Abstract. We consider a long-established approach to text analysis applying it to the specific structure of oratory and spoken arguments. This method consists of deriving measures of the so-called “Fractal dimension”. Building on previous work linking “aesthetic appeal” to fractal dimensions of a particular value from the fields of music and literary study, we present empirical analyses of a number of different “persuasive texts” against a range of different choices for determining fractality. Initial results suggest that distinctive “oratorical aims” as may be represented in a text become evident via distinctive fractal dimension.

Keywords. Argumentation and computational linguistics; Fractal dimension; persuasive argument

Introduction

The subject of this paper is, in many ways, a little unusual. It is, however, we contend strongly motivated by observations and discoveries resulting within a number of disparate and seemingly unrelated fields. In very informal terms we are concerned with the following question: what (if any) are the “common elements” that can be associated with persuasive oratory? In studying this topic, the analytic framework adopted focuses on “structural” aspects that may be (implicitly) embedded in strong exemplars of persuasive speech and such that the presence of these structures is such as to be (again, implicitly) recognised by, resonate with, and appeal to their target audience. More formally, we consider the question of estimating the so-called “fractal dimension” of some well-known and highly-regarded examples of persuasive speech with the aim of assessing to what extent this dimension is coincident across the chosen examples.

The paragraph above, of course, already begs a number of questions: what are the “structural aspects” that have been identified within other domains and to what degree do these studies support a connection between properties of fractal dimension and (for want of better term) “aesthetic appeal”?

We give an overview of the ideas underlying estimating “fractal dimension” and then, in Section 2 discuss related studies of fractal properties. In Section 3, a few of the components of arguments presented as speech are discussed and we comment on their persuasive power in respect of “general audiences” so as to motivate concentration on the text rather than its style of delivery. In Section 4 we describe the source texts used in our subsequent study and the bases for determining fractal dimension of these. The results derived are presented in Section 5, conclusions being offered in Section 6.
1. Informal Introduction to Fractal Dimension

The concept of fractal dimension originates from the work of Mandelbrot [16]. Given the technical intricacies required for a full formal definition,\(^1\) we focus on the principal qualities of interest.

The idea of “dimension” is familiar within everyday objects. The (normal concept) of “dimension” is as a whole number, however, fractal dimensions arise when this whole number convention is insufficient: for objects which are interpreted as having fractional dimensions. With “conventional” notions of dimension there is a relation between dimension and scaling. So, suppose for example, we have a line which is 1 metre in length. If we have a 1 metre measuring stick we need apply this exactly once to determine the line’s length. Every time, however, the length of the measuring rule is reduced to a half of what it was previously it must be applied twice as often. Typically if we examine how the number of applications \((N)\) changes as the available length is scaled by some factor, \(\varepsilon\) say, for a line this is \(N = 1/\varepsilon = \varepsilon^{-1}\). In general, for an object in \(D\) dimensions the “number of applications” \((N)\) required to “measure” the object using a device of size \(K\) then \(\varepsilon K, \varepsilon^2 K\) etc increases according to \(N \propto \varepsilon^{-D}\) (that is, \(N\) is proportional to some power of the “scaling measure” \(\varepsilon\)).

The idea of “measurement by counting the number of objects of given form within a larger object” raises one of the key properties linking “fractal dimension” with its use in the areas discussed in this article: that of so-called “self-similarity”. Informally self-similarity (within a structure, \(S\)) expresses the idea that \(S\) is built from “smaller” identical (or “near-identical”) copies of (the structure \(S\)) and (by implication) the same construction process can be extended to build “larger” objects of which \(S\) is a component.

This property is found in many natural structures and has been extensively studied. Examples are found in geological formations, e.g. Batty [2]; biology and medicine, see e.g. Havlin et al. [10] and the recent collection of Nonnenmacher, Losa and Weiber [18]; and within other physical sciences, see e.g. Stanley and Ostrowsky [21].

We conclude with a brief look at one method used to estimate fractal dimension.

At an abstract level we have a set (description) of a given size \((N)\) and a “scaling (or ranking) factor” \((0 < \varepsilon < 1)\). The dimension is simply \(-\log F(\varepsilon)/\log \varepsilon\). In this abstraction \(F(\varepsilon)\) captures “the number of times (frequency) the scale \(\varepsilon\) must be used to measure \(N\)”.

A standard approach that has been applied in adapting this notion to linear structures (such as music, text etc) considers \(N\) as the number of basic units within the source and estimates the fractal dimension relative to the frequency of occurrence of distinct items \((w)\) and a defined “ranking” of \(w\). Thus, a first estimate of the fractal dimension of a text \(T\) is given by determining the slope of the “best-fit line” when plotting \(\log(1/k)\) (Horizontal axis) against \(\log F(k)\) (y-axis). Here \(k\) is the index or rank of a particular unit of interest and \(F(k)\) the (percentage) number of occurrences. The gradient \(D\) of the line suggests this frequency behaves according to \(F(k) \propto k^{-D}\). Examples of “basic unit” that have been adopted in earlier studies range from individual letters in Eftekhari [6]; distinct words (and word length), e.g. Najafi and Darooneh [17]; and sentence length, e.g. Grabska-Gradzińska et. al [9]. The question of level of granularity appropriate to the analysis of language has been considered by, among others, Kohler [14].

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\(^1\)A set with “non-integral Hausdorff dimension”. Equivalently, in Mandelbrot’s formalism, “a set whose Hausdorff dimension strictly exceeds its topological dimension”. 
2. Previous work on Fractal Dimension: Music & Literature

The investigation of fractal elements within creative arts dates back to (at least) the mid 1970s. Regarding literary texts such study has principally focused on analytic (as opposed to synthetic) properties. With respect to Music, however, fractal properties have been used to underpin creative methods (the specialist AI discipline of “Algorithmic Composition”, surveyed in Edwards [5] and more recently in greater depth within Fernández and Vico [7]) as well as attempting to find a rationale as to why particular musical creations are more “appealing” than others. In the latter context the rôle of fractal dimension has proved to be of some interest.

Investigating this question, Voss & Clarke [23] examine the characteristics of “spectral density” (a measurement that can be interpreted in terms of fractal dimension) of the sounds in various musical genres. In extremely loose terms, their findings can be summarised as classifying “sound streams” as falling into one of three categories: so-called $1/f^0$ noise, equating to the phenomenen of “white” noise; $1/f^2$ noise or “Brownian” noise; and finally, $1/f^1$ noise. The experimental studies of Voss and Clarke led them to the conclusion that the first two categories ($1/f^0$ and $1/f^2$) are found unappealing: the former sounding too random and unstructured, the latter too controlled and repetitive. In contrast, patterns exhibiting $1/f$ behaviour were regarded as aesthetically satisfying by their audience. The fractal dimension as measured in “randomly generated” $1/f$-noise has been used to underpin algorithmic composition methods building on mapping complex number sequences (eg as occuring in generating Mandelbrot or Julia sets) to standard tone systems (such as MIDI inputs). This approach is explored in work of Walker [24] and Sukumaran & Thyagaraja [22].

The empirical findings of Voss and Clarke are examined further in the study of Manaris et al. [15], where, amongst other experiments the fractal dimension of 196 selected pieces covering a number of distinct genres is measured. The outcomes display fractal dimension ranging from 0.81 (12-tone) to 1.53 (Punk rock) with an average over all 196 pieces of 1.203.

Much closer to the topic of this paper are the studies of fractal dimensions in texts. In [6], Eftekhari presents a model (based on a letter-frequency ranking order which we discuss in Section 4) to analyse fractal dimension in Shakespeare’s tragedies. Analogously to the hypothesis implied by Voss and Clarke’s notion of $1/f$-noise providing an “aesthetically satisfying” measure of music, Eftekhari’s study demonstrates fractal dimension bounded strictly above 0 but without being reaching a level that might be seen as “repetitive and contrived” (i.e. of a quality similar to $1/f^2$-noise): empirically derived fractal dimension ranging from 0.45 (Hamlet) to 0.5985 (Macbeth). Fractal structures are considered as an approach to automatic keyword extraction by Najafi and Darooneh [17] using Darwin’s *On the origin of species* as a basis text. More generally the issue of fractal structures in text and languages has been considered in work of Grabska-Gradzińska et. al [9] with respect to sentence lengths over a selection of 30 literary works. Building on work of Hrebíček [11,12,13], Kohler [14], and Andres [1] all treat the question of existence and verification of fractal elements in language and text.

One concept running through most of the approaches mentioned above (often explicitly stated as such, e.g. in Manaris et al. [15], Hrebíček [13]) is the principle known

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2 The article by Martin Gardner [8] offers a lucid summary of Voss and Clarke’s work together with an overview of a “random $1/f$-noise generator”.

3 The term “fractal dimension” is not used in Manaris’ study: it is clear, however, that this is what is involved.
as *Zipf’s Law*. This was proposed in Zipf [25,26] and is an (empirically based) observation about the relative frequency of occurrence of individual words in a collection. Thus, suppose one orders (all) words \(w_1, w_2, \ldots, w_k, \ldots\) by their frequency of use, i.e. \(w_1\) is the most commonly used word, \(w_2\) the second most, etc. Now consider any source text within this language. Given any word \(w\) let \(r_w\) be its rank and \(f(r_w)\) its frequency of occurrence within the text. Zip’s Law asserts \(f(r_w) \propto r_w^{-\alpha}\) for \(\alpha \sim 1\). In other words, the “second most frequent word (in the language)” occurs roughly half as often in any given text as the most frequent word; the “\(k\)th most common word (in the language)” occurs proportionate to \(1/k^n\) within a text. Zipf’s Law is empirically supported by a number of studies. Its interest in the context explored in this paper is the link between the exponent \(\alpha\) within this power law and the notion of fractal dimension. A good overview of Zipf’s Law in text and language analysis may be found in Piantadosi [19].

In summary the commonalities between aspects of music, literature and language as identified in earlier investigations of fractal dimension provide a good motivation for examining these in the specific class of texts represented by persuasive oratory.

### 3. Some facets of persuasive speech and their relevance

There is an element, commonly found and exploited within the more histrionic and emotive exemplars of oratorical delivery which could be summarised in the following contention: (Non-specialist) audiences react to the sound and style of delivery. They do not (in general) analyse argument content in a logical and rational manner. This is, of course, an exaggeration but we would argue not an excessive one. That language and style may override logic and rationality has been exploited as a dramatic convention for over 2,000 years.\(^4\) It is, without question, a factor assumed (even relied upon) by advocates of more extreme political views. Overall, we find a number of elements within the action of delivering an argument that persuades its audience, that are independent of the “logical” content. For example: variations in vocal tone and emphases; gestures and emotional displays; standard oratorical devices (eg “rule-of-three”). In considering the efficacy of a speech and the structural issues underlying the present paper, devices such as those just listed are problematic. We have the text itself available but, often, little guidance as to how this text was first presented. This is especially so with regards to examples for which only a written record survives. In contrast to music for which a sophisticated notational system not only for sounds but also dynamics has evolved over several centuries, there are minimal methods of annotating text to indicate how (in the opinion of its author) the text should be spoken.\(^5\) In total, in examining notions such as fractal properties of persuasive oratory, typically, the principal (and, often, only) sources are the texts themselves.

We would claim, however, that the (in many ways enforced) focus on textual content should not be seen as a weakness. In support of this claim it is noted that what is considered as “persuasive style” changes significantly over time. The renowned classical orator, Cicero, delineated oratorical styles into High (sometimes referred to as “Grand”), Mid-

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\(^4\)See, e.g. the analysis of one famous speech from Aeschylus’ *Agamemnon* in Dunne [3].

\(^5\)An exception is verse, where various systems have been used to indicate stress and rhythm patterns.
dle, and Low with these having the respective aims of “moving”, “pleasing”, and “teaching”. Regarding the “Grand Style”, the 18th century actor Thomas Sheridan,6 claimed: “Before you can persuade a man into any opinion, he must first be convinced that you believe it yourself. This he can never be, unless the tones of voice in which you speak come from the heart, accompanied by corresponding looks, and gestures, which naturally result from a man who speaks in earnest.” [20]

Some, not always extremist, politicians are well-known for indulging in “grand style” delivery.7 It is, however, equally the case that (what is perceived) as over-indulgence can be a source of ridicule (despite the fact that, at other times, exactly the same style would be found commendable). Just as in theatrical traditions, tastes in delivery and oratorical style may change over comparatively short periods of time.8 This variability in what is seen as acceptable, “persuasive” style offers a strong case (in terms of analysing inherent structural aspects) for focusing on the element that remains constant: fashion in delivery may change but the text remains the same.

4. Experimental Structure: sources and analysis

In this section we first discuss the source texts considered and then outline the methodology for determining fractal aspects of these. We consider five base examples. In one case both the French source and an English translation feature; in another the source text is in Latin. All are examples of the so-called “Grand style”, in the sense that a distinguishing feature of this is the use of florid and heightened language (in addition to those presentational characteristics discussed in the previous section). In one case, there are surviving records of the text being presented.

4.1. Dr Martin Luther King Jr.’s “I have a dream” – 28th August 1963, Washington D.C

Delivered to a crowd numbering several hundreds of thousands at the Lincoln Memorial as part of the March on Washington for Jobs and Freedom. The speech was a key event in the U.S. Civil Rights movement of the 1960s.

4.2. Clarence Darrow’s A Plea for Mercy, concluding address, September9 1924

Darrow’s closing defence argument in the Leopold-Loeb murder trial is not concerned with the guilt or innocence of the accused: having admitted guilt, Darrow’s concern was

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6The father of the playwright R. B. Sheridan.
7One instance, familiar to those over the age of fifty in the U.K., is the former Labour Party Leader Neil Kinnock. His 1985 Conference speech – “I’ll tell you what happens with impossible promises. You start with far-fetched resolutions. They are then pickled into a rigid dogma, a code, and you go through the years sticking to that, out-dated, mis-placed, irrelevant to the real needs, and you end in the grotesque chaos of a Labour council – a Labour council – hiring taxis to scuttle round a city handing out redundancy notices to its own workers” – being a typical example. The effect of this particular speech (when used within an election campaign advert), however, owes as much to skilled film editing as its actual content, cf. Dunne [4, p. 239, fn. 9].
8One example is found in Joseph Mankiewicz’ 1953 film adaptation of Julius Caesar in which four of the leading rôles represent four distinctive acting traditions spanning barely thirty years: classical American (Louis Calhern; title part); modern American “method” (Marlon Brando; Mark Antony); classical British tradition (John Gielgud; Cassius); and contemporary British style (James Mason; Brutus).
9This is the date given on www.americanrhetoric/speeches/cdarrowpleaformercy.htm. Other (longer) transcripts gives dates covering 22 – 25th August.
to argue that a life term rather than capital sentence be passed. In contrast to King’s speech, Darrow’s presentation targets a single individual. Background and discussion of some aspects may be found in Dunne [4, pp. 242-3].

4.3. Thomas Paine’s The Crisis, 23rd December 1776

Unlike the previous two examples, there is no record of Paine’s text ever being spoken by Paine himself. The text was sent as a letter to Washington whose army seemingly faced defeat at the hands of the British colonial forces. On Washington’s instructions it was printed as a pamphlet and read aloud to inspire his troops and encourage recruitment.

4.4. Emile Zola’s polemic J’accuse, 13th January 1898

An open letter to Félix Faure the French President published on the front page of the Parisian daily L’Aurore and accusing not the President but senior army and political figures of incompetence in investigating leaks of military secrets. Zola’s letter further alleges the same individuals conspired to cover up the innocence of Alfred Dreyfus, an army captain found guilty of treason and, subsequently, cashiered and sentenced to penal servitude overseas for life.

4.5. St. Paul’s 1st Letter to the Corinthians

While the extent to which this forms a “spoken” text may be debated, there are a number of strong arguments for its inclusion. Firstly, it is one of the few examples (among the Pauline epistles) of a text which is generally accepted as homogenous. Secondly, given that it would have been sent to a community whose members would be unlikely to be literate, it is reasonable to assume its content would have been disseminated orally.\(^\text{10}\) As one final supporting feature the text is highly oratorical: stylistic devices abound among which are the use of catalogues, rich metaphors and symbolism. The text (in a way similar to the example from Zola above) offers the opportunity to examine to what extent the features forming the central topic of this paper are language independent. We consider two standard English translations\(^\text{11}\) and, also, examine the characteristics of one Latin text.\(^\text{12}\)

4.6. Experiment Structures

The components we review in examining fractal structures are: letters, words and sentences. Within these we have a number of alternatives all of which focus around the question of how a specific token is assigned a rank. Thus the basic approach may be summarised as: in order to determine the fractal properties of a text \(T\) treated as a collection of \(N\) tokens with \(F\) distinct forms, e.g. 26 letters in an alphabet:

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\text{E1. Assign each distinct token a unique numerical ranking (an integer value between 1 and } F).\]

\(^{10}\)In environments where basic literacy is near universal, it is still standard practice for Church leaders to issue so-called “Pastoral” letters which may be presented during services as an alternative to an homily.

\(^{11}\)The 1582 Douay-Rheims text and the 1611 King James Version.

\(^{12}\)The so-called Clementine Vulgate text prepared in 1598.
E2. Determine how often a token, \( w \), with a specific rank \( r \) appears in the text.

E3. For each possible rank (between 1 and \( F \)) find the “best-fit” line on a log–log plot of (percentage) “number of occurrences of token with rank \( k \)” (y-axis) against \( 1/k \) (x-axis).

The gradient of the line resulting in (E3) provides one measure of fractality.

A central issue concerns how to define the ranking measure that underpins (E1). There are a number of possibilities dependent on the nature of the basic token of interest. We consider the following choices.

L. Tokens are ranked by increasing length. Hence number of letters in a word, number of words in a sentence. In this case, for example, words of two letters all receive rank 2. Similarly, all sentences with 10 words are given rank 10. We denote the former measure by \( LW \) and the latter by \( LS \).

O. Tokens are ranked by their order of occurrence in a text. This measure is applicable to letter and word bases, and may be combined with length measures. In total we obtain the four ranking functions:

OA. Tokens are letters. A letter, \( c \), is assigned the rank value \( k \) by \( OA \) if it is the \( k \)’th distinct character seen in the text. For example, for the text “this is a strange question is it not?”, \( OA(t) = 1 \), \( OA(q) = 10 \), etc.

OW. Tokens are (literal) words. Hence, in the previous example, \( OW(is) = 2 \), \( OW(not) = 8 \). Notice that \( is \) (the token of rank 2) has two separate occurrences.

OLW. A combination measure. Basic tokens are words assigned an initial measure based on their length. The ranking scheme orders these length values by their order of occurrence. From the example, \( OLW(is) = 2 \) (the second length encountered is 2); \( OLW(it) = 2 \) and \( OLW(question) = 5 \).

OLS. Similar to \( OLW \) but with the basic tokens being sentences initially measured in terms of the number of words within.

A. The tokens are letters. The rank of a letter being its position under alphabetical ordering. This measure is used in the study of Shakespeare’s texts by Eftekhar [6]. It is worth noting that a similar ranking scheme at the word level based on lexicographic order is extremely weak: texts have dimension between 0.002 and 0.06 with determination coefficients a maximum of 0.005.

Z. By “local” frequency of occurrence. At the letter level, Eftekhar refers to this as the “Zipf order” and uses it to define the so-called “Zipf dimension” as a comparator for the fractal dimension arising via A. We use similar orderings, namely:

ZA. The ranking corresponding to frequency of occurrence of individual letters, i.e. Eftekhar’s Zipf order. Following the example given above, \( ZA(i) = 1 \) (letter \( i \) appearing 5 times); \( ZA(q) = 12 \).

ZW. Frequency of occurrence of (literal) words: \( ZW(is) = 1 \), but \( ZW(w) = 2 \) for all other words in this (short) example.

ZLW. Similar to the measure \( OLW \) but in which the final ranking is determined by “frequency of word length” rather than by “order of word length”. For example, \( ZLW(is) = 1 \) (there are 3 words of length 2), however, \( OLW(is) = 2 \) (a word of 2 letters is the second distinct word-length seen).
ZLS. Similar to OLS (and ZLW) with the ordering determined by sentence length.

Each of the eight distinct source texts is analyzed in terms of these eleven measures (step E2). The final stage described in E3 uses a standard “least-squares” analysis whose “accuracy” is measured through the so-called “Determination coefficient” (denoted following standard usage, $R^2$).

In order to reduce “noise” effects some preliminary processing of the source texts was performed. The main changes being:

C1. all letters are converted to lower case,
C2. all letters with diacritical marks (in the source) are replaced by the unaccented letters. Ligatures such as æ and ø are replaced by the corresponding letter pair, i.e. ae and oe.
C3. the terminal sentence indicators (“?” and “!”) are replaced by “.”.
C4. all other punctuation marks are removed.

We note that C4 has a slight effect on word-based analyses (eg in replacing “there’s” by “theres” rather than “there is” or even “there s”). This does not, however, appear to be significant.

5. Experiment Outcome

In addition to the “grand” style examples introduced in the preceding section, we examine the characteristics of a text that could reasonably be taken as an example of “Low” style, recalling that in the classical division of styles the aim of such is to educate. To this end we use the following text

5.1. Voice of America “Special English” Broadcasts

The broadcaster Voice of America developed, in the mid-1950s a simplified English base (together with guidelines on presentational style). This uses a core basic vocabulary of around 1500 words and although originally intended for propaganda broadcasts to Eastern Europe, it is now used as a method of teaching English to non-native speakers. The example text we consider presents an introduction to American History which, in its broadcast form, runs just under three hours.

Table 1 summarises the main characteristics of the nine texts analysed. In Table 2 the outcome of token ranking by length is presented, while Table 3 gives the results for the set of token ordering approaches. In Table 4 we use the alphabetical ordering scheme described in Eftekhari [6]. Finally, Table 5 presents divers instantiations of Zipf’s order.

5.2. Commentary on Experimental Outcome

We first recall some aspects of the “determination coefficient” $R^2$ as an indicator of how well a line $y = mx + b$ fits a set of $t$ values $\{<x_1, y_1>, \ldots, <x_t, y_t>\}$ such as those

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13 All of the sources are available from web-based repositories.
14 http://www.manythings.org/voa/history/
15 The series considered was presented in 11 sections of 15 minutes duration.
that half falling below. A well-known aspect of a number of the approaches we discuss is
roughly half the contributing data points lying above the line \( y \) fits the data presented. Typically when \( R^2 \sim 0.5 \) one finds roughly half the contributing data points lying above the line \( y = mx + b \) and roughly half falling below. A well-known aspect of a number of the approaches we discuss is that \( R^2 \) is often rather low, e.g. in [6] the analysis of (what we have termed) \( D_A \) leads to \( R^2 \) with values between 0.06 and 0.09. Such outcomes are common given the nature
Typically, in the analysis of music and text one finds weak fractal structures. Comparing the outcome reported in Table 4 against the findings in [6], with the exception of the two non-English examples the values for $D_A$ lie between 0.54 (English translation of Zola) and 0.64 (both translations of the Vulgate): these outcomes are similar to the 0.45 to 0.6 ranges in [6]. It is worth observing that the text samples being considered in our study have lengths that are much smaller than those used in the earlier study: between 7228 and 68, 277 as compared to 77, 254 and 135, 003. A similar pattern is present under the Zipf letter order (in this case carrying over to the two non-English texts): the determination coefficients are all over 0.5 and the dimension lies between 1.32 and 1.48.

Turning to the other mechanisms, which are not used in [6], we find several aspects meriting comment, although reasons of space preclude a full analysis. Worth noting, however, are the following:

a. The sentence length measures $D_{LS}$ and $D_{OLS}$ for VOA: both of which are 0.95 and differ noticeably from word length measures $D_{LW}$ (2.12) and $D_{OLW}$ (2.46) on the same text.

b. The apparent effect of text translation on $D_A$: the French text of Zola reports $D_A \sim 0.34$ against its English version score of 0.54. Similarly the Vulgate text gives $D_A \sim 0.3$ in contrast to the translations both of which report $D_A \sim 0.64$. On a related point, the difference between $D_f$ (measured on KJV) and $D_I$ (measured on Douay) (for all approaches) is at most 0.123 (for $D_{OLS}$). With the

<table>
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<th>Text Name</th>
<th>$D_A$</th>
<th>$R^2$</th>
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<tr>
<td>Darrow (Sn. 4.2)</td>
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<td>0.0931</td>
</tr>
<tr>
<td>King (Sn. 4.1)</td>
<td>0.5813</td>
<td>0.1087</td>
</tr>
<tr>
<td>Paine (Sn. 4.3)</td>
<td>0.5893</td>
<td>0.0933</td>
</tr>
<tr>
<td>Zola (English) (Sn. 4.4)</td>
<td>0.5422</td>
<td>0.1062</td>
</tr>
<tr>
<td>Zola (French) (Sn. 4.4)</td>
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<td>0.0353</td>
</tr>
<tr>
<td>KJV (Sn. 4.5)</td>
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<td>0.1003</td>
</tr>
<tr>
<td>Douay (Sn. 4.5)</td>
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<td>0.0989</td>
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<tr>
<td>Vulgate (Sn. 4.5)</td>
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<th>$R^2$</th>
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<td>2.1281</td>
<td>0.7177</td>
<td>0.7868</td>
<td>0.7428</td>
<td>0.7911</td>
<td>0.9194</td>
</tr>
<tr>
<td>KJV (Sn. 4.5)</td>
<td>1.4817</td>
<td>0.539</td>
<td>2.4369</td>
<td>0.7197</td>
<td>1.0542</td>
<td>0.7295</td>
<td>1.1442</td>
<td>0.9731</td>
</tr>
<tr>
<td>Douay (Sn. 4.5)</td>
<td>1.4793</td>
<td>0.5363</td>
<td>2.477</td>
<td>0.7231</td>
<td>1.1198</td>
<td>0.7349</td>
<td>1.1518</td>
<td>0.972</td>
</tr>
<tr>
<td>Vulgate (Sn. 4.5)</td>
<td>1.4776</td>
<td>0.5988</td>
<td>2.0232</td>
<td>0.6385</td>
<td>1.272</td>
<td>0.7883</td>
<td>0.8142</td>
<td>0.939</td>
</tr>
<tr>
<td>VOA (Sn. 5.1)</td>
<td>1.4296</td>
<td>0.5923</td>
<td>2.6445</td>
<td>0.6419</td>
<td>1.6824</td>
<td>0.6662</td>
<td>1.0903</td>
<td>0.97</td>
</tr>
</tbody>
</table>
c. In texts for which there is concrete evidence that these were spoken (i.e. Darrow, King, Paine and VOA) as opposed to those for which this style of delivery is conjectured, there is a marked difference between VOA and the others for $D_{OLW}$: $\sim 0.68$, $\sim 1.26$, and $\sim 0.77$. Similar patterns are found for $D_{LW}$ (differences of 0.53, 0.71 and 0.66) and $D_{LS}$ (0.58, 0.76, and 0.8). For Zipf order data, although $D_{ZW}$ and $D_{ZA}$ are similar over all four instances, the other two measures exhibit differences of (at least) 0.71 and 0.89 (Darrow’s being the “closest” text).

The aspect observed in (a) (using an analogy with Voss & Clarke’s [23] concept of $1/f$-noise in relation to music) suggests that the sentence structure from VOA (consciously or otherwise) is aurally satisfying whereas the proximity to “Brownian noise” found in corresponding word lengths indicates a highly regular and repetitive nature. This view would be consistent with one pedagogical approach: basic units (“words”) are seen in a “repetitive” (rote-learning) context, however, in audibly communicating the more complicated notion of “sentence form” a more appealing structure occurs.

Whether the behaviour in (b) is a side-effect of different size alphabets (the French text has no occurrence of the letter “w”; the Latin text neither “w” nor “k”) or indicative of a more general phenomenon is unclear. While there are similar differences apparent in the French-English comparison under $D_{OA}$ and $D_{OLW}$ (of $\sim 0.33$), the three versions of Sn. 4.5 on $D_{OA}$ differ by under $\sim 0.021$. On the other hand, comparison of KJV and Douay with Vulgate on $D_{OW}$, $D_{OLW}$, $D_{ZW}$ and $D_{LW}$ reveals distinctive behaviour with differences $\sim 0.29$ ($D_{OW}$), $\sim 0.49$ ($D_{OLW}$), $\sim 0.33$ ($D_{ZW}$) and, most markedly, $\sim 1.06$ ($D_{LW}$).

The behaviour observed in (c) is particularly interesting. We gave one rationale for one aspect exhibited by VOA. The word level behaviour in (known) spoken texts, all of which are “Grand style” speeches is distinct from the word level measures $D_{LW}$ and $D_{OLW}$ for the “Low style” educational text.

6. Conclusions and Further Directions

In this paper we consider an approach to the analysis of texts independent of argument structure and logic: the implicit elements arising from fractal structures. It is stressed that “argument” in this context is used in a very general sense not with regard to any internal structural form. Such study follows an established tradition of applying these techniques not only to literary texts but to other “linear” structures such as music. Our empirical study considered three levels of granularity between character and sentence level structures within a range of nine texts all but one selected as exemplars of so-called “Grand” or “High style” oratory. Some distinctive aspects arise depending on the provenance of the text, its aims and the manner in which a given metric is applied. The potential to study such data on several levels, in effect rules out any notion of there being a “single definitive” choice with which to categorise the concept of “fractal dimension of text” but does raise challenging questions of capturing measures that combine several approaches. In this regard more detailed study would have to address the issues raised by (comparatively) brief textual sources. Two particular issues may well merit further investigation: translation dependencies (as summarised in the review of French-English
and Latin-English work) and whether, as suggested in a very basic way by our study, a clear separation between text consciously prepared for oral presentation and other written argument forms may be drawn.

References