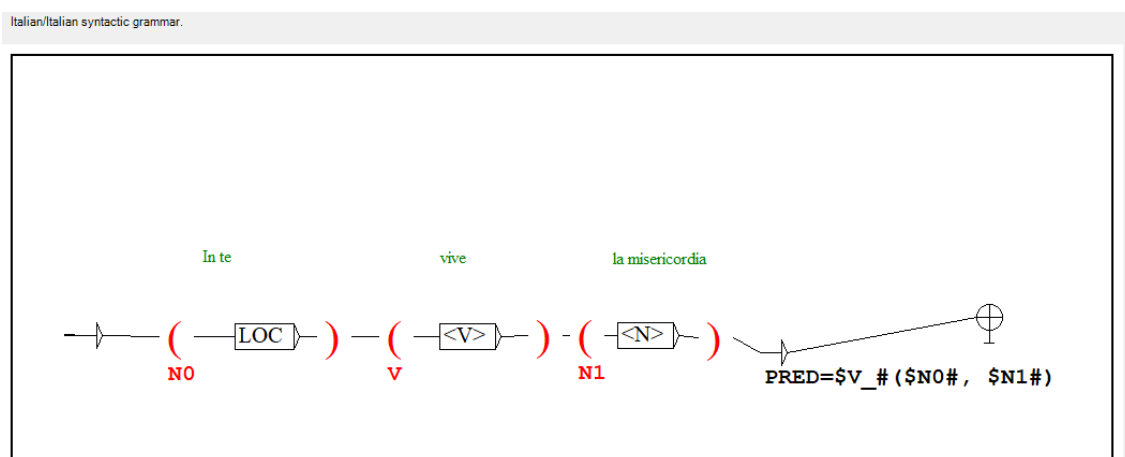
NooJ is a linguistic development software which allows linguists to formalize various types of linguistic description: spelling, lexicons for single words, multi-word units, frozen, inflectional, derivational expressions, morphology, local, structural, and transformational syntax. NooJ was developed by Max Silberztein, and is the evolution of Intex (Silberztein, 1993, 1999) on which Dr. Silberztein worked over the decade 1992–2002 under the guidance of Maurice Gross at LADL (1975) Why we are using NooJ? We took the words of Silberztein (2016):

*There are many potential applications of descriptive linguistics for NLP; spell checkers, intelligent search engines, information extractors and annotators, automatic summary producers, automatic translators, etc. These applications have the potential for considerable economic usefulness, and it is therefore important for linguists to make use of these technologies and to be able to contribute to them<sup>1</sup>.*

One key feature about NooJ is that all linguistic descriptions are reversible, i.e., both a parser (to recognize sentences) and a generator (to produce sentences) can use them. In this manner, we can show and build, by combining a parser and a generator and applying them to syntactic grammar, a system that takes a sentence as input and produces all the sentences that share the same lexical material as the original sentence (Silberztein, 2016).

We take the sentence: *La misericordia vive in te* (Mercy lives in you). In the grammar, we can see two nominal syntagms at the ends of the sentence and the verb in the middle. To differentiate between them, they are numbered differently, namely <N0> and <N1>, by establishing at the end of the syntactic chain, the rules of concordance. The <N1> allows to identify the locative.

See Fig. 2:



**Fig. 2.** Minimum sentence Fs = N0 VN1

The second one can be implemented in NooJ via the following grammar. In Fig. 3 we have a change of order with respect to Fig. 2, the is now the locative and the the subject nucleus. Again at the end of the chain we have the matching rules. See Fig. 3

<sup>1</sup> Silberztein (2016), p. 1

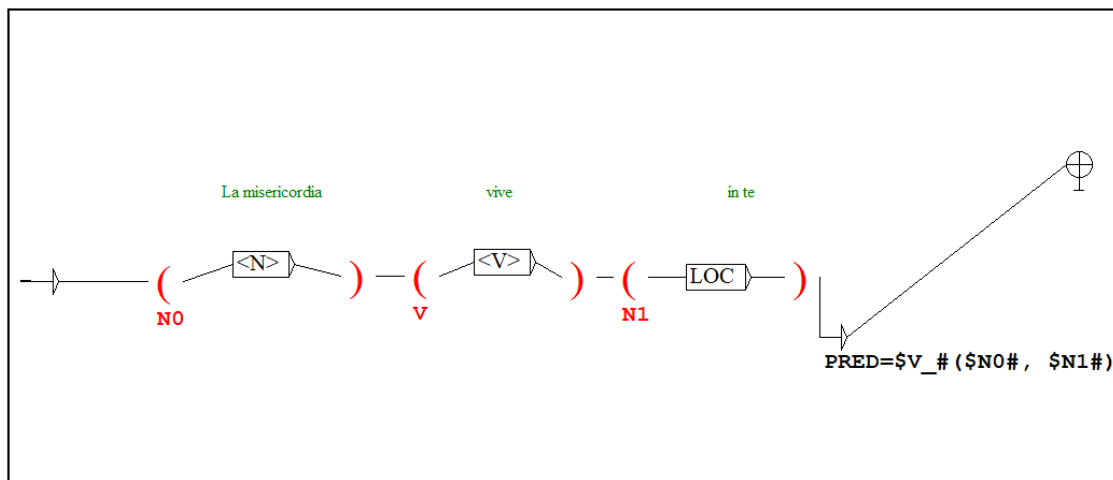


Fig. 3. Processed sentence LOC V N0

This graph uses three variables: \$NO, \$V, and \$N1. When parsing the sentence: *Mercy lives in you*, the variable \$NO stores the word *Mercy*, and \$V stores *live*. \$N1 stores *in you*. The output of the grammar "\$N1 is \$V\_V+PP of \$NO" produces the string *Mercy lives in you*. Note that morphological operations such as "\$V\_V+PP" operate on Atomic NooJ's Linguistic Units (ALUs) rather than simple strings; in other words, NooJ knows that the word form is an instance of the verb *vive* and can produce all word forms conjugated and derived from this ALU (such as *living*). Here, \$V\_V+PP takes the value of the variable \$V (*ama*), lemmatizes it (*lives*), produces all its verb forms, and selects those that have +PP properties. The transformational and distributional analyses of the minimal phrase of the chosen triplet have a fixed formal code and represent a minimal unit.

#### 4. Quantum and linguistic contextuality: a description

A finite projective plane of order  $n$  is formally defined as a set of  $n^2 + n + 1$  points with the properties that:

- any two [points](#) determine a [line](#);
- any two [lines](#) determine a [point](#);
- every point has [lines](#) on it, and
- every line contains points;
- every line in the plane has at most three points;
- each point on the plane has a maximum of three lines.

In doing so, this process may result in the establishment of a quantum contextual relationship. We report an integral, according to Planat (2016):

*What is it that we humans depend on? We depend on our words. Our task is to communicate our experiences and ideas to others. We must strive continually to extend the scope of our description, but in such a way that our messages do not thereby lose their objective or unambiguous character. We are suspended in language in such a way that we cannot say what is up and what is down. The word "reality" is also a word, a word that we must learn to use correctly. The two-dimensional finite [projective plane](#) over ("of order two") is illustrated above. It is a [block design](#) with the [Steiner triple system](#) and the unique [configuration](#). The [incidence graph](#) of the Fano plane is the [Heawood graph](#). A projective plane, sometimes called a [twisted sphere](#) (Henle, 1994) is a surface without boundary derived from a usual [plane](#) by the addition of a [line at infinity](#). Just as a straight line in projective geometry contains a single [point at infinity](#) at which the endpoints meet, a plane in projective geometry contains a single [line at infinity](#) at which the edges of the [plane](#) meet. A projective plane can be constructed by gluing both pairs of opposite*

edges of a [rectangle](#) together, giving both pairs a half-twist. It is a one-sided surface but cannot be realized in three-dimensional space without crossing itself.


Starting from De Bueriis' concept (2019) that sentences are syntagma, we aim to transfer the quantitative to the linguistic context. Through a complete study of graph theory, parts of sentences can be converted back to graphs, and the finite geometry of the commutation relations among the operators of Pauli can be generalized from N-qud. Then, we will identify them in the Dante Alighieri's Divine Comedy. After having identified them in Cantos XXXIII v. 18–21 from Paradise and in the tercet of Canto III from Inferno 1-3, we will have in the group a relation of equivalence for the sake of composition associative property, closure, identity, and reverse. Our reformulation will involve dividing the core sentence elements into categories of general operators and compositions that define sentences. Thus, Canto XXXIII from Paradiso will feature these elements based on its lexical-grammatical coding:

- 1) *In te misericordia, Loc N0 in te pietate;*
- 2) *Loc N0 in te magnificenza;*
- 3) *Loc N0 in te s'aduna (quantunque in creatura) è di bontate Loc V (det loc) V 1 N: Divina Commedia Inferno's Canto III; Divina Commedia Inferno's Canto III: 'Per me si va né la città dolente: Deit V Loc N1; 6: per me si va ne l'eterno dolore Deit V Loc N1*
- 7) *Per me, si va tra la perduta gente Deit V Loc N1.*

To submit to composition techniques as per closure: se  $g_1 \in G$  e also  $m(g_1, g_2) \in G$ , we will have in the linguistic technique of repetition that: If  $g_1 = g_2$ , also in Loc N0; Loc N0 also  $m(g_1, g_2) \in G$  or Loc N0:

*Associative:  $m(g_1, m(g_2, g_3)) = m(m(g_1, g_2), g_3)$  we'll have  $m \text{ Deit } (V) \text{ Loc N0 } (g_1, m(g_2, g_3))$   
 $\text{Deit } (V) \text{ Loc N} = m \text{ Deit } (V) \text{ Loc N } (m(g_1, g_2) \text{ Deit } (V) \text{ Loc N}, g_3 \text{ Deit } (V) \text{ Loc N}).$*

The song tercet of Canto XXXIII from Paradiso has been based solely on composition and uniqueness, but the elements of identity and inverse are also present. Furthermore, the laws of linguistic transformation, including substitutional and positional syntagmatic manipulations, can be applied, as we have mentioned in the target verses. As a result, the pronominal and elliptical technique of the nuclear operator has a significant locative presence. Therefore, we are pleased to learn that Dante Alighieri instructs us to focus on the emotional element of the verse, represented by the deictic element, and in the composition, we will have similarly:

Inversion: *Mercy in you: Deit N 0      N o deit      *  
Substitute handling:  $N_1(\text{loc}) N_0$

To transfer to the graph (Planat *et al.*, 2006) in which the author states that the paradigm of quantum contextuality can be formulated in terms of properties and thus of a graph, we can, of course, in the target verses:

*Before we want to introduce a simple geometric model that has the smallest project plan for purposes (PG (3,2): the Fano plane), it is best identified in a text as 1) the points, 2) the lines. One line corresponds to at least three points possessing one property common. There are many ways to explain that this is a common property. Please try to define what is in a phrase. In quantitative physics, the points are the operators and the points of a mutually commutator line. Also, for the line (a, b, c), on a  $[a, b] = [a, c] = [b, c]$  or  $[.,.]$  is the switching (of group) of the operators (the points a, b, or c) et  $[a, b] = b^{(-1)} * a^{(-1)} * b * a$ ,  $a^{(-1)}$  is the inverse of a. One line is one context. To make the analogy between a triplet of points and a codon (in biology), a codon code for a protein, the codons are not ambiguous, nor can they be remembered if they are ever degenerated: more codons can be coded for the same protein.*

Paradiso Canto XXXIII verses for the constant alliterative presence of homophonous sounds or for phonic repetition and pronominal manipulations at the beginning of sentences 3/3:

Inferno Canto III verses 1-3: for the constant alliterative presence of homophonous sounds or for the phonic recursion and for the pronominal manipulations at the beginning of sentence 3/3,

The nodes are the triplets of Canto XXXIII from Paradiso, which are 4; III Inferno, v. 1-3; therefore, there are seven nodes.

Suppose that the plane is made up of seven points. In our case, there are seven sentences, and the tercets are three sentences characterized by alliterative homophony and dislocation pronominal manipulation. Each straight line is a triple of three points, and the possibility of an oppositional tonal match is one in three.

In line with the above, these approaches based on the Fano Plane show Dante's emotional calculation in his **tercets** of the Divine Comedy, which connect both quantum and linguistic contextuality. As shown in this finite project plane (the Fano plane), we can identify in a text 1) the points and 2) the lines. A line corresponds to at least three points having a common property. Subsequently, if we would like to define what it is in a sentence, we would have to explain what a common property is. Let us see that in quantum physics, points are operators, and the points of a line switch each other. As a result, A line is a context:

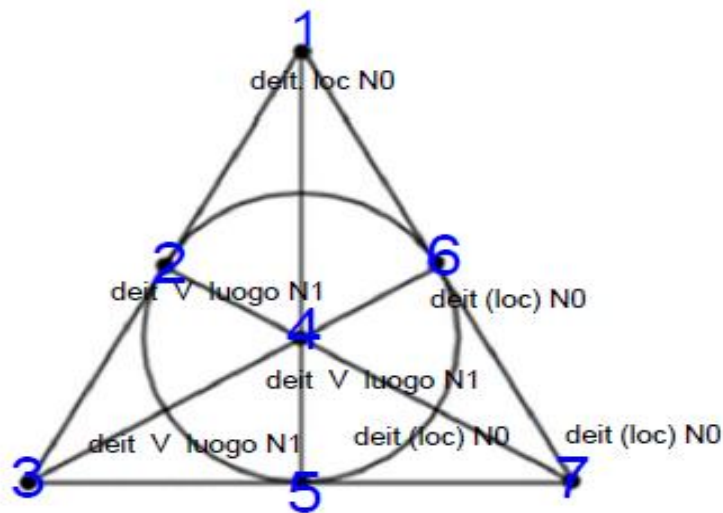


Fig. 4. Emotional calculation in Dante's triplets XXXIII and Canto III based on the Fano Plane

In the line where the points are = 3-4-6, the tone is a dominant negative emotion 2 = deit V place N1

In line 1-6-7 there is a positive explosion of joy = deit loc N0

In the line where the points are 3-4-6, the tone is a dominant negative emotion. 2 = deit V place N1

In lines 1-6, there is a positive explosion of joy = deit loc N0.

In this sense, as Weisstein (2007) points out, the two-dimensional finite projective plane over  $GF(2)$  ("of order two"), illustrated above. As stated by this author, then, it is a block design with  $v=7$ ,  $k=3$ ,  $\lambda=1$ ,  $r=3$ , and  $b=7$ , the Steiner triple system  $S(7)$ , and the unique  $7_3$  configuration, the incidence graph of the Fano plane is the Heawood graph, and the connectivity of the Fano plane corresponds to the order-2 two-dimensional Apollonian network. In the same way, Planat and Saniga (2007) state that the Fano Plane belongs to a large family of *projective configurations*, which consist of a finite set of points and a finite set of lines such that each point is incident with the same number of lines and each line is incident with the same number of points. In a more detailed way, they point out (2007: 3) that:

*Such a configuration may be denoted  $(v_a, e_b)$ , where  $v$  stands for the number of points,  $e$  for the number of lines,  $a$  is the number of lines per point and  $b$  the number of points per line. If the number of points equals the number of lines one simply denotes a configuration as  $(v_a)$ , although it is not, in general, unique. A configuration is said to be self-dual if its axioms remain the same by interchanging the role of points and lines. The Fano plane is a configuration  $(7_3)$ .*



Therefore, Planat's methodology provides us with an insight into the interpretation and pragmatic review of the literature in this area of study, so that we will be able to offer further explanation and context following the Fano Plane Dante's emotional calculation in his triplets of the Divine Comedy, as well as NooJ transformational and distributional analysis.

Proceeding in the exposed sense, we notice that in order to establish a connection between the contextual clues of quantum and linguistic meaning, it is necessary to identify the points and lines in a text. This is to be done before introducing a simple geometric model as the smallest finite projective plane (PG (3, 2)). A line is defined as a set of points that share a common property. If we were to examine the rhetoric and style of the three songs of the Divine Comedy, such as Hell, Purgatory, and Paradise, to gain insight into the Dantesque poem, it could be argued that the text metaphorically represents a journey of redemption. Therefore, the author uses two techniques to describe emotionality: the symbolism of the number "3" and the phonological technique, which are evident in Dante's triplets. Similarly, Planat *et al.* (2020) identify two subgroups of index 15 and 28 of  $\pi_1(\partial W)$   $\pi_1(\partial W)$  that connect to the three-dimensional projective space  $PG(3,2)$   $PG(3,2)$  and to the Grassmannian  $Gr(2,8)$   $(2,8)$ , respectively. As stated by these authors, the former finite geometry is pertinent to the two-qubit model of quantum computing, while the latter geometry is linked to Cayley–Dickson algebras, which have been previously used in particle physics:

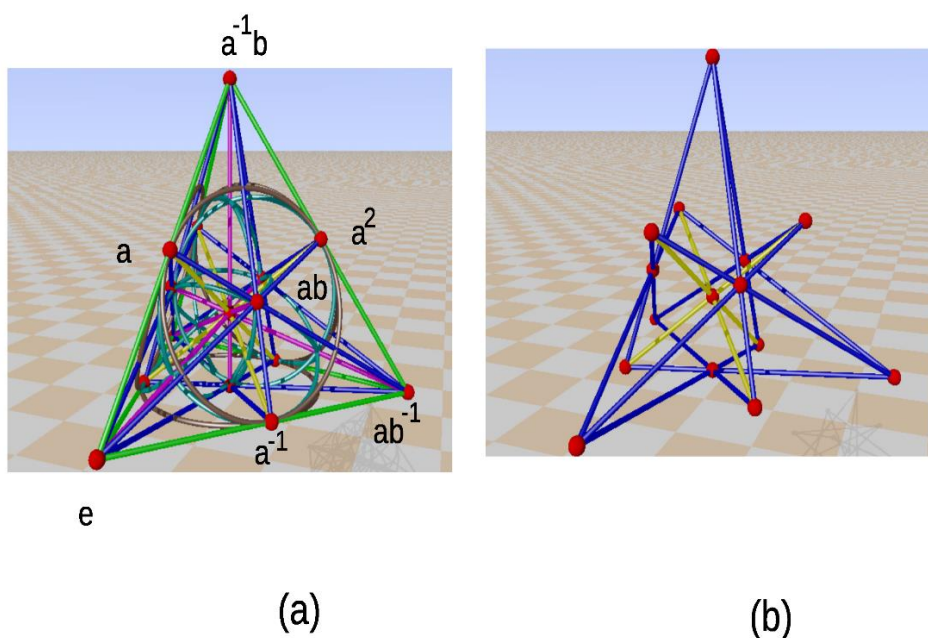


Fig. 5. Picture of the smallest finite projective space PG (3, 2)

## 5. Linguistic environment and digital intelligence WT (©2020 BIVUTEGMS)

DIGITAL INTELLIGENCE WT (2020) BiVuTeGMS's linguistic environment requires an 'excellent' human mind to control and guide the domain during the first phase, i.e. data production, and in the second phase for textual editing.

The archiving process is followed by a blended domain composed of databases: -1 taxonomies of sentences, parts of sentences, phrases, or parts of phrases, reconverted into acronyms that have undergone validations such as: analysis and detection of linguistic mechanisms (manipulations of substitutions, permutations, syntagmatic and phonological calculation, production calculation of the average of the chosen sentences. 1.2 NooJ uses graph theory techniques and tools to reconvert parts of sentences or phrases into graphs in a linguistic

environment (<sup>2</sup>parallel production of the presence of the same phenomenon with two justifications for linguistic and mathematical fields). The ultimate reduction in terms of acronyms or the consequence of fixed sentences.

An editorial sheet, reformulation, reconversion of sentences, or textual parts are how the digital archive is supported. The data or sentences follow the archiving process to describe the formal process: -1) data collection (sentences) and calculation of linguistic mechanisms and average calculation- reductions into categories (LGLI) production of formal codes in NooJ<sup>3</sup>, as well as transformational and distributional analysis of selected traits in high-computational environments and scientific validation. Reductions of sentences into acronyms. The central part of the software consists of a digital sheet in which operator writes, translates, reconverts using acronyms (i.e. phrases fixed) and phrases free which, produces, when necessary, the operator digitally. Editor text is named after its similarity to sheet paper (also, goodbye dear rag). It can create typologies of different and dependent texts depending on its skills and human resources. Giving digital intelligence human excellence is more important, which is why the functions are: the outline of a text that has sentences that are free of paraphrases; translation and reformulation from one language to another L 1 L 2 L 3, including iconic languages. See Figure 6:

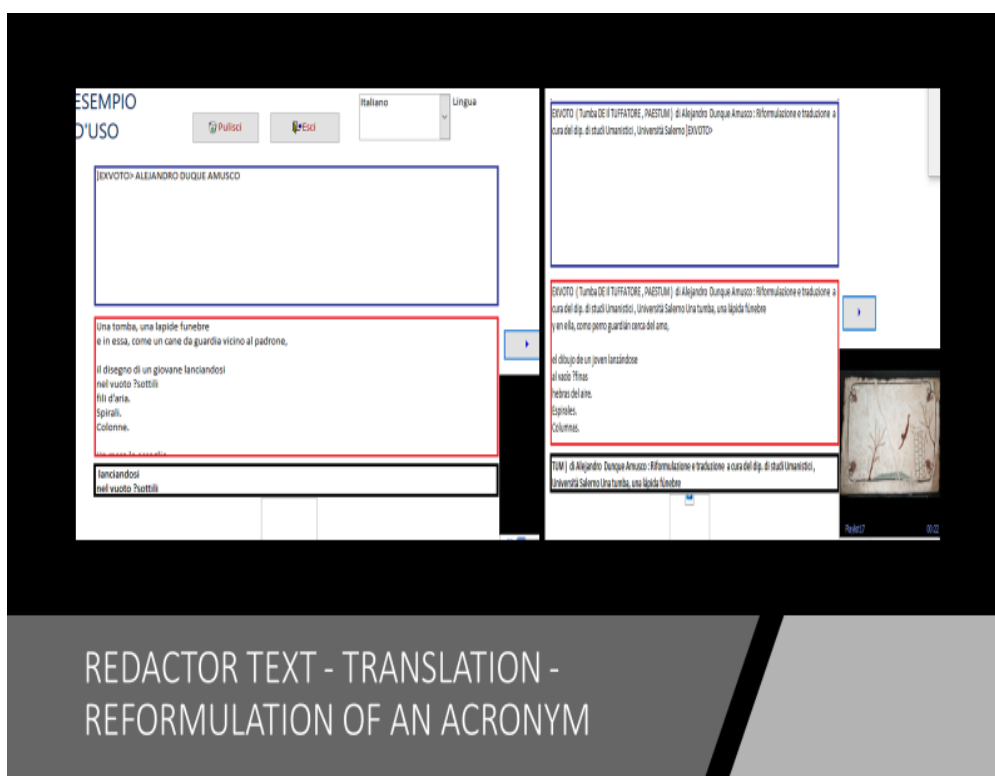


Fig. 6. Reformulation of an acronym

In summary, Digital Intelligence W.T. is a redactor text, which that performs the functions of a reformulator, translator, converter, and database. It consists of a multilingual database and a writing sheet. The model is comprised of three different components: 1) a scientific analysis and identification of the rhetorical style of the speaker through phonological calculations, which are then combined with NooJ's descriptive linguistic techniques (lexicon-grammar); 2) a scientific description of the transformational and substitutive manipulations of a sentence; and 3) a probabilistic computation of a sentence on the NooJ model in linguistic environments.

<sup>2</sup> Many texts on graph theory can be consulted, both at an advanced and introductory level: among the latter we highlight at least Chartrand & Zhang (2012), Voloshin (2009) and Wilson (1972, 1996).

<sup>3</sup> NooJ is a linguistic environment, i.e. a high-computation linguistic Web.

## 6. Conclusion

The research is the resulting product from studies on the scientific models used in Planat's studies, as stated in the linguistic context. Regarding graph theory, we draw on Bueriis and Langella. As demonstrated by Silberztein's research, one of NooJ's functions can be employed to elucidate the grammatical equivalence between transformed sentences, utilizing the NooJ model. For example, we would have many sentences constructed in the same equivalence class from *Joe loves Lea*. To NooJ, the two phrases *Joe loves Lea* and *Joe does not love Lea* are interchangeable. It is evident that both contain the same semantic material, even if one is positive and the other is negative.

Likewise, the goal of our team has been to describe a scientific model that analyzes sentences, detects their linguistic mechanisms, deepens their syntactic analysis, transformational analysis, and then formalizes their certainties in a text constructor. In other words, the approach follows the models of the masters of rhetoric and style of the classical world, the techniques of linguistic processes typical of generative grammars, and above all, the NooJ Lexicon-Grammar. The model is irrefutable and explains the linguistic mechanisms related to a minimum sentence, nuclear and extra-nuclear operators, and describes their effects. It includes NooJ syntactic analysis, transformational analysis, and transformational grammar. M. Silberztein serves as a tool for the validation of descriptions and the formulation of hypotheses regarding the text constructor. NooJ morphological grammars can be employed not only to identify, analyze, and describe words but also to generate dictionary style lists. Thus, a simple initial elementary sentence, such as *Joe loves Lea*, can be transformed into one million declarative sentences, thereby validating the reliability of NooJ dictionaries<sup>4</sup>.

We can therefore describe a process that begins with the poetic text and progresses to the grammar of formal languages. This is the first point. The second point concerns the construction of databases that are the product of increasingly sophisticated graphical supercomputations, which are becoming increasingly like Artificial Intelligence.

The work aims to provide a challenge to physicists, linguists, and philosophers to help us move forward.

## References

- Alighieri, D., Binyon, L., & Rossetti, D. G. (1979). *The divine comedy* (p. 624). London: Folio Society.
- De Bueriis, G., & Langella, A. M. (2019). Algebraic Lexicon Grammar. *Rhesis: International Journal of Linguistics, Philology and Literature*, 11(3), 21-42.
- Flaccus, Quintus Horatius, Roland H. Mayer, and Wyatt Horace. (1989). *De arte poetica*. Vol. 2. Cambridge University Press.
- Gross, M. (1975). "Méthodes en syntaxe, Paris, Hermann."
- Harris, Z. S. (1957). Co-occurrence and transformation in linguistic structure. *Language*, 33(3), 283-340.
- Harris, Z. S., & Harris, Z. S. (1970). *Morpheme alternants in linguistic analysis* (pp. 78-90). Springer Netherlands.
- Henle, M. A. (1994). *Combinatorial Introduction to Topology*. New York: Dover, pp. 110-111.
- Jakobson, R. (2009). "The metaphoric and metonymic poles. *Metaphor and metonymy in comparison and contrast*. De Gruyter Mouton. 41-48.
- Planat, Michel, and Metod Saniga. (2007). "On the Pauli graphs of N-qudits." *arXiv preprint quant-ph/0701211*. Online: <https://arxiv.org/pdf/quant-ph/0701211.pdf>.
- Planat, M. (2016). Two-letter words and a fundamental homomorphism ruling geometric contextuality. *arXiv preprint arXiv:1605.07118*. Online: [Two-letter words and a fundamental homomorphism ruling geometric contextuality \(researchgate.net\)](https://www.researchgate.net/publication/308111118).

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<sup>4</sup> See Appendix

Planat, M., Aschheim, R., Amaral, M. M., & Irwin, K. (2020). Quantum computation and measurements from an exotic space-time R 4. *Symmetry*, 12(5), 736. Online: <https://www.mdpi.com/2073-8994/12/5/736>.

Planat, M., Saniga, M., & Kibler, M. R. (2006). Quantum entanglement and projective ring geometry. *SIGMA. Symmetry, Integrability and Geometry: Methods and Applications*, 2, 066.

Silberztein, M. (1993). *Dictionnaires électroniques et analyse automatique de textes: le système INTEX*. Masson.

Silberztein, M. (1999). "Text indexation with INTEX." *Computers and the Humanities* 33.3 (1999): 265-280.

Silberztein, M. (2016). *Formalizing natural languages: The NooJ approach*. John Wiley & Sons.

Silvestri, D. (1996). Analisi linguistica della poesia, in *Analisi linguistica della poesia e fenomenologia della traduzione poetica*. 1. La ricorsività vocalica, a cura di Domenico Silvestri e Clara Montella, Napoli, Arte tipografica: 7-28.

Weisstein, Eric W. "Fano Plane." From *MathWorld*--A Wolfram Web, (2007). Online: <https://mathworld.wolfram.com/FanoPlane.html>.

## Resources on internet

-Dante e la numerologia nella Divina Commedia:

<http://www.tuttomondone.it/numerologia-divina-commedia/>

## Appendix

### Repetitions of verses in the Divine Comedy

Text	Before	Seq.	After
	men paia il mal futuro	e	'l fatto, veggio in Alagna
	in Alagna intrar lo fiordaliso,	e	nel vicario suo Cristo esser
	deriso; veggio rinovellar l'aceto	e	'l fiele, e tra vivi
	l'aceto e 'l fiele,	e	tra vivi ladroni esser anciso
	'è Terrenzio nostro antico, Cecilio	e	Plauto e Varro, se lo
	nostro antico, Cecilio e Plauto	e	Varro, se lo sai: dimmi
	sai: dimmi se son dannati,	e	in qual vico' Paradiso, Canto
	se si conosce, il cinque	e	'l sei; e però ch
	il cinque e 'l sei;	e	però ch'io mi sia
	però ch'io mi sia	e	perch'io paia più gaudioso
	'l vero; ché i minori	e	' grandi di questa vita miran
	al padre, ché 'l tempo	e	la dote non fuggien quinci
	la dote non fuggien quinci	e	quindi la misura. Non avea
XIX (versi 76-78) Muore non battezzato	e		senza fede: ov'è questa
'assetta, che fa lo Scotto	e		l'Inghilese folle, sì che
sua meta. Vedrassi la lussuria	e		'l viver molle di quel
molle di quel di Spagna	e		di quel di Boemme, che
un emme. Vedrassi l'avarizia	e		la viltate di quei che
Anchise fini la lunga etate;	e		a dare ad intender quanto
noteranno molto in parvo loco.	E		parranno a ciascun l'opere
l'opere sozze del barba	e		del fratel, che tanto egregia
fratel, che tanto egregia nazione	e		due corone han fatte bozze
due corone han fatte bozze.	E		quel di Portogallo e di
bozze. E quel di Portogallo	e		di Norvegia li si conosceranno
di Norvegia li si conosceranno,	e		quel di Rascia che male
rivolgon sé onde son mosse,	e		altre roteando fan soggiorno; Paradiso