Writing Style Change Detection on Multi-Author Documents

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Overview of the Approach

• Use Authorship Verification for Style Change Detection

• Authorship Verification:
  ◦ Given two documents, predict if they were written by the same person
  ◦ PAN 2020 Results: 0.953 AUC, 0.891 F1-Score
  ◦ PAN 2021 Results: 0.972 AUC, 0.926 F1-Score
  ◦ ~ 275k document pairs, ~4.8k tokens per document

• Style Change Detection:
  ◦ ~ 11k training records
  ◦ ~ 52 tokens per paragraph
Authorship Verification Approach

Feature Extraction & Scaling

Logistic Regression Classifier

Classifier Probability ($P$)
Style Change Predicting

\[ \text{AV Approach} \]

\[ \text{AV}(p_1, p_2) \]
\[ \text{AV}(p_1, p_3) \]
\[ \text{AV}(p_1, p_4) \]
\[ \vdots \]
\[ \text{AV}(p_{n-1}, p_n) \]

\[ \frac{n(n-1)}{2} \text{ pairs} \]

\[ (p_1, p_2) \]
\[ (p_1, p_3) \]
\[ (p_1, p_4) \]
\[ \vdots \]
\[ (p_{n-1}, p_n) \]

Task Predictions

\[ \text{Task 3 Ground Truth} \]
Features

- Character tri-grams (TF – IDF)
- Special Characters (TF – IDF)
- Frequency of Function Words
- Average number of characters per word
- Distribution of word-lengths (1-10)
- Vocabulary Richness measures*
- Unique Spellings (fraction of tokens)*
  - Commonly misspelled words, British spelling of words, and popular online abbreviations

* Included after early submission
Features

Example:
There should be some setting file to edit manually I guess.

POS Tags:
[['There', 'EX'], ['should', 'MD'], ['be', 'VB'], ['some', 'DT'], ['setting', 'VBG'], ['file', 'NN'], ['to', 'TO'], ['edit', 'VB'], ['manually', 'RB'], ['I', 'PRP'], ['guess', 'VBP'], ['.', '.']]

Parse Tree:
(S
  (NP There/EX)
  (VP should/MD be/VB)
  (NP some/DT setting/VBG file/NN)
  (VP to/TO edit/VB)
  manually/RB
  (NP I/PRP)
  (VP guess/VBP)
  ./.
)

- POS-Tag tri-grams (TF – IDF)
- POS-Tag Chunk tri-grams (TF – IDF):
  - [NP, VP, NP, VP, RB, NP, VP, .]
- POS Tag chunk construction (TF – IDF):
  - [NP[EX], VP[MD VB], NP[DT VBG NN], VP[TO VB], NP[PRP], VP[VBP]]
- Function-word and POS tag hybrid tri-grams*:
  - [There should be some VBG NN to VB RB I VBP .]
- POS tag ratios*

* Included after early submission
Task 1: Single vs. Multiple

- Predict: Whether the text is written by a single author or by multiple authors
- If mean AV score of adjacent paragraphs $> 0.5 \Rightarrow$ Multi-Author

$$\frac{\sum_{i=1}^{n-1} AV(p_i, p_{i+1})}{n - 1} > 0.5$$
Task 2: Style Change Basic

- Find the position of style changes
- If AV score for two adjacent paragraphs $> 0.5 \Rightarrow$ style change
- $AV(p_i, p_{i+1}) > 0.5 \quad \forall i \in [1, n - 1]$
Task 3: Style Change Real-World

- Uniquely identify each author (max 4 authors)
- Use hierarchical clustering to cluster authors with similar writing style
- Use a threshold of 0.5
- If > 4 clusters, set max_clust=4
## Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Submission</td>
<td>0.622</td>
<td>0.640</td>
<td>0.326</td>
</tr>
<tr>
<td>Local Validation Set</td>
<td>0.649</td>
<td>0.644</td>
<td>0.428</td>
</tr>
<tr>
<td><strong>Final Evaluation</strong></td>
<td><strong>0.634</strong></td>
<td><strong>0.657</strong></td>
<td><strong>0.432</strong></td>
</tr>
</tbody>
</table>
Thank You!

Questions:
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Source Code and Models:
https://github.com/rhiats/style_change_detection_pan2021

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