Investigating Lexical and Syntactic Differences in Written and Spoken English Corpora

Presented by

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Outline

Introduction

- Disparities between speaking and writing form an important narrative.

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- Disparities between speaking and writing form an important narrative.
- Challenges in deriving precise algorithms.
- Understanding these differences aids cognitive insights.
- Focus on Syntactic and lexical differences in speeches and writings :

  CoreNLP and BERT(Text analysis)

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- Research Questions:

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  1. Which syntactic features best differentiate written text from speech transcription?
  2. Which lexical features best differentiate written text from speech transcription?
  3. Do feature-based algorithms or BERT perform better at this task?

Related Work

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- Biber (1986a,b) analyzed linguistic features, revealing four textual dimensions.

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- Freedman and Krieghbaum (2014-2017) used machine learning to analyze educational dialogues and writing styles.

Datasets

- Transcriptions of presidential speeches and books from George Washington.

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- Texts are preprocessed to remove:
  1. Numbers
  2. Currency values
  3. Excess whitespace
  4. Chunked into 512 tokens using nltk to standardize length.

Features

- Morphological aspects:

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  1. Average syllables per word

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  2. Readability

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1. Number of words in a sentence
2. Percentage of POS (verb, adjective, noun, adverb, coordinators)
3. Percentage of personal pronouns (first, second, and third)

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Syntactical aspects:

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1. Frequency and percentage of subordinate clauses

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1. Frequency and percentage of subordinate clauses
2. Depth of parse tree
3. Frequency and percentage of noun phrases
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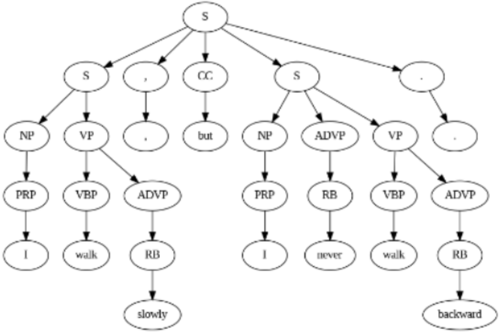
Text-level aspects:

1. Sentences

Features

- CoreNLP was used to parse sentences.
- Tree generated by CoreNLP for the sentence -I walk slowly, but I never walk backward.



Experiments

Three experiments were conducted to derive significant features from text data using various machine learning techniques.

- Experiment 1: Parse Trees and Feature Extraction:
  - Extracted features based on sentence parse trees.
  - Used SVM and Random Forest models for classification.
  - Removed highly correlated features (e.g., character count, verb count) to avoid redundancy.

Experiments

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- Experiment 2: Lexical Diversity and Readability:
  - Calculated metrics such as ARI, Flesch-Kincaid, TTR, and more.
  - Removed outliers (data points greater than 3 standard deviations from the mean).
  - Applied Random Forest to the refined metrics.
  - Retained impactful features like average sentence length, word length, and Maas, which measures lexical diversity unaffected by text length.

Experiments

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- Experiment 3: Used BERT to distinguish between writing and speaking styles:
  - Trained BERT model on sentences from original data.
  - Focused on transcribed speeches vs written books by US presidents.
  - Demonstrated BERTâs effectiveness, suggesting deep neural networks can enhance text classification.

Results

Experiment 1: Syntactic Features

```
Model Performance:

SVM Accuracy: 54%
Random Forest Accuracy: 61%
RF outperformed SVM and the other models.
```

Key features included length, noun percentage, verb percentage, and parse tree depth etc.

Results

Experiment 2: Lexical Diversity

```
Model Performance:

RF Accuracy with Complexity Metrics: 72.2%
Added Avg_Sentence & Word_Length: 79.2%
After Removing Correlated Features: 87.4%
Only Avg_Sentence & Word_Length: 92.9%
```

Key features such as word length, average sentence length, and Maas effectively distinguish speeches from written text more than complex methods.

Results

Experiment 3: Differentiating with BERT

```
Model Performance:

Accuracy: 90% using the ktrain library.
Batch size = 6, max features = 35,000.
BERT outperformed both SVM and RF
```

Data: Random under-sampling for balance. Split: 80/20. Validation: Random forest (max depth 15) for feature importance.

Tables

Table 1: Evaluation of Syntactic Models and BERT

	Labels	Precision	Recall	F1
SVM	Spoken	58.6%	24.3%	34.4%
	Written	52.2%	82.7%	64.0%
RF	Spoken	60.9%	61.0%	61.0%
	Written	61.0%	60.9%	60.9%
BERT	Spoken	89.9%	90.4%	**90.1%**
	Written	90.6%	90.1%	**90.3%**

Table 3: Hypothesis Testing for Lexical Features

Feature	p-value
maas	1.95e-9
Average Sentence Length	1.31e-5
Average Word Length	1.78e-4

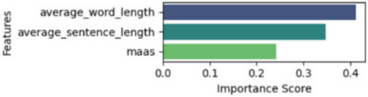
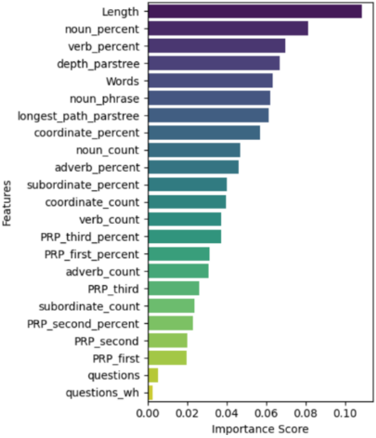


Figure 4: Feature Importance for Lexical Features



Conclusions

- 1. Syntactic Features Distinction:
    - Key features like sentence length and parse tree depth effectively differentiate spoken from written texts.
- 2. Effectiveness of Simple Lexical Metrics:
    - Average word and sentence length outperformed complex metrics, significantly enhancing the accuracy.
- 3. Superiority of BERT:
    - Achieved the highest accuracy, without extensive feature engineering.
    - Traditional models remain valuable for identifying features, aiding in the interpretability of text classification tasks.

Limitations and the Future Work

- Limited Access to Primary Sources and Complexity in Feature Coding
  - Restricted access to presidential books limited dataset diversity.
  - Complex feature coding due to ambiguous definitions.
- Expanding the Dataset and Adding More Linguistic Features:
  - Expand the dataset with more sentences.
  - Add features to improve model accuracy..
  - Develop better AI techniques for distinguishing speech from writing.


Thank you