Stylistic Variation in an Information Retrieval Experiment

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Abstract. Texts exhibit considerable stylistic variation. This paper reports an experiment where a corpus of documents (N= 75 000) is analyzed using various simple stylistic metrics. A subset (n = 1000) of the corpus has been previously assessed to be relevant for answering given information retrieval queries. The experiment shows that this subset differs significantly from the rest of the corpus in terms of the stylistic metrics studied.

1 Introduction

Texts vary not only by topic. Stylistic variation between texts of the same topic is often at least as noticeable as the topical variation between texts of different topic but same genre or variety; style is, broadly defined, the difference between two ways of saying the same thing.

Stylistic variation in a given text, given the liberal definition above, can occur in many ways and on many linguistic levels: lexical choice, choice of syntactic structures, choice of cohesion markers on a textual level, and so forth. Some choices are constrained by the intended audience and discourse ecology the text is produced in; some are left to be entirely determined by the author’s preferences and personal idiosyncrasies. In this experiment the stylistic variation investigated is taken from a fairly well-edited body of text – the Wall Street Journal – where presumably most writers conform to the expected norms of writing, and if not, the texts will be edited by professional editors to conform to them. The focus will be on stylistic variation based on the specific genres or functional styles that occur in a daily newspaper – as opposed to individual styles [13]. Especially, the experiment investigates how the variation relates to the usefulness of texts in a large scale information retrieval experiment.

This experiment makes some simple measurements of style markers, indicative of stylistic variation and of genre, on a largish corpus of documents, and compares a subset of documents that have previously been judged relevant for answering queries in an information retrieval experiment with the rest of the corpus.

2 Corpus and Statistical Measurements

The Text REtrieval Conference (TREC), organized in the form of a competition by US government research agencies, gives participating research organizations access to a large corpus of texts and a set of queries that are to be used for retrieving texts from the corpus. The texts that the organizations and systems participating in the competition suggest as most relevant for a query are read by a number of judges, and assessed as either relevant or not relevant. These assessments – the relevance judgements – are used in this experiment to categorize the entire corpus. Given a query, the corpus has three types of document: relevant texts, not relevant texts, and not judged (i.e. not retrieved) texts [6]. In this experiment, if a text was judged relevant for any query at all in the test set we will consider the text relevant.
For this experiment, a part of the TREC test corpus was selected: 74,516 Wall Street Journal articles from years the 1990, 1991, and 1992. Of these documents, 1116 were marked relevant for at least one of fifty queries (TREC queries 201-250) and 12,482 marked non-relevant - judged, but not relevant for any of the queries. Initially, the documents were analyzed to obtain simple sentence statistics and to obtain simple measures for syntactic complexity.

3 Hypotheses

The hypotheses of the experiment were 1) that certain genres or types of text would be more likely to provide the answers the human judges would prefer, and 2) that this preference is clear enough to be detectable even using the fairly simple mechanisms tested in this experiment.

The stylistic variation was expected from two reasons. Firstly, by the likelihood that the corpus contains materials that will never be useful in a generally framed information retrieval task such as TREC: stock report tables and the like; secondly, by the fact that the human judges, while well trained for the task, are likely to exhibit biases for certain types of documents, namely those which are easy to judge as being relevant or not.

4 Results

The results are positive. Texts that were found relevant did differ systematically from texts which are not found relevant; for most metrics tested, the difference was statistically significant even by univariate tests. In addition, we find that relevant texts and non-relevant texts taken together – i.e. texts retrieved by systems participating in the TREC evaluation – differ from the rest of the corpus in a systematic manner. The difference between relevant and non-relevant texts is much smaller than the difference between either of them and the non-judged portion of the corpus.

In summary, the results of this experiment show that retrieved highly ranked texts – both relevant and non-relevant – are longer, with a more complex sentence structure than the rest of the corpus, and that relevant texts differ from nonrelevant in that they tend to be even more complex textually.

1 3493 articles were retrieved for more than one query. Three articles were retrieved for more than 25 of 50 queries.

2 Since normal distribution assumptions cannot be expected to hold for language data of this sort, we used the Mann Whitney U rank sum test, which makes fewer assumptions about the values and distributions of the variables, to test for the significance of detected differences. There are no standard tests for multivariate significance for “nonparametric” variables, i.e. variables without an approximation of their value space; this means that this experiment will miss interactions between variables, testing them one by one, rather than risking a false positive result from using a multivariate test based on false assumptions. The Mann Whitney U test is one of two equivalent formulations – the other is Wilcoxon’s rank sum test – for calculating significant differences between some measurement in two sets. The sets are sorted together by the result of the measurement, and the sum of ranks is calculated for one of the categories. If there is a difference in the measurement results between the categories, the sum will tend to be either high or low; the thresholds for a significant difference from the expected average value for the rank sum are calculated using the relative sizes of the sets.
4.1 Simple statistics: Sentence Length and Word Statistics

A simple word count reveals that relevant texts on the average are longer than other texts — which also has been observed, pointed out, and utilized by the very successful Cornell research group at the latest TREC conference [3].

Word statistics — word length, long word counts, type/token ratios — as a measure of terminological complexity have often been paired with sentence length to produce readability scores and recently to study variation in various varieties of language, as well as perform genre discrimination [1, 2, 8, 9]. Table 1 contains a summary of the simple statistics. Relevant texts, besides being longer, also have longer sentences. The differences between relevant and non-relevant are significant in a Mann Whitney test on a 95% confidence level for all statistics except average word length.

| Category         | Number Word count | Type-token ratio | Word length | Words per sentence |
|------------------|-------------------|------------------|-------------|--------------------|
| Relevant         | 1116              | 755              | 0.527       | 5.08               | 19.8               |
| Misses           | 12482             | 675              | 0.551       | 5.07               | 19.3               |
| Not judged       | 60918             | 396              | 0.611       | 5.03               | 19.2               |

Table 1. Simple statistics for the corpus

Longer texts are more likely to be relevant at least partly due to the fact that longer texts range over several topics, and thus there is a chance that a long text will touch a relevant topic. In this experiment, we find that not only are relevant documents longer, but all documents retrieved by systems, even those assessed by human judges as irrelevant, also are longer than the average document. Not only will longer texts touch relevant topics — but apparently they may well touch irrelevant but confusingly similar topics.

The non-retrieved portion of the corpus turns out to contain large numbers of very short items, and large numbers of tables and numerical information, both short and long, which the retrieval systems have not proffered to the assessors for consideration. These texts presumably simple have less topical information, and thus are hit less often by the retrieval systems used. Running a subtopic segmentation algorithm over a number of texts produces the expected result. For the experiment we ran a system — TextTiles — which cuts up a text into tiles, tentative subtopic segments [7]. For the purposes of the experiment, only the number of tiles were retained. The number of tiles was higher for the relevant documents than for the non-relevant ones, but when the experiment was rerun on texts categorized by length, we find that long relevant texts tend to have fewer subtopics than the short ones, in contrast with the shorter texts - see Table 2. The difference is better than 95% significant by Mann Whitney U for the larger number of documents, for the long texts the risk of random results is around 10%.

4.2 Syntactic complexity

Syntactic complexity is a dimension which exhibits considerable variation between genres [10, 11]. Indeed, most stylistic measures heretofore have been attempts to find shortcuts for measuring syntactic complexity along with lexical complexity as measured by word length and word length. This experiment ran on a smaller corpus of only relevant and non-relevant documents.
type-token ratios. Sentence length as used above is one such method, although arguably a blunt one – what syntactic constructions are complex in themselves, and when they are evidence of complexity in an already complex subject matter is a matter of contention [4].

As a somewhat deeper approximation of clause complexity, we will look at the average depth of output trees from a robust parser built for information retrieval purposes [12]. The parser was set to skip parsing after a timeout threshold, and when it does so, it notes it has done so in the parse tree. These skip marks were counted – again, as an indication of clausal complexity. We find as shown, in Table 3, a clear distinction between the various categories of document. Relevant documents have, on average, deeper parse trees and more skips. Both measures show a significant difference between relevant and non-relevant documents, again by a Mann Whitney test on better than a 95% confidence level.

| Category          | Number | Tiles |
|-------------------|--------|-------|
| Relevant          | 756    | 3.8   |
| Not relevant      | 4406   | 3.6   |
| Relevant          | 176    | 8.1   |
| Misses            | 985    | 8.8   |

Table 2. Average number of tiles

| Category   | depth skips |
|------------|-------------|
| Relevant   | 10.0 0.499  |
| Non-relevant | 9.88 0.456 |
| Not assessed | 9.56 0.409 |

Table 3. Trees and Skips

5 Defining Genres

Stylistic variation, as indicated above, is partly an effect of genre variation. To get closer to the genres one can expect to find in the corpus text one issue of Wall Street Journal (910102) was categorized manually into ten rough categories: articles, business news with, and without tables, lists of paragraph length items, editorials, letters, paragraph-length items, “What’s News” (menu-type lists of one-sentence items), tables, and single one-sentence items. This was used as a training set to categorize the entire corpus: simple stylistic measurements for the hand categorized data – as shown in the previous section⁴ – were used in a discriminant analysis, and the resulting discriminant functions were used to automatically categorize the entire corpus. The details of the method are not important: the result is sloppy in any case. No checking was

⁴ With one extra measure added: digits per character, multiplied by 1000.
| N  | Genre Category | Tree Skips Words Depth | Types /Word | Chars /kChars | Digits Words /Sent |
|----|----------------|------------------------|-------------|--------------|------------------|
| 11 | A 331 Relevant 10.2 0.527 | 980 0.478 | 5.09 | 3.13 | 19.4 |
| 11 | A 3094 Not Relevant 10.0 0.511 | 988 0.476 | 5.05 | 3.01 | 18.9 |
| 11 | A 7907 Not Judged 9.86 0.498 | 782 0.503 | 4.99 | 3.44 | 18.2 |
| 209 | B 5 Relevant 8.40 0.360 | 6717 0.323 | 4.74 | 32.7 | 21.1 |
| 209 | B 70 Not Relevant 8.40 0.341 | 3933 0.346 | 4.82 | 21.5 | 17.7 |
| 209 | B 134 Not Judged 8.20 0.165 | 1481 0.335 | 4.62 | 38.9 | 27.1 |
| 13 | C 309 Relevant 9.89 0.502 | 677 0.511 | 5.08 | 7.38 | 20.3 |
| 13 | C 2516 Not Relevant 9.87 0.482 | 656 0.504 | 5.09 | 7.73 | 20.7 |
| 13 | C 10844 Not Judged 9.44 0.459 | 528 0.516 | 5.00 | 10.4 | 20.5 |
| 6006 | D 124 Relevant 9.63 0.480 | 1009 0.495 | 4.95 | 5.25 | 18.2 |
| 6006 | D 1278 Not Relevant 9.53 0.477 | 1075 0.484 | 4.94 | 4.89 | 17.9 |
| 6006 | D 4604 Not Judged 9.38 0.464 | 835 0.514 | 4.90 | 6.00 | 17.8 |
| 2613 | E 49 Relevant 10.3 0.516 | 1249 0.442 | 4.89 | 2.97 | 19.5 |
| 2613 | E 604 Not Relevant 9.91 0.503 | 1228 0.446 | 4.90 | 3.06 | 18.9 |
| 2613 | E 1960 Not Judged 9.95 0.499 | 855 0.486 | 4.86 | 3.24 | 18.7 |
| 3187 | F 48 Relevant 10.6 0.580 | 597 0.554 | 5.17 | 4.32 | 21.2 |
| 3187 | F 707 Not Relevant 10.1 0.484 | 503 0.577 | 5.20 | 3.49 | 19.8 |
| 3187 | F 2432 Not Judged 9.78 0.434 | 367 0.600 | 5.12 | 4.53 | 19.6 |
| 21 | G 183 Relevant 10.3 0.452 | 241 0.629 | 5.18 | 6.25 | 20.8 |
| 21 | G 2526 Not Relevant 9.90 0.409 | 189 0.644 | 5.17 | 7.29 | 20.3 |
| 21 | G 19232 Not Judged 9.55 0.388 | 169 0.651 | 5.10 | 8.73 | 19.6 |
| 3539 | H 21 Relevant 9.24 0.397 | 535 0.588 | 4.91 | 21.1 | 13.7 |
| 3539 | H 490 Not Relevant 8.83 0.402 | 643 0.543 | 4.85 | 27.0 | 11.7 |
| 3539 | H 3028 Not Judged 8.17 0.331 | 467 0.566 | 4.83 | 27.1 | 14.5 |
| 1096 | I 6 Relevant 9.12 0.460 | 377 0.603 | 4.35 | 51.1 | 18.7 |
| 1096 | I 145 Not Relevant 8.33 0.275 | 677 0.610 | 4.29 | 77.2 | 17.0 |
| 1096 | I 945 Not Judged 7.12 0.150 | 250 0.691 | 4.67 | 65.2 | 24.9 |
| 10 | J 41 Relevant 10.1 0.476 | 107 0.743 | 5.23 | 6.31 | 22.4 |
| 10 | J 1052 Not Relevant 10.4 0.330 | 75 0.800 | 5.24 | 7.25 | 20.2 |
| 10 | J 9832 Not Judged 10.1 0.328 | 70 0.805 | 5.15 | 8.14 | 19.5 |

Table 4. Clusters based on stylistic data, and their proportions of relevant documents
made to see how well and consistently the articles were categorized in the genres given; the idea was simply to have a seed set to cluster the documents around. In Table 4 some statistics for each category are shown; the category names have been replaced with letters so as not to imply the categories are consistent with real life genres.5

The hypothesis was that a simple stylistic clustering might well prove useful thanks to its anchoring in genre, and in spite of this anchoring being quite tentative. The table shows that there are considerable differences between the categories in stylistic metrics – unsurprisingly, since they have been clustered to maximise that difference – but more importantly, the categories show considerable differences in how large a proportion of the documents are relevant, and most importantly, in how the relevant documents differ from the nonrelevant ones stylistically. For instance, whereas in category A, relevant documents will have longer sentences on average than non-relevant and non-retrieved documents, in categories C and H the relevant documents will have shorter sentences; and whereas most categories prefer documents with a low type-token ratio, category H prefers documents with a high ratio.6

6 Conclusions

Texts differ in style. In this experiment, automatically retrieved texts differed from non-retrieved texts along several simple stylistic metrics. This shows that either 1) retrieval mechanisms are biased for style, or more likely, 2) style and topic go hand in hand. Neither of these results are surprising. Nonetheless, they may be a useful point to note for information retrieval system designers.

What is more interesting, and a good starting point for user-oriented information retrieval studies is utilizing this type of measure in distinguishing interesting texts from less interesting ones. This will entail analyzing the tasks and expectations of users; this experiment shows that for a certain set of users and for a certain scenario a clear bias towards a certain types or genres of text can be found, namely the one between relevant and non-relevant in the experiment.

The experiment also shows that stylistically determined genres or functional styles are different as regards potential usefulness for the queries tested, and that the distinctions between relevant and non-relevant differ between genres.

The differences between relevant and non-relevant texts found should not be taken as general results: while useful in a TREC context, as shown by the results from Cornell, they are clearly an effect of the task, corpus, and assessors. These results should be taken as a starting point in investigating how situations affect measures of stylistic variation.

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5 The determined reader will be glad to know that the order of the document clusters in the table is the same as in the listing of the hand assessed seed categories in the beginning of the paragraph.

6 These differences are significant on a better than 95% level, by Mann Whitney U; most numbers in Table 4 have not been checked, however.
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