Atticism: The Language of 5th-century Oratory or a Quantifiable Stylistic Phenomenon?

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Abstract: This paper comparatively explores Atticism as it first appeared in fifth-century Greek oratory and was later revived by Imperial Greek authors. Using Dionysius of Halicarnassus and his appreciations of oratory and orators as a frame of reference and then expanding his inferences on works of Imperial era, I attempt to parameterize Atticism as a phenomenon. Ultimately this study will apprise us of the usage of Atticism in Imperial Roman oratory as well, as it then becomes obvious that Atticism has transcended the boundaries of language and has transformed into a constructional rhetorical system. This paper employs a unified node-based metric formulation for implementing various syntactical construction metrics, indicative of the syntactical attributes of the sentences. The developed metrics were applied to annotated texts of six authors, which were then comparatively examined using Principal Component Analysis.

Keywords: Attic oratory, computational linguistics, treebanks, node-based metrics, Principal Component Analysis

1 Introduction

5th- and 4th-century BCE orators, Lysias, Isocrates, Demosthenes, are the par excellence representatives of Attic oratory and paragons of Atticism due to their proper usage of Attic forms and expressions. Asiatic oratory ensues along with a general decadence in rhetorical productions that has been credited to the influx of eastern elements until Atticism is revived in Imperial times. Dionysius of Halicarnassus, the 1st-century BCE teacher of rhetoric, attributes this literary upward shift to the Romans - either that means a re-appreciation of Greek eloquence or implies a political vindictiveness that expresses itself through language and literature on behalf of the Roman subjects against their rulers. The fact remains, though, that there is an overwhelming production of grammar books and lexica focusing on Atticism, all the while determining Greekness as well. Additionally, Cicero and Quintilian express their esteem of Atticism and instruct Roman orators on how to achieve it. This acknowledgment alone is enough to put forward not only an issue of political standing of Greek language and literature, but also to contend that Atticism filtered through centuries and literary genres was modulated into a stylistic construction that transcends language. Cleanness of expressions, comprehensiveness, cohesiveness and other structural attributes alongside linguistic appropriateness in the language that is used in each case bear the tag of “Atticism.” In this paper, my intention is to parameterize Atticism, attempting to determine attributive characteristics of
Lysias, Isocrates, and Demosthenes that have also been pinpointed by Dionysius of Halicarnassus in his treatises on the orators. Additionally, Imperial orators - Lucian, Dio Chrysostom, and Aelius Aristides - will be examined so as to determine whether their style is traditionally Attic or it is simply the usage of Attic dialect that has led modern scholars to the conclusion that Imperial orators revived Atticism. Computational linguistics, stylometry, and network analysis have been employed in several cases to pursue linguistic and stylistic studies as well as author attribution. Passarotti et al. (2013) perform a lexical-based comparative examination between Seneca, Cicero and Aquinas, employing Principal Component Analysis (PCA). Eder et al. (2013) and Burrows (2002, 2006) used stylometry to achieve a multilevel analysis of texts. The critical difference with the present study, though, is that stylometry does not account for syntactical characteristics and constructions. Ferrer I Cancho et al. (2004, 2010) and Passarotti (2014) used network theory to study linguistic constructions. Bamman et al. (2008, 2009), Passarotti (2010) and Mambrini et al. (2012, 2013) examine issues in Latin and Ancient Greek dependency respectively. For detailed bibliographical references on similar studies, see also Bozia (2015). In this study I utilize node-based metrics to parameterize Attic constructions.

Section 1.1 furnishes a theoretical presentation of Attic dialect, its appearance as linguistic choice and its subsequent appropriation of both linguistic and political preponderance. Section 1.2 then proceeds to discuss the Imperial revival of Atticism as presented by Dionysius of Halicarnassus in his treatises on oratory and the orators, determining whether there are syntactical attributes that could qualify an orator as Attic that can be discerned in both classical Attic orators and their Imperial descendants. Section 2 presents the methods developed for the quantification of rhetorical style. Epideictic speeches of six orators were syntactically annotated and then node-based metrics were developed in order to analyze the style of each author. Section 3 discusses the logic behind the developed metrics, the way they work as numerical descriptors of the sentences and the significance of the acquired results.

1.1 Atticism: one of the Hellenic dialects or a symbol of Greekness?

Close study of the works of lexicographers and grammarians reveal a number of unexpected constituents regarding Atticism. Atticism was perceived as the Attic way of expression alongside the Aeolic, Doric, and Ionic dialects. Diomedes, the grammarian, states that there are five languages of Greek - Ionic, Doric, Attic, Aeolic, and Koine. (G.L. 1.440\textsuperscript{1})

Hence, contrary to the minute paradigms and extensive discussions of barbarism and solecism (linguistic, pronunciation, and syntactical infelicities that on occasion are attributed to dialectical deficiencies), Diomedes perceives the dialects as derivatives of the same language.

In a fragment of Posidippus, there is a blatant contradistinction between Atticism and Hellenism in favor of the latter. The author strongly criticizes a user of Atticism as pretentious and too ornate. The point is rather interesting especially if we consider that the same oppositional thesis rose between Atticism and Asianism.

Even though there is one Hellas, there are, however, many cities.

You, on the one hand, Atticize whenever you speak such utterances of yours in this language. We, the Greeks, Hellenize. Why you occupy yourself with syllables and letters and drag liveliness to odiousness? (Posidipp. 28)

In the Scholia ad Aristophanem 1A De Comoedia, Hellenism and Atticism are juxtaposed. The distinctions listed are ten — analogy, etymology, figures, formation of nouns, allegory, numbers, genders, breathings, tenses, and accents.

One needs to pinpoint that there is no evaluation of Hellenism and Atticism, or any remark regarding their respective potency or refinement. However, it should be noted that the differences being mentioned, such as differences in the gender of words, resemble the characteristics of barbarisms and solecisms. Would that indicate that initially the evolution from the classical, typical

\textsuperscript{1} Grammatici Latini
Greek to Attic entailed alterations to the degree of language debasement or in the case of Atticism over refinement? Therefore, it is interesting to consider that up to a point attikizein was appreciated as differing from hellenizein. That realization prompts us to ponder on the gradual validation of Atticism as representative of Greekness.

It seems that progressively Atticism, the most popular of the dialects, assumes an even more independent role that especially during the Imperial era transcends the boundaries of linguistic usage. Paramount literary works are written in Attic dialect, and Attica is the geographical area that through its history embodies Hellenism. Swain (1996) and Whitmarsh (2001) among others discuss Imperial Attic authors and Atticism in the Second Sophistic. Therefore, it is only reasonable that during the Empire Atticism becomes the flagship promontory against Romans and Romanness, as Bowie (1970) suggests. Furthermore, the appearance of Asianism, albeit succinct, needed a counterpart, and Atticism had literary creations in its record that provided a balanced, and structurally formulated style to which authors could resort. For discussions on Atticism and Asianism, see: (Rohde 1886), (Schmidt 1887), (Radermacher 1899), (Wilamowitz 1900), (Norden 1915) and (Dihle 1977). (Goudriaan 1989), (Gelzer 1979) and (Wisse 1995) also provide us with comprehensive overviews of the debates along with elucidating parameterization of classicism and Atticism. There have also been comparative stylistic considerations of Atticism and Asianism, attempting to consider the linguistic aspects of those movements. De Jonge (2008) succinctly summarizes the debates against the backdrop of Dionysius of Halicarnassus. Another significant turn in Atticism’s history is its modulation into a writing style beyond language. Cicero in Brutus and De Oratore (Brut. 27ff; 284-285; De or. 3.28) and Quintilian in Institutio Oratoria (Inst.10.1.76-80; 12.10.21-24) among others espouse Atticism, theorize upon its construction, characteristics and merits and wish to teach it for the benefit of Roman oratory. O’Sullivan (1997) discusses Caecilius’, Cicero’s, Quintilian’s, and Dio’s modulating canons of orators and their models of Attic historians. Innes appraises the Attic revival in Rome as a “mutual cross-fertilization between Greeks and Romans” (Innes 1989, 246).

Consequently, Atticism effectively appropriates legitimacy, encompassing linguistic propriety, paideutic standing, and social status. Setting the paradigm, lexicographers start compiling forms and examples of usages. The distinction, though, is not between Attic, Doric, Ionic, and Aeolic. Instead it is between Attic, Hellenic, and Koine Greek. More specifically, Moeris sets the tone from the title “Μοίριδος ἀττικιστοῦ λέξεις ἀττικῶν καί ἑλλήνων κατά στοιχεῖον.” Moeris differentiates between usages of the Hellenes, the Attics, and rarely the ancients. More specifically, he differentiates between Attic versus Hellenic and common usage. Another contradistinction is Hellenic versus common and common versus Attic (197.5, 198.2). However, the point, which intensely furnishes the spirit of the era, is the opposition between primary Attic and secondary Attic (194.29). There is in fact a third occurrence in which Moeris references a middle Atticism (213.2). (The references follow Boeker’s edition of Moeris)

Therefore, the appreciation of Dionysius of Halicarnassus for Atticism fits well within the socio-political context of Atticism’s reevaluation. In his introductory statement Dionysius in De Antiquis Oratoribus furnishes a comprehensive history of oratory, which provides an overview of the significant historical points in the evolution of oratory always against the backdrop of socio-historical changes.

We ought to acknowledge a great debt of gratitude to the age in which we live, my most accomplished Ammaeus, for an improvement in certain fields of serious study, and especially for the considerable revival in the practice of civil oratory. In the epoch preceding our own, the old philosophic Rhetoric was so grossly abused and maltreated that it fell into a decline. From the death of Alexander of Macedon it began to lose its spirit and gradually wither away, and in our generation had reached a state of almost total extinction... Our own age has demonstrated this. Whether at the instance of some god, or by the return of the old order of things in accordance with a natural cycle, or through the human urge that draws many towards the same activities: for whatever reason, the ancient sober Rhetoric has thereby been restored to her former rightful place of honor, while the brainless new Rhetoric has been restrained from enjoying a fame which it does not deserve and from living in luxury on the fruits of another’s labors.\(^2\) (D. H. Orat.Vett 1,2).

\(^2\) “Attic and Greek Diction of Moeris the Atticist according to the parts of speech.”

\(^3\) All translations of Dionysius of Halicarnassus are by Usher (1974)
1.2 Defining Atticism

Considering the lexicographers and grammarians cited in the previous section, one concludes that Atticism pertains both to linguistic and structural choices. However, the polarity between Hellenic and Attic and primary and secondary Attic among others, render the quantification and parameterization of Atticism problematic. A pivotal criterion, which is beyond the scope of this paper, lies in the time frame within which each of the works was authored. The perceptions of what is current or ancient vocabulary and whether Hellenic and Attic are synonyms alter according to the socio-political status quo.

Foregoing inner dialectical and political conflicts, should we attempt to take for granted and use as a basis the conclusions of theoreticians, such as Dionysius of Halicarnassus, we might be able to determine some generic Attic constructions—a process that could ultimately help us reverse engineer syntactical metrics-markers for Atticism as a whole and then determine the minute dialectical differences as furnished in the various definitions. To this end, Dionysius’ theoretical commentary is being considered alongside syntactically annotated sentences of the respective authors, attempting to validate and ultimately quantify his inferences.

Studying Dionysius' treatises on the orators punctiliously, one should notice his underlying commentary of Atticism and the modulations of style that seem to be in tune with the lexicographers' appreciations of the dialects.

More specifically, Dionysius considers Lysias the paragon of Atticism.

He is completely pure in his vocabulary, and is the perfect model of the Attic dialect—not the archaic dialect used by Plato and Thucydides, but that which was in general currency in his day. (D.H. Lys. 2)

Upon closer study of the treatise, one needs to probe into what makes Lysias the model of Atticism. Dionysius furnishes the readers with examples, such as the following:

Purity of language, correct dialect, the presentation of ideas by means of standard, not figurative expressions; clarity, brevity, concision, terseness, vivid representation. (D.H. Lys. 13)

As to his composition, it is absolutely simple and straightforward. He sees that characterization is achieved not by periodic structure and the use of rhythms, but by loosely constructed sentences. (D.H. Lys. 8)

Using Lysias as his framework, Dionysius proceeds to cognitively interpret and describe the other Attic orators. Dionysius discusses Isocrates and comparatively studies his style with that of Lysias. Such a comparative analysis gives us a more perspicuous account of Atticism, something that purveys us a framework with attributes that would be deemed Attic.

His style has the following characteristics: it is as pure as that of Lysias; not a word is used at random; and the language conforms closely to the most ordinary and familiar usage. (D.H. Isoc. 2)

I pronounced both to be masters of lucidity and vividness, but found Lysias the more successful in the concise expression of ideas, and Isocrates the superior at rhetorical amplification...I judged Lysias to be the simpler in sentence-structure and Isocrates the more elaborate; the former more convincing in creating the illusion of truth, the latter the more powerful master of technique. (D.H. Isoc. 11)

Other interspersed proclamations regarding the two orators seem to be justified when we analyze their sentence structure. Dionysius asserts that Isocrates' diction is as pure as that of Lysias (D.H. Isoc. 2). Lysias also excels in succinctness, while Isocrates in amplification.

On the other hand, it is compact, closely-knit style like the other...it sprawls and overflows with its own exuberance. (D.H. Isoc. 2)

The comparison is visualized in the figure below.
Fig 1. Syntactical comparison of Lysias’ *Olympicus* 1.1 (top) and Isocrates’ *De pace* 3.1 (bottom).

The Treebank annotation furnished showcases that Lysias’ sentence is more tightly composed with just one secondary clause that is parallel to the prepositional phrase introduced with ἐνεκα. The two sub-branches depending on the coordination καί give the sentence a structured and balanced form. Isocrates, on the other hand, after having introduced two major coordinations δὲ, also explores the affluence of the Greek in participles and with one coordination introduces three sub-branches of three supplementary participles, all dependent on the same main verb.

Even though the Atticism of Isocrates is never questioned, Dionysius insists upon the need for syntactical brevity. Dionysius proceeds with a profound examination of Isocrates’ style. He dissects the
latter's sentences, pinpointing parallelisms and rhyming clauses and constructions. He also draws the reader's attention to the symmetry of the clauses, which is not always regarded as a merit.

Which is artificial rather than natural. In three clauses of equal length is characteristic of Isocrates's arrangement. (D.H. Isoc. 20)

Such a treatise that combines the theoretical framework of oratory alongside technical aspects of actual speeches further apprises us of the structural essence of Attic oratory. Additionally, in Isocrates 20 Dionysius offers his insight by rewriting some of the orator's sentences. The first picture in the figure below shows Isocrates' sentence and the second Dionysius' suggestion that opts for clarity and brevity. The major disparity between the original and the rewrite is that the latter transformed an entire secondary clause, which clearly elongated the sentence, to a single participle that condenses the same meaning within one word. Even visually the syntactical tree is simpler and more comprehensive.

Fig 2. Syntactical comparison of Isocrates' (left) and Dionysius' (right) version.

Dionysius, when it comes to his discussion of Demosthenes, pursues what could be perceived as the first form of computational linguistics and scientific inquiry in the field of literary analysis. He states that there are three distinct types of stylistic diction—an elaborate that is best used by Thucydides, a simple whose best representative is Lysias, and a third that is a perfect amalgamation of the previous two. Demosthenes is the archetypal writer in this category alongside Isocrates and Plato.

This passage illustrates the striking, elaborate style which is remote from normality and is full of every kind of accessory embellishment. Thucydides is the standard and pattern of this style, and no subsequent writer employed it to greater effect or imitated him with complete success. (D.H. Dem. 1)

The second kind of style is plain and simple. Its artistry and power seem to consist in its resemblance to the language of ordinary speech...The man who perfected it and realized its potential as a distinct style was Lysias, the son of Cephalus. (D.H. Dem. 2)

The third kind of style was a mixture formed by combining the other two...It is impossible to find any other writers, except Demosthenes, who practiced the essential and ancillary virtues of this style to greater effect, or who expressed themselves in more beautiful language and adorned it more skillfully with additional touches of artistry. (D.H. Dem. 3)
Another characteristic of Demosthenes’ constructive pattern is, according to Dionysius, the complexity of his sentences, in which he begins with a clause, which is then interrupted in order to introduce a second, which in turn is also broken unfinished, while a third is introduced.

In the first place, before rounding off the first idea (if it should be so called), a second idea is introduced; then a third is subjoined before the second is complete, and material belonging to the second is tacked on after the third has been completed. (D.H. Dem. 9)

Figure 3 demonstrates one of Demosthenes’ sentences syntactically analyzed. The complexity of the sentence, the secondary clauses, and dependent phrases are on par with Dionysius’ apprehension of the orator. Furthermore, the developed metrics discussed in this paper can contribute to the quantification of the sentence’s complexity.

Our analysis becomes more intriguing when we examine Imperial Greek oratory, in which the revival of Atticism is manifest. Lucian of Samosata, the second-century CE orator, imitates classical Attic dialect and prides himself in his acquired Greekness, or chastises himself whenever he commits a linguistic blunder.

To be honest, however, their praise caused me considerable annoyance, and when they had gone and I was left alone, I reflected as follows: “So this is the only attraction in my writings, that they are unconventional and keep off the beaten track, while good vocabulary, conformity to the ancient canon, penetration of intellect, power of perception, Attic grace, good construction, general competence, perhaps have no place in my work. Otherwise they would not have ignored these qualities and praised only the novel and strange element in my style. I, fool that I was, had thought when they rose in approbation that perhaps this particular feature too had some attraction for them — I remembered the truth of Homer’s remark that the new song takes the fancy of an audience; but I did not think to attribute so much — indeed all of it — to novelty, but supposed novelty to be a kind of additional ornament making some contribution indeed to the approbation of my work, the audience’s real praise and commendation, however, going to those other qualities. As a result my elation overstepped its bounds — to think I nearly believed them when they called me unique and in a class apart in Greece and other flatteries of this kind.” (Zeux., 2)

There have also been extensive discussions on Dio’s and Aristides’ Atticism. Schmidt (1887-1897: i.72-191), Swain (1996, 27-42; 187-241; 254-297), Whitmarsh (2001, passim) elaborate on implicit and explicit Atticism—both on linguistic level and the assumption of different literary personae all imbued with different forms.

4 Translation by Harmon (1913)
E. Bozia

and levels of Greekness. Lucian, Dio, and Aelius Aristides embrace Atticism in both their linguistic choices and sentence structure. However, upon closer reading, one notices significant variations. Of course the purpose of their delivered orations and the different intended audiences had also predetermined the stylistic variations. How do we consider these variances, though? Should they be appreciated as forms of Atticism or do they err significantly from the traditional constructions? Cicero was already one of the first to elaborate on stylistic differences in Brutus, arguing in favor of the variegated nature of Atticism and against branding any intricacy of style as Asiatic.

But if he bestows the name of Atticism on a half-starved, a dry, and a niggardly turn of expression, provided it is neat, correct, and elegant, I cannot say, indeed, that he bestows it improperly; as the Attic orators, however, had many qualities of a more important nature, I would advise him to be careful that he does not overlook their different kinds and degrees of merit, and their great extent and variety of character. The Attic speakers, he will tell me, are the models upon which he wishes to form his eloquence. But which of them does he mean to fix upon? for they are not all of the same cast. Who, for instance, could be more unlike each other than Demosthenes and Lysias? or than Demosthenes and Hypereides?5 (Cic. Brut. 285)

In this study I work on the same basis, as I attempt to establish a framework within which Atticism seems to be working. A computational analysis therefore could provide us with measurable and appreciable characteristics.

2 Methods: Quantifying Rhetorical Styles

In this section I develop metrics to quantify the syntactical structure of the sentence, parameterizing the morphology of the tree. For the purpose of this analysis, epideictic speeches of the aforementioned orators were annotated syntactically in the form of treebank annotation, as shown in figures 1 and 2, using the Arethusa annotation framework through Perseids (www.perseids.org). I contend that this formational consideration of rhetorical speeches will shed light on statistical distributions of syntactical phenomena and consequently the evolution of oratory and the involvement of Atticism. More specifically, a more or less intricate authorial style translates into the morphology of the tree, namely the width and depth of the branches and the syntactical tags describing each lemma. In the next section a quantification framework is presented using node-based sentence metrics.

2.1 Node-based sentence metrics

The structure of a syntactically annotated sentence is defined as a linearly ordered set of elements $S=\{n_1, n_2, \ldots, n_j\}$, where each element $n_i$ is a tree node ($n_i \in T$) and $T$ denotes the space of tree nodes. It should be noted that every tree node is a tree on its own, while also being the root of that tree. Therefore, a syntactically annotated sentence is a linearly ordered set of as many trees as the words in the sentence. Furthermore, in this space the operator $\text{children of}$ is defined, which maps each node to a set of children nodes that are also elements of the same sentence ($\text{children of}: T \to \{T\}$). A node without children is mapped to the empty set through this operator (i.e. when $x=0$). The word order in a sentence defines the linear order of the tree nodes in the set $S$. Additional operators can also be defined to implement other characteristics of the nodes, such as syntactical tags, for example the mapping $\text{isATR}: T \to \{0,1\}$ could indicate if a given node is an attributive.

In order to quantify the use of Attic in this case, one needs to extract numerical descriptors for each annotated sentence in a given corpus. Therefore, a set of metrics could be defined within the space $S$ of sentences that will then allow us to perform further comparative analyses. The syntactical morphology of the sentence is depicted in the connectivity of the nodes. This paper explores the possibility to establish a node-based metric so as to quantify the local morphology of each individual node and ultimately assess

5 Translation by Sutton and Rackham (1942)
the complexity of the sentence. A sentence metric is a function that maps each sentence to the space of real numbers \( f: S \rightarrow \mathbb{R} \), where \( S \) denotes the previously defined space of syntactically annotated sentences.

A generalized sentence metric can be expressed as the weighted sum of node-based metrics:

\[
f(S) = w_1 \mu(n_1) + w_2 \mu(n_2) + \cdots + w_k \mu(n_k) = \sum_{i=1}^{k} w_i \mu(n_i)
\]

where \( \mu(n) \) is a node metric that operates on node \( n \) and computes a numerical value (\( \mu: T \rightarrow \mathbb{R} \)). The weights \( w_i \) determine each node's degree of syntactical and positional contribution in the sentence. Figure 4 illustrates the evaluation of Eq. 1 on an abstract sentence with 7 words.

The form of node-based sentence metrics as defined in Eq. 1 is generic enough so that it can implement a wide variety of sentence metrics that can quantify syntactically annotated sentences. The following sections demonstrate in six detailed examples the construction of sentence metrics using Eq. 1.

**Fig 4.** Illustration of node-based sentence metrics. Each node has an assigned weight and a metric value. The total value of the sentence metric is \( w_1\mu_1 + w_2\mu_2 + \cdots + w_7\mu_7 \).

### 2.2 Simple node-based sentence metrics

A basic example of a simple node-based sentence metric is the one that calculates the number of words in a sentence. Such metric can be expressed in the form of Eq. 1 by setting \( w_i = 1 \) for all nodes in the sentence, \( \mu(n) = 1 \) for all nodes. In this case, the value of Eq. 1 will correspond to the number of words in a given sentence as it is shown in Figure 5.

**Fig 5.** Calculation of the “number of words” as a node-based sentence metric. In this example the result is \( 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 + 1 \times 1 = 7 \).

Another simple example of a node-based sentence metric is the one that calculates the number of attributives in a sentence. Such a metric can be expressed in the form of Eq. 1 by setting \( w_i = 1 \) for all nodes in the sentence, \( \mu(n) = 1 \) for the attributive nodes, and \( \mu(n) = 0 \) for the rest of the nodes. In this case, the node metric \( \mu(n) \) implements the is attributive metric and the value of Eq. 1 will correspond to the number of attributives in a given sentence as it is shown in Figure 6.
2.3 Relative sentence metrics

In order to quantitatively compare annotated sentences from one or more corpora, it is essential to be able to express metrics as percentage of the number of the words in a sentence, as such numerical descriptors can give a better indication of the complexity of a sentence. For instance, a big number of attributives in a relatively small sentence could signify a more intricate writing style. Such relative sentence metrics can be defined in the same way as the previous examples. An example of a relative node-based sentence metric is the one that calculates the percentage of leaves in a sentence. Such metric can be expressed in the form of Eq. 1 by setting $w_i=1/k$, where $k$ is the number of the words in a sentence, $\mu(n_l)=1$ for the leaves, and $\mu(n_r)=0$ for the rest of the nodes in the sentence. In this case, the node metric $\mu(n_i)$ implements the is leaf metric and the value of Eq. 1 will correspond to the percentage of leaves in a given sentence as it is shown in Figure 7.

Similarly, the example in Figure 6 can be expressed as a relative sentence metric by setting $w_i=1/k$ for all the nodes in the sentence. In this case the value of Eq. 1 will correspond to the percentage of attributives in a sentence.

2.4 Recursive sentence metrics

Although the previous examples demonstrated the construction of basic sentence metrics using Eq. 1, more complex metrics can be defined by setting the weights $w_i$ and the node metric $\mu$ accordingly. It should be noted that, despite the linear form of Eq. 1, non-linear metrics can also be established, using $w_{root}=1$, $w_{rest}=0$, and setting $\mu(n_{root})$ to be a non-linear function that can operate on the entire sentence tree by recursively traversing it from the root.
An example of a recursive sentence metric is the one that calculates the height of the syntactical tree of a sentence. Such metric can be expressed in the form of Eq. 1 by setting \( w_{root} = 1 \) and \( w_{i \neq root} = 0 \) for the rest of the nodes in the sentence. The node metric \( \mu(n_i) \) will recursively implement the height of the tree metric for the sub-tree \( n_i \). In this case, the value of Eq. 1 will correspond to the height of the syntactical tree of a given sentence as it is shown in Figure 8.

\[
\begin{align*}
\text{Weights} & \quad 1 \\
& \quad 0 \\
& \quad 0 \\
& \quad 0 \\
& \quad 0 \\
\text{Metric values} & \quad 4 \\
& \quad 3 \\
& \quad 1 \\
& \quad 2 \\
& \quad 1 \\
\end{align*}
\]

**Fig 8.** Calculation of the “height of the tree” as a node-based sentence metric. In this example the result is \( 0 \times 1 + 0 \times 3 + 0 \times 1 + 1 \times 4 + 0 \times 1 + 0 \times 2 = 4 \).

Another example of a recursive sentence metric is the one that calculates the relative size of the largest family in a syntactical tree. Similarly to the previous example, such metric can be expressed in the form of Eq. 1 by setting \( w_{root} = 1/k \), where \( k \) is the number of words in the sentence and \( w_{i \neq root} = 0 \) for the rest of the nodes in the sentence. The node metric \( \mu(n_i) \) will recursively implement the largest family of the tree metric for the sub-tree \( n_i \). In this case, the value of Eq. 1 will correspond to the size of the largest family in the syntactical tree of a given sentence calculated as percentage of the total number of words in the sentence as it is shown in Figure 9.

\[
\begin{align*}
\text{Weights} & \quad 1/7 \\
& \quad 0 \\
& \quad 0 \\
& \quad 0 \\
& \quad 0 \\
\text{Metric values} & \quad 3 \\
& \quad 0 \\
& \quad 1 \\
& \quad 0 \\
& \quad 0 \\
\end{align*}
\]

**Fig 9.** Calculation of the “size of the largest family as percentage of the words”. In this example the result is \( 0 \times 1 + 0 \times 3 + 0 \times 1 + 0 \times 1 + 1/7 \times 3 + 0 \times 1 + 0 \times 1 = 3/7 \).

### 2.5 Computer implementation

This analytical framework was implemented in JavaScript/HTML5 as a cross-platform programming environment. The developed interface includes API for defining custom node-based sentence metrics and is compatible with the Ancient Language Dependency Treebank (ALDT) format version 1.5 currently used by Perseids. In this interface a custom metric is defined as:

1. `var example=new NodeMetric(“Num of attrib.”);`
2. `example.weight=function(node){return 1;};`
3. `example.metric=function(node){return node.getRelation()==”AT R”};`
4. `var value=example.apply(sentence);`

The above example shows a case in which \( w_i = 1 \) and \( \mu(n_i) = 1 \) if \( n_i \) is ATR (attributive), or 0 if otherwise. This implements the node-based sentence metric demonstrated in Figure 6. The last line in the example shows...
how a metric can be applied to a Treebank sentence, which is given as a TreebankSentence object variable (here named sentence).

3 Results

The purpose of this framework is to set certain metrics and apply them on a collection of treebanks. This process will produce several numerical descriptors of each sentence that can quantify syntactical construction. These numbers can then be used as an input in any classification or pattern analysis algorithm, such as Principal Component Analysis, to examine similarities between works, authors, and writing styles.

For this pilot study, approximately one hundred sentences were annotated, using the Perseids Treebank Annotator. Five node-based metrics were implemented, using the presented framework, which are the ratios of the: a) number of leaf nodes, b) number of ATR nodes, c) tree height, d) tree width, and e) maximum number of branches in a single node, to the total number of nodes in the sentence. Considering that this pilot study was conducted on a relatively small corpus, in an attempt to produce trustworthy results, the metrics that were used were selected as robust descriptors of the morphology of the sentence and were not prone to noise deriving from local syntactic variations. Using these metrics, each sentence became a point in a 5D space. This point cloud was processed using PCA in Matlab to map the data onto the plane of the largest spread as shown in Figure 10. The plane of the largest spread was computed using the principal and secondary Eigen axes calculated by the PCA. Table 1 presents the contribution of each metric to the principal and secondary Eigen Axes.

Table 1. The contribution of each metric to the computed Eigen axes

<table>
<thead>
<tr>
<th>Node-based Sentence Metrics</th>
<th>Principal Eigen Axis</th>
<th>Secondary Eigen Axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Number of Leaves</td>
<td>18.96%</td>
<td>24.97%</td>
</tr>
<tr>
<td>Relative Height</td>
<td>7.57%</td>
<td>50.78%</td>
</tr>
<tr>
<td>Relative Width</td>
<td>34.06%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Relative Largest Family Size</td>
<td>35.71%</td>
<td>4.61%</td>
</tr>
<tr>
<td>Relative Number of Attributives</td>
<td>3.70%</td>
<td>19.50%</td>
</tr>
</tbody>
</table>

Fig 10. Plots of the sentence dataset on the plane of the two dominant eigenvectors. Each sentence is represented by one point (circle) in this plot.
The plots in Figures 10 and 11 clearly furnish the affinities or lack thereof between the discussed orators. There are three different viewpoints from which to examine and interpret these plots. Starting with individual orators, the plots indicate affinities between Lysias and Lucian. The latter proclaims in several places in his work that he opts and strives for Attic writing style. His dialect is distinguished for its Attic purity, even though the orator dates in the second century CE. Therefore, the sentence plot in Figure 11 is an attestation of the close proximity between Lysias’ and Lucian’s ellipses. Isocrates is the other ellipse that coincides with the aforementioned authors. Based on the analysis presented in Section 2, Isocrates, albeit less succinct, is still regarded for the cleanness of his expression. On the other hand, Dionysius’ of Halicarnassus explication of the style of Demosthenes as a perfect mixture of simple and florid expects the locality of the orator in the figure. Additionally, Dio converges significantly with Demosthenes, Lysias and Aelius Aristides, which can be explained when one considers that Dio constantly alters his style according to his intended audience, but also the fact that Dio as well as Demosthenes and Aristides had clearly politicized their rhetorical practice. Finally, Aelius employs Attic constructions, having, however, resorted to a more convoluted form of expression. Hence, he does not relate closely with the majority of the other orators.

The second viewpoint from which to consider the orators is in groups—the classical Attic and the Imperial orators. It is interesting to note that Demosthenes and Isocrates do not coincide, but Lysias is the connecting ellipse between the two. This showcases that, albeit classical Attic orators, they have distinct writing styles. They are, however, undeniably Attic, and the affinities with Lysias, the quintessential Atticist, prove that they share common traditional elements. Close examination of the Imperial orators proves that they also have distinct similar elements. All three ellipses coincide considerably, which would mean that the revived Atticism opted for standardized schemas for self-validation. In the future, isolating certain constructions and determining whether they are particular to Atticism in general, classical, or Imperial Atticism will further this analysis.

The third approach to the plots is the apparent unity of Atticism. It should be considered that regardless of stylistic differences and the ultimate attempt to establish a syntactical territory for each one of these authors, hence parameterizing Atticism, a major point that is obvious through the plot is that there is no author who is entirely disconnected from the group, thus reinforcing the idea that there was indeed an Attic framework which was first established by the 5th- and 4th-century Attic orators and was then recononized and revived in Imperial times. Additionally, we should not discount the possibility that the metrics set for

Fig 11. Visualization of the point set of Fig.9 as Gaussian distributions. The distribution of the sentences of each author is depicted as an ellipse. The center of each distribution is marked by a circle, and the median is marked by an asterisk.
this study may have not be adequately discriminating. On the one hand, we can establish that Atticism is a formalized phenomenon, but we also need to define different metrics, pertaining to certain syntactical constructions, that could perhaps be more descriptive of each author. Consequently, the structural analysis of Atticism—classical and Imperial—will be further dissected, and our understanding will be more percipient.

To conclude, in this paper a framework was presented for the analysis of stylistic similarities in certain 5th- and 4th-century and Imperial Attic orators. A limited pilot study was performed as a proof of concept. In the future, I intend to annotate a larger amount of those authors’ epideictic speeches and create more complex metrics that will serve as more discrete descriptors of stylistic patterns. Therefore, the comparisons will apprise us of the stylistic attributes of certain authors that are considered seminal in the formation of Atticism and of others who have revived Atticism, using it as a medium for the entire literary movement of the Second Sophistic in the Imperial Era. Subsequently, I will determine whether 5th- and 4th-century Attic and then respectively Imperial writers utilize certain preset motifs that would validate them as Attic as well as whether there are features that distinguish Classical from Imperial Atticism. Ultimately, I expect to identify constructional characteristics of Atticism as a phenomenon, something that will enhance our understanding of Atticism as a linguistic and rhetorical current.

References


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