Deceiving Authorship Detection

Tools to Write Anonymously & Current Trends in Adversarial Stylometry.

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Privacy, Security and Automation Lab

- Faculty
  - Dr. Rachel Greenstadt
- Graduate Students
  - Sadia Afroz (Deception Detection Lead)
  - Diamond Bishop
  - Michael Brennan
  - Aylin Caliskan
  - Ariel Stolerman (JStylo Lead Developer)
- Undergraduate Students
  - Pavan Kantharaju
  - Andrew McDonald (Anonymouth Lead Developer)

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26C3/28C3 Diff

- Review & Updated Analysis of 26C3 Material
  - New Corpus (45 authors)
  - New Method (Writeprints)
  - Much more robust results.
- The tools we discussed are now built!
  - JStylo
  - Anonymouth
- Detecting Deception in Adversarial Writing

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An Overview

- What is “Authorship Recognition” and “Adversarial Stylometry”?
- What is the anonymity threat?
- Analyzing & Deceiving Authorship Recognition
- Two Tools
  - JStylo
  - Anonymouth
- Detecting Deception

What is Authorship Recognition?

- The basic question: “who wrote this document?”
- **Stylometry**: The study of attributing authorship to documents based only on the linguistic style they exhibit.
  - “Linguistic Style” Features: sentence length, word choices, syntactic structure, etc.
  - Handwriting, content-based features, and contextual features are not considered.
  - Individuals have unique writing styles because language is learned on an individual basis.
- In this presentation, stylometry and authorship recognition are used interchangeably.

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What is Adversarial Stylometry?

- Adversarial Stylometry: Applying deception to writing style in order to affect the outcome of stylometric analysis.
  - But, is writing style modifiable? (Yes!)
  - Is it possible to deceive stylometry through altered writing style? (Yes!)
  - What are the implications of looking at stylometry in an adversarial context?

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How Can Stylometry be a Threat?

- Supervised Stylometry
  - Given a set of documents of known authorship, classify a document of unknown authorship.
  - Hypothetical Scenario: Alice the Anonymous Blogger vs. Bob the Abusive Employer.
- Unsupervised Stylometry
  - Given a set of documents of unknown authorship, cluster them into author groups.
  - Hypothetical Scenario: Anonymous Forum vs. Oppressive Government.

Purely Hypothetical?

- Previous examples are purely hypothetical. What about a real example?
- From "Inside WikiLeaks" by Daniel Domscheit-Berg:
  - "I nudged Julian with my foot. We exchanged glances and started giggling. If someone had run WikiLeaks documents through such a program, he would have discovered that the same two people were behind all the various press releases, document summaries, and correspondence issued by the project. The official number of volunteers we had was also, to put it mildly, grotesquely exaggerated."

Adversarial Stylometry: A Review

- Understand the threat model
- Build a corpus.
- Evaluate current methods of stylometry against adversarial text.
- Analyze results and develop tools.

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Threat Model

- Threat: Authorship recognition can identify you if there are sufficient writing samples and a set of suspects.
  - 6500+ words of training data per author
  - 500+ words of testing data
  - 50 or less suspects
  - These may be different:
    - Tweets (short messages)
    - Large numbers of authors (Writeprints)
- Old assumption: Writing style is invariant.
  - It's like a fingerprint, you can't really change it.

Circumvention Methods

- Challenge: conceive methods of circumventing writing style analysis.
  - **Obfuscation**
    - An author attempts to write a document in such a way that their personal writing style will not be recognized.
  - **Imitation**
    - An author attempts to write a document such that the writing style will be recognized as that of another specific author.
  - **Translation***:
    - Machine translation is used to translate a document to one or more languages and then back to the original language.

Building a Corpus

- Corpus = Dataset of documents.
- Data sets for adversarial stylometry do not exist. Participants are required to craft intentionally adversarial passages.
- Participation had three parts:
  - Submit 6500 words of pre-existing writing from a formal source.
  - Write a new 500 word obfuscation passage.
    - Task: Describe your neighborhood.
  - Write a new 500 word imitation passage.
    - Task: Imitate Cormac McCarthy, describe your day.
- Authors had no formal training or knowledge in linguistics or stylometry.

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Brennan-Greenstadt Corpus

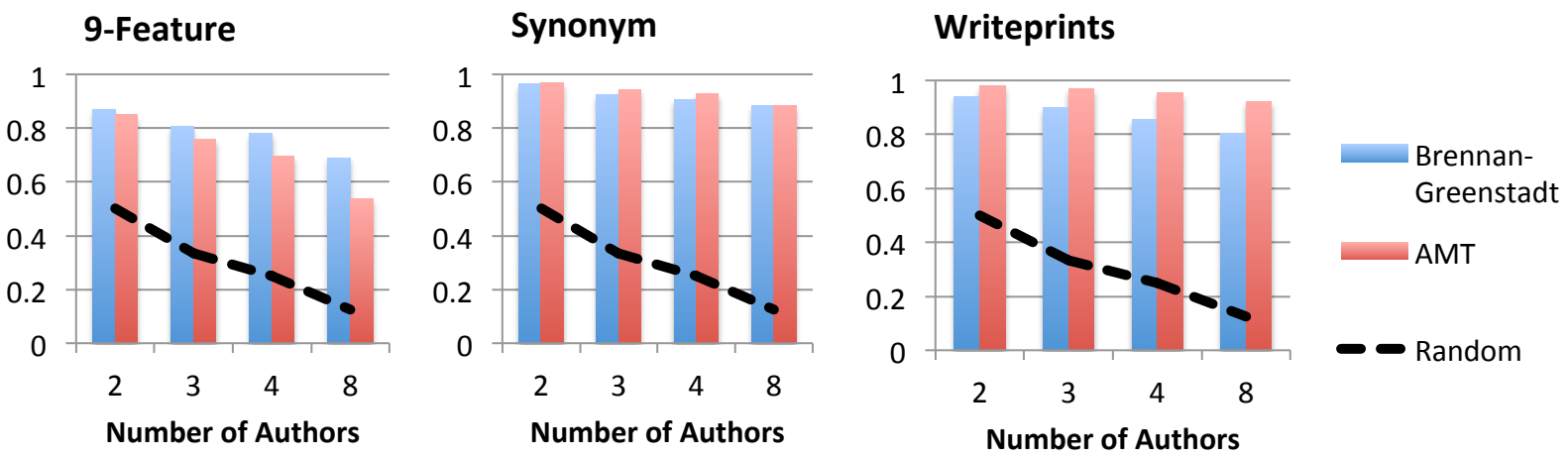
- 12 Individual Authors.
- Participants contacted through classes, colleagues, friends at Drexel University.
  - Motive for proper participation.
- One-on-one interaction with participants.
- Corpus is publicly available at https://psal.cs.drexel.edu
- Good for preliminary results, but we need something better.
  - Too small.
  - Too homogenous.

Building a Better Corpus with Amazon Mechanical Turk

- Drexel AMT Corpus
  - AMT = Amazon Mechanical Turk
- Same tasks as previous corpus.
- Only 45 of 101 of submissions are usable!
  - 45 Accepted Submissions.
  - Guidelines without spoiling data set. Must follow directions and:
    - Pre-existing writing must be formal in nature
    - Remove non-content
    - Minimal dialogue/quotations
    - Refrain from submitting: small samples, lab reports, Q&As, etc.
- Released today. Publicly available at https://psal.cs.drexel.edu
- This corpus is large, diverse, and unique.

Original vs. AMT Corpus

- AMT Corpus evaluated just as strongly as Drexel.
  - 9-Features does worse, Synonym does the same, Writeprints does better.



Evaluate Stylometry Methods Against the Corpus

- Three methods of Stylometry
  - 9-Feature / Neural Network
  - Synonym-Based Approach
  - Writeprints / SVM

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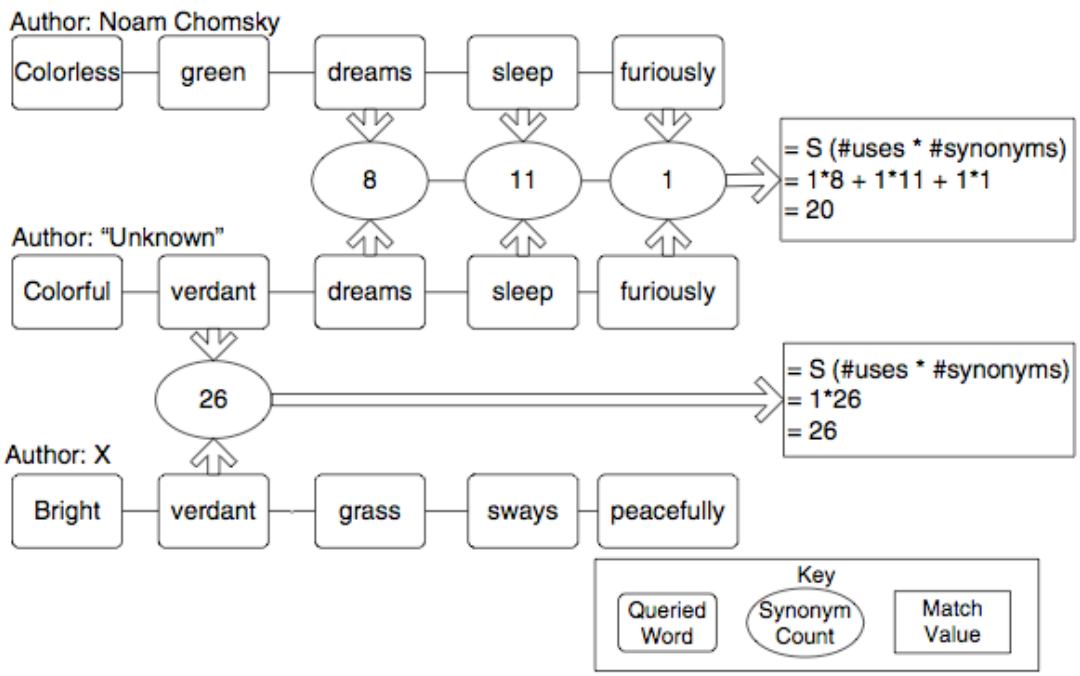
Method 1:
9-Feature Set Neural Network

- Simple stylometric approach. Demonstrates potential effectiveness with a small number of obscure metrics.
- 9-Feature Set
  - Unique words, Complexity, Sentence Count, Average Sentence Length, Average Syllable Count, Character Count, Letter Count, Gunning-Fog Readability Index, Flesch Reading Ease Score.
- Neural Network Classifier.

Method 2: Synonym-Based Approach

- Examines word choices when compared to available synonyms and frequency of use.
- Clark & Hannon, 2007.
- Good demonstration of single feature type stylometry.



Method 3: Writeprints (SVM)

- Based on the Writeprints approach by Abbasi & Chen, 2008.
  - Writeprints Baseline Feature Set.
  - Contains hundreds of features including character and word n-grams, function words, parts-of-speech tags, punctuation, and character level metrics.
- Support Vector Machine Classifier
  - Standard for multi-class classification in stylometry.
- Implementation of the full Writeprints approach uses a more extensive feature set and unique classification approach.

Detecting Authorship

- Four experiments.
  - **Baseline**: Evaluate the non-adversarial passages to establish a baseline accuracy for each method and feature set.
  - **Obfuscation**: Attempt classification of the obfuscation passages when classifiers are trained on the baseline data.
  - **Imitation**: Attempt classification of the imitation passages.
  - **Imitation Success**: Analyze the number of successful imitations.

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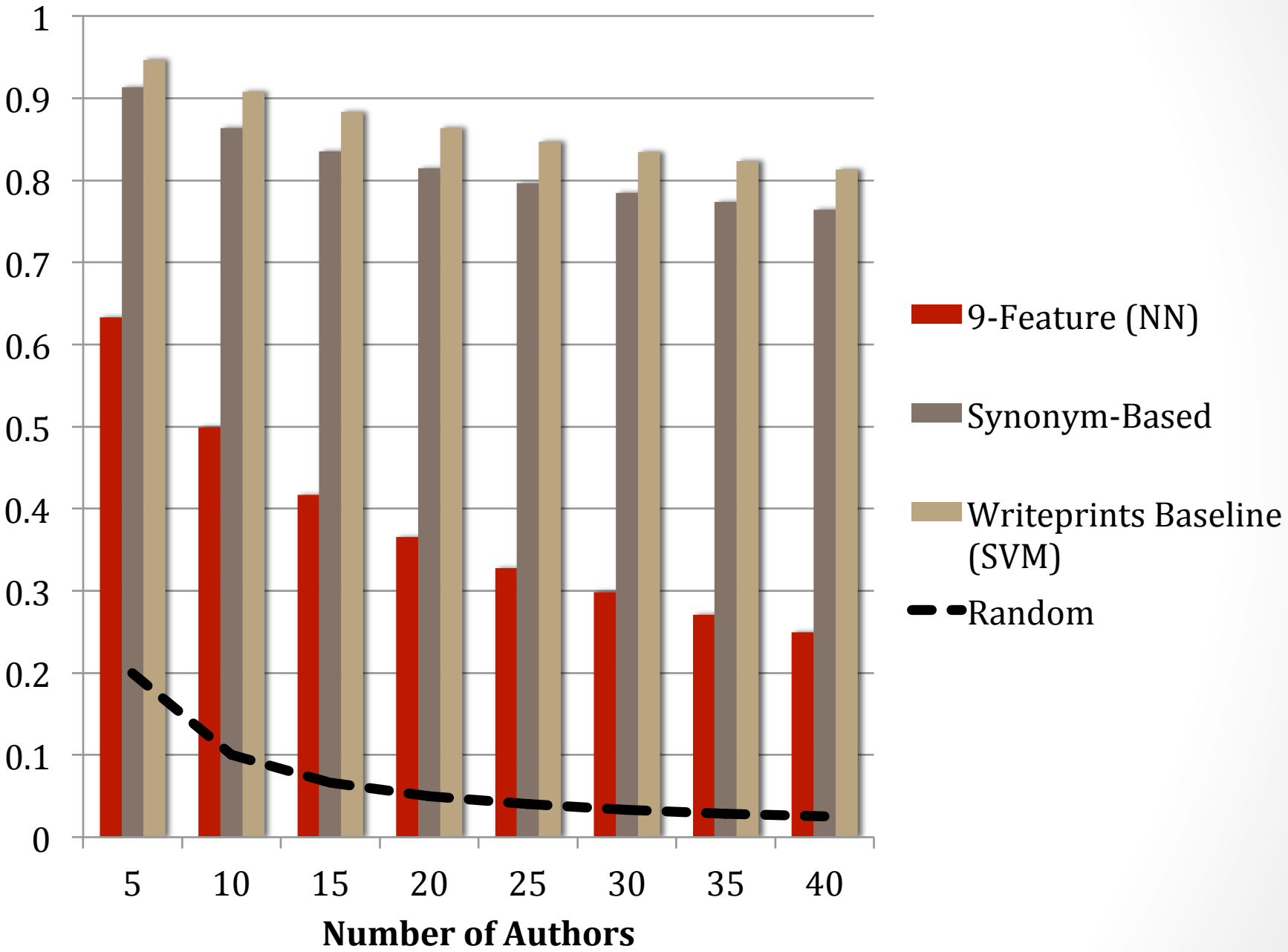
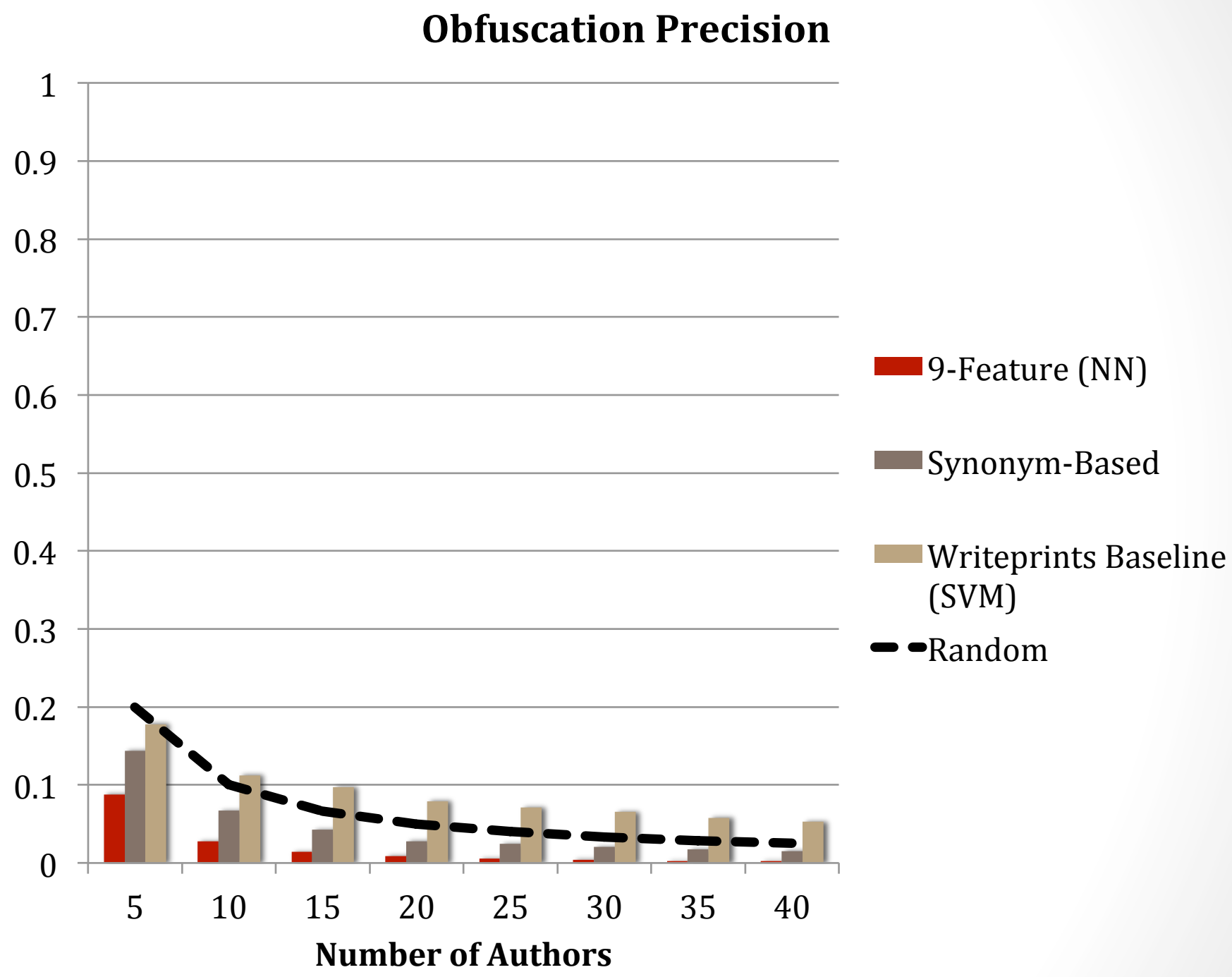
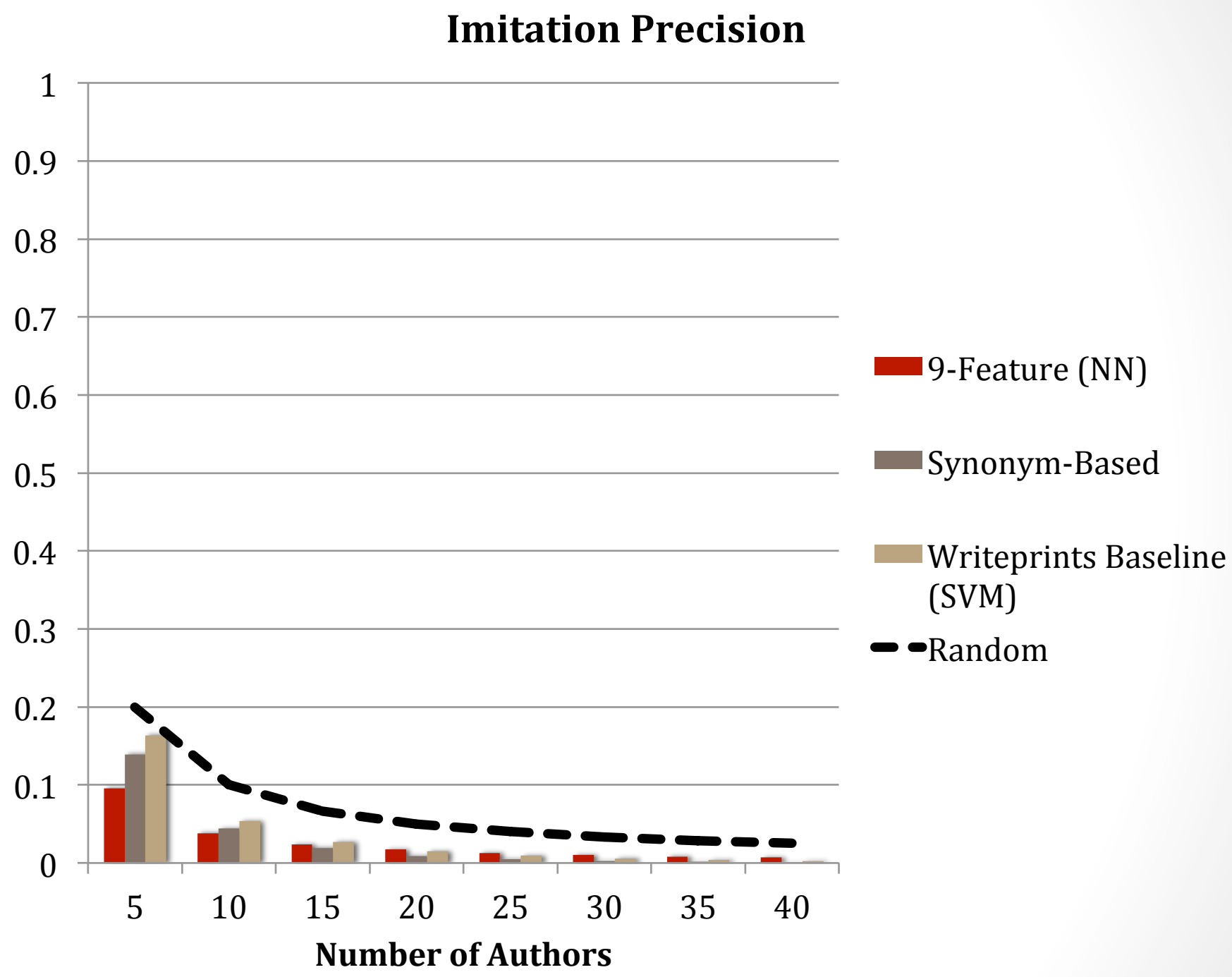
Baseline Precision




Obfuscation Precision
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Number of Authors
9-Feature (NN)
Synonym-Based
Writeprints Baseline (SVM)
Random


Imitation Precision
1
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0.8
0.7
0.6
0.5
0.4
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0.2
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0
5
10
15
20
25
30
35
40
Number of Authors
9-Feature (NN)
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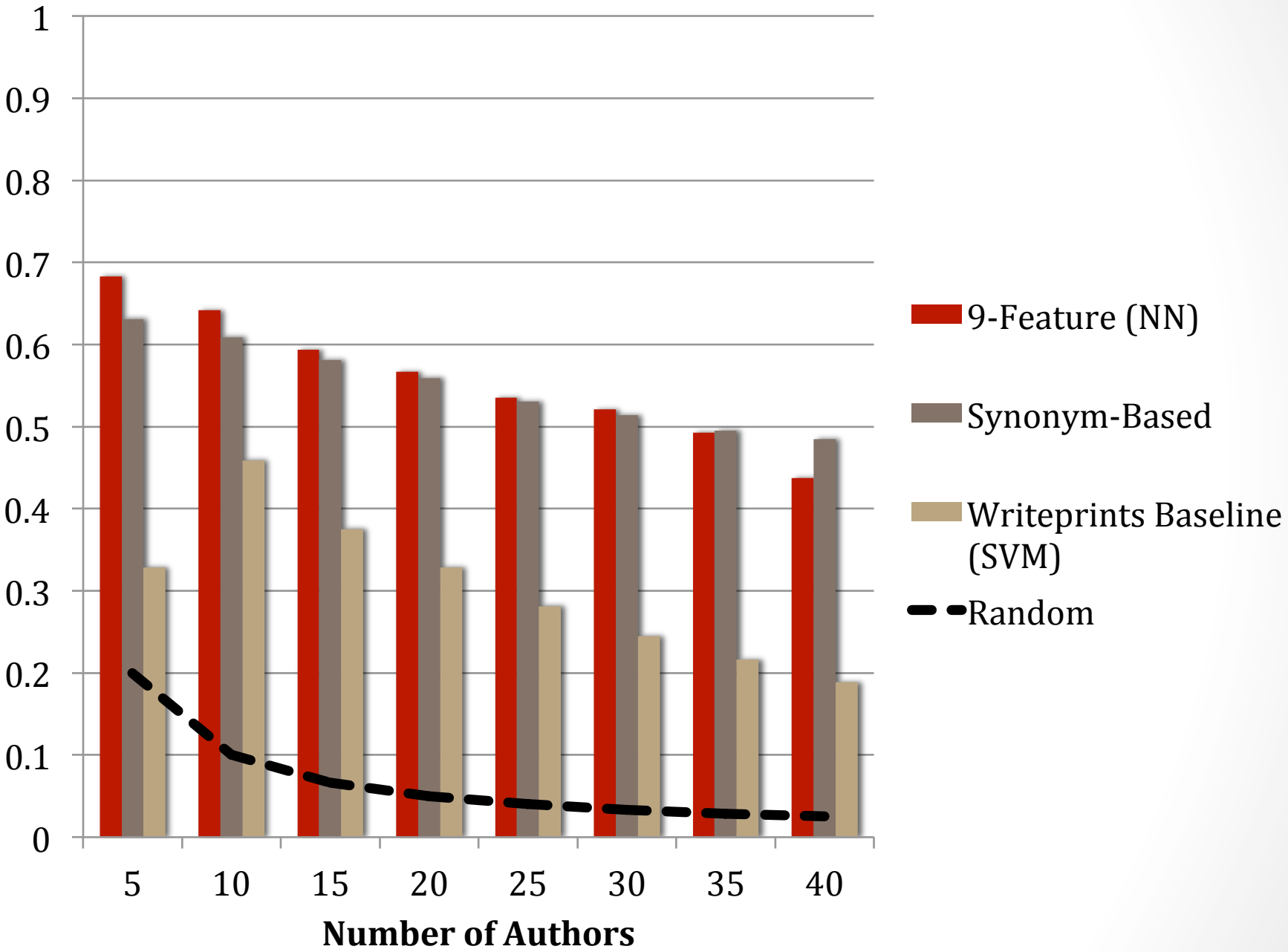
Random

Imitation Success (Framing Cormac McCarthy)



Two Tools

- JStylo: Authorship Recognition Analysis Tool.
- Anonymouth: Authorship Recognition Evasion Tool.
- Free, Open Source. (GNU GPL)
- Alpha releases available today at https://psal.cs.drexel.edu
  - Migrating to GitHub soon.

JStylo: The Problem

- Stylometry-based research is difficult.
- Existing tools are good but limited.
  - Weka provides a suite of machine-learning classification tools.
    - Not tailored for text analysis – no feature extraction ability.
    - Functions better as an API for software development.
  - JGAAP has a strong basic toolset for stylometry.
    - Limited in running multiple feature sets.
    - Strong API.
    - Extendable. Intended to be used this way.
- Nuances of stylometry are not easy to grasp.
- Many open research questions related to authorship. We need an easy-to-use tool that both researchers and non-technical users can understand.

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JStylo

- JStylo is an authorship recognition analysis tool. It is built upon a framework of:
  - JGAAP (Java Graphical Authorship Attribution Project)
  - Weka 3 Data Mining Software
- Features
  - Two existing adversarial corpora, featured in this presentation, and new corpus building functionality.
  - Wide selection of writing feature extractors and ability to add new extractors.
  - Wide selection of machine learning based classifiers.
  - Intuitive GUI.
- Alpha Release Available Now: https://psal.cs.drexel.edu

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JStylo Demo

JStylo

Documents | Features | Classifiers | Analysis

New Problem Set | Save Problem Set... | Load Problem Set...

Test Documents

Title	Path
aa_obfuscation.txt	./corpora/amt/aa/aa_obfuscation.txt
b_obfuscation.txt	./corpora/amt/b/b_obfuscation.txt
bb_obfuscation.txt	./corpora/amt/bb/bb_obfuscation.txt
c_obfuscation.txt	./corpora/amt/c/c_obfuscation.txt
cc_obfuscation.txt	./corpora/amt/cc/cc_obfuscation.txt
d_obfuscation.txt	./corpora/amt/d/d_obfuscation.txt
dd_obfuscation.txt	./corpora/amt/dd/dd_obfuscation.txt

Add Document(s)... | Remove Document(s) | Preview Document

Training Corpus

- amt_obfuscation
  - aa
  - b
  - bb
  - c
  - cc
  - d
    - d_01_1.txt
    - d_02_1.txt
    - d_03_1.txt
    - d_04_1_2.txt

Add Author... | Add Document(s)... | Edit Name...

Remove Author(s) | Remove Document(s) | Preview Document

Document Preview - d_obfuscation.txt

So I grew up kind of poor. It wasn't like a ghetto or anything but there sure weren't a lot of paved roads. I lived in a trailer on a bumpy dirt road with a lot of other trailers. I don't even know where the nearest grocery store was back then but it was kind of a trip. There was a gas station just up the way that had a convenience store with it and you could get some stuff to eat there if you didn't mind paying the extra for the "convenience." Right across the dirt road there wasn't anything but a big field but now it's a subdivision. My grandpa had a big yard and we got to play in that a lot. He even had a pond that you could catch frogs in if you were real patient. It was real quiet at night because there wasn't much traffic and you could really see the stars because there weren't a lot of houses to brighten up the sky at night and there still aren't any streetlights. I remember we weren't allowed in the field across the road because it was private property and we'd get in trouble if any of us got hurt playing over there. We went anyway. My bus stop was always down at the convenience store because there was an old subdivision down there that more kids lived in and I was the only one that lived on the dirt road. I didn't mind the walk because when you're a kid any time that you get to spend alone without any parents or teachers to bother you is a good time and I liked feeling independent and grown-up enough to walk all the way down the street on my own.

Anyway the place is a lot different now. There's a Winn-Dixie and a Wal-Mart and even a Target a bit farther away. That subdivision is there now. The houses are getting kind of run down and the gas station convenience store has an Asian bakery in it now. It's a good bakery and it's the only place in town

Clear Preview

About... | Next

(send bug reports, suggestions, questions to ariels@drexel.edu)

JStylo

Documents | Features | Classifiers | Analysis

New Problem Set | Save Problem Set... | Load Problem Set...

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bb_obfuscation.txt	./corpora/amt/bb/bb_obfuscation.txt
c_obfuscation.txt	./corpora/amt/c/c_obfuscation.txt
cc_obfuscation.txt	./corpora/amt/cc/cc_obfuscation.txt
d_obfuscation.txt	./corpora/amt/d/d_obfuscation.txt
dd_obfuscation.txt	./corpora/amt/dd/dd_obfuscation.txt

Add Document(s)... | Remove Document(s) | Preview Document

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  - aa
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  - bb
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  - cc
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Add Author... | Add Document(s)... | Edit Name...

Remove Author(s) | Remove Document(s) | Preview Document

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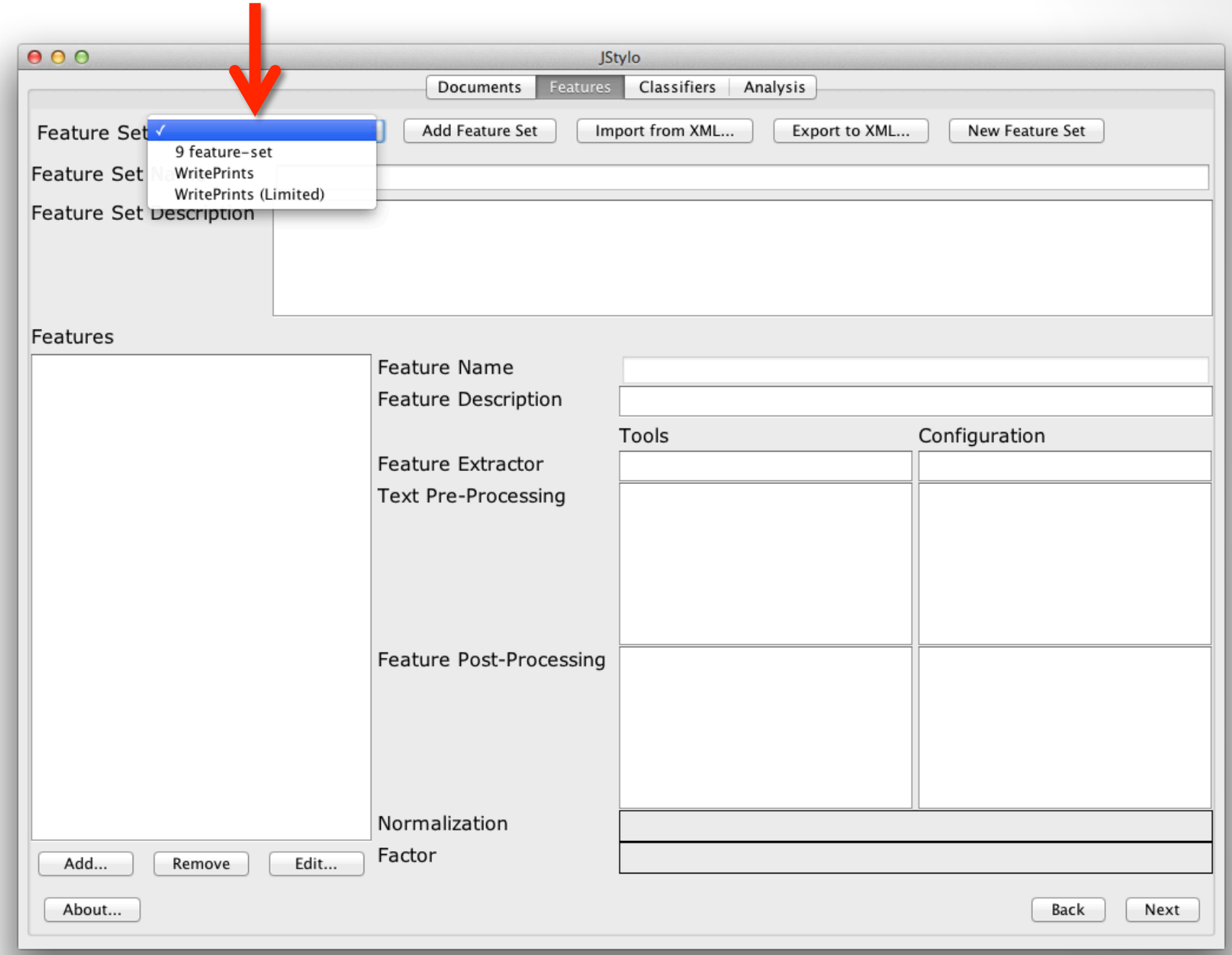

(send bug reports, suggestions, questions to ariels@drexel.edu)

JStylo

Documents | Features | Classifiers | Analysis

Feature Set: 9 feature-set

Add Feature Set | Import from XML... | Export to XML... | New Feature Set

Feature Set Name: 9 feature-set

Feature Set Description: 9 features used by Brennan and Greenstadt.

Features

- Unique Words Count
- Complexity
- Sentence Count
- Average Sentence Length
- Average Syllables in Word
- Gunning-Fog Readability Index
- Character Space
- Letter Space
- Flesch Reading Ease Score

Add... | Remove | Edit...

Feature Name	Complexity	
Feature Description	Ratio of unique words to total number of words in the document.	
	Tools	Configuration
Feature Extractor	Unique words count	
Text Pre-Processing	Word-edges Punctuation Stripper Unify Case	
Feature Post-Processing		
Normalization	Number of words in the document	
Factor	1.0	

About... | Back | Next

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About... | Back | Next

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JStylo

Documents | Features | Classifiers | Analysis

Available WEKA Classifiers

- weka
  - classifiers
    - bayes
      - NaiveBayes
      - NaiveBayesMultinomial
    - functions
      - Logistic
      - MultilayerPerceptron
      - SMO
    - lazy

Selected WEKA Classifiers

weka.classifiers.functions.SMO

Classifier Arguments

' 1 -K weka.classifiers.functions.supportVector.PolyKernel -C 250007 -E 1.0

Add

Classifier Arguments

Remove

Classifier Description

that case the coefficients in the output are based on the normalized data, not the original data --- this is important for interpreting the classifier.)

Multi-class problems are solved using pairwise classification (1-vs-1 and if logistic models are built pairwise coupling according to Hastie and Tibshirani, 1998).

To obtain proper probability estimates, use the option that fits logistic regression models to the outputs of the support vector machine. In the multi-class case the predicted probabilities are coupled using Hastie and Tibshirani's pairwise coupling method.

Note: for improved speed normalization should be turned off when operating on SparseInstances.

For more information on the SMO algorithm, see

J. Platt: Fast Training of Support Vector Machines using Sequential Minimal Optimization. In B. Schoelkopf and C. Burges and A. Smola, editors, Advances in Kernel Methods - Support Vector Learning, 1998.

S.S. Keerthi, S.K. Shevade, C. Bhattacharyya, K.R.K. Murthy (2001). Improvements to Platt's SMO Algorithm for SVM Classifier Design. Neural Computation. 13(3):637-649.

Trevor Hastie, Robert Tibshirani: Classification by Pairwise Coupling. In: Advances in Neural Information Processing Systems, 1998.

About... | Back | Next

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JStylo

Documents | Features | Classifiers | Analysis

Analysis Type

- (•) Train on training corpus and classify test doc...
- ( ) Run 10-folds cross validation on training cor...

Configuration

- [x] Output feature vectors (ARFF format)
- [x] Use sparse representation for feature vectors

Post Analysis

Training to ARFF... | Training to CSV...

Test to ARFF... | Test to CSV...

Run Analysis | Stop

Results

2011-12-28, 13:59:31 | 2011-12-28, 14:04:39 | 2011-12-28, 14:12:27 | 2011-12-28, 14:23:35

```
{0 233,1 0.47166,2 26,3 19,4 1.550607,5 12.215385,6 2663,7 2084,8 56.368623,9 _dummy_}
2011-12-28, 14:23:40 Starting training and testing phase...

===============================================================================

Running analysis with classifier 1 out of 1:
> Classifier: weka.classifiers.functions.SMO
> Options:    -C 1.0 -L 0.0010 -P 1.0E-12 -N 0 -V -1 -W 1 -K weka.classifiers.functions.supportVector.PolyKernel -C 250007 -E 1.0

2011-12-28, 14:23:40 Starting classification...
2011-12-28, 14:23:40 done!

Results:
========
doc \ author      aa                b                 bb                c                 cc                d
-----------------------------------------------------------------------------------------------------------------
aa_obfuscation.txt   0.222222         0.185185          0.148148          0.259259 +        0.074074          0.111111
b_obfuscation.txt   0.185185         0.148148          0.259259 +        0.222222          0.074074          0.111111
bb_obfuscation.txt   0.222222         0.185185          0.259259 +        0.148148          0.074074          0.111111
c_obfuscation.txt   0.222222         0.148148          0.259259 +        0.185185          0.074074          0.111111
cc_obfuscation.txt   0.185185         0.148148          0.259259 +        0.222222          0.074074          0.111111
d_obfuscation.txt   0.222222         0.148148          0.259259 +        0.185185          0.111111          0.074074
dd_obfuscation.txt   0.222222         0.148148          0.259259 +        0.185185          0.111111          0.074074
```

Save Results...

About... | Back

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```
Results:
========
doc \ author      aa                b                 bb                c
-----------------------------------------------------------------------------------
aa_obfuscation.txt   0.222222        0.185185        0.148148        0.259259 +
b_obfuscation.txt   0.185185        0.148148        0.259259 +      0.222222
bb_obfuscation.txt   0.222222        0.185185        0.259259 +      0.148148
c_obfuscation.txt   0.222222        0.148148        0.259259 +      0.185185
cc_obfuscation.txt   0.185185        0.148148        0.259259 +      0.222222
d_obfuscation.txt   0.222222        0.148148        0.259259 +      0.185185
dd_obfuscation.txt   0.222222        0.148148        0.259259 +      0.185185
```

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Run Analysis | Stop

Results

2011-12-28, 13:59:31 | 2011-12-28, 14:04:39 | 2011-12-28, 14:12:27 | 2011-12-28, 14:23:35 | 2011-12-28, 14:23:54

```
Correctly Classified Instances          61               61.6162 %
Incorrectly Classified Instances        38               38.3838 %
Kappa statistic                          0.5338
Mean absolute error                      0.2127
Root mean squared error                  0.315
Relative absolute error                 89.4837 %
Root relative squared error             91.4539 %
Total Number of Instances               99

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 0         0         0          0        0           ?        ___
                 0.357     0.071     0.455      0.357    0.4         0.687    aa
                 0.647     0.159     0.458      0.647    0.537       0.841    b
                 0.842     0.075     0.727      0.842    0.78        0.95     bb
                 0.611     0.062     0.688      0.611    0.647       0.88     c
                 0.944     0.099     0.68       0.944    0.791       0.947    cc
                 0.077     0         1          0.077    0.143       0.817    d
Weighted Avg.    0.616     0.081     0.663      0.616    0.579       0.863

=== Confusion Matrix ===

  a  b  c  d  e  f  g   <-- classified as
```

Save Results...

About... | Back

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```
=== Summary ===

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               TP Rate   FP Rate   Precision   Recall   F-Measure   ROC Area  Class
                 0         0         0          0        0           ?        ___
                 0.357     0.071     0.455      0.357    0.4         0.687    aa
                 0.647     0.159     0.458      0.647    0.537       0.841    b
                 0.842     0.075     0.727      0.842    0.78        0.95     bb
                 0.611     0.062     0.688      0.611    0.647       0.88     c
                 0.944     0.099     0.68       0.944    0.791       0.947    cc
                 0.077     0         1          0.077    0.143       0.817    d
Weighted Avg.    0.616     0.081     0.663      0.616    0.579       0.863
```

(send bug reports, suggestions, questions to ariels@drexel.edu)

JStylo Dev Goals

- Wider selection of classification methods and features.
  - Writeprints, Synonym-based, more Weka methods.
  - Ensemble classifiers, weighted averaging.
  - Greater pre and post-processing options.
- Easier to use and understand for non-technical users.
  - Adding an online tutorial.
  - GUI installs of new feature extractors and classifiers.
- Logging and graphing results over multiple experiments.
  - Visualization of documents, authors, and classifications.

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Anonymouth: The Problem

- Authorship recognition can be a legitimate threat to privacy and anonymity.
- Intuition in changing writing style goes a long way, but may not be enough and may not be sustainable over multiple documents.
  - We already see methods that offer some resistance to adversarial passages.
- Fully automated text anonymization is an intractable problem.
  - We need a solution that explains authorship recognition nuances as needed and assists the authoring making the most useful changes towards anonymity.

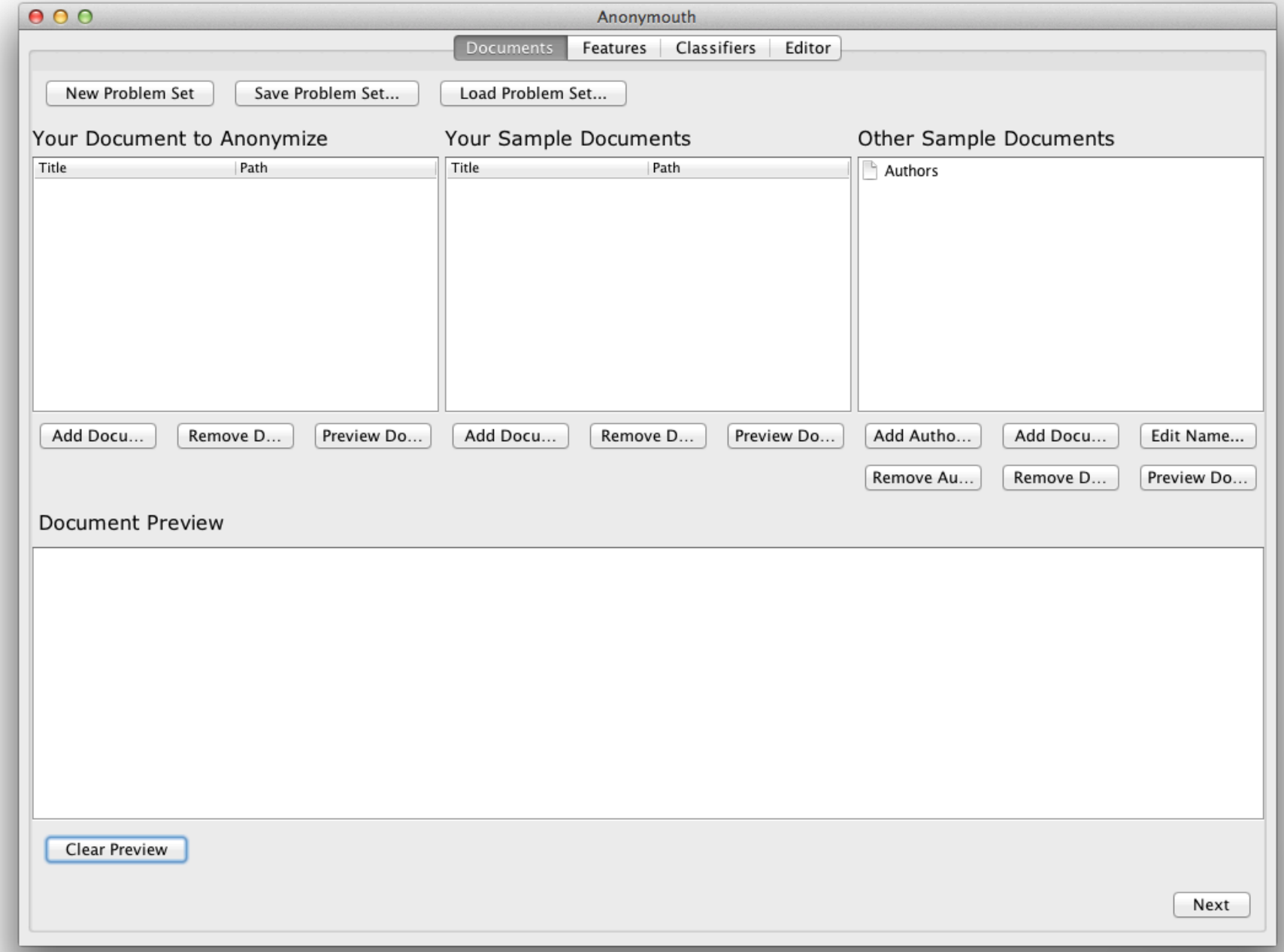
Drexel UNIVERSITY

Anonymouth

- Anonymouth is an authorship recognition circumvention tool. It is built upon a framework of:
  - JStylo (JGAAP & Weka)
  - WordNet
- Features
  - Corpora, feature extractor, and classifier functionality from JStylo.
  - Suggestion system for modifying documents to evade authorship detection. Ideal value for each feature is calculated, existence of the features is highlighted, user is assisted in changing them.
  - Iterative approach to anonymizing writing style.
    - Dictionary / Synonyms / Interactive Editing Console
- Alpha Release Available Now: https://psal.cs.drexel.edu

Drexel UNIVERSITY

Anonymouth Demo



(send bug reports, suggestions, questions to awm32@drexel.edu)

Anonymouth

Documents | Features | Classifiers | Editor

New Problem Set... | Save Problem Set... | Load Problem Set...

Your Document to Anonymize

Title	Path
a_09_3.txt	/Users/robotcaptain/Dow...

Add Docu... | Remove D... | Preview Do...

Your Sample Documents

Title	Path
a_01_1.txt	/Users/robotcaptain/Dow...
a_02_1_2.txt	/Users/robotcaptain/Dow...
a_03_2.txt	/Users/robotcaptain/Dow...
a_04_2_3.txt	/Users/robotcaptain/Dow...
a_05_3.txt	/Users/robotcaptain/Dow...
a_07_3.txt	/Users/robotcaptain/Dow...
a_08_3.txt	/Users/robotcaptain/Dow...
a_10_3.txt	/Users/robotcaptain/Dow...
a_11_3.txt	/Users/robotcaptain/Dow...
a_12_3.txt	/Users/robotcaptain/Dow...
a_06_3.txt	/Users/robotcaptain/Dow...

Add Docu... | Remove D... | Preview Do...

Other Sample Documents

- Authors
  - d
  - b
  - c
    - c_01_1.txt
    - c_02_1.txt
    - c_03_1.txt
    - c_04_1.txt
    - c_05_1.txt
    - c_06_1.txt
    - c_07_1.txt

Add Autho... | Add Docu... | Edit Name...

Remove Au... | Remove D... | Preview Do...

Document Preview - a_09_3.txt

life often contains.

Machismo, sometimes classified as a psychological trait, at its simplest, is the belief of male superiority. Machismo is meant to be acted out as a positive ideal, focusing on the protection of women, children, and those less fortunate (Vigil 37). In Hispanic culture, machismo is a defining aspect of a male's identity (Brezinka). Most men view this as a source of pride and honor, but Vigil suggests that when a man's basic function, as defined by machismo, is threatened by environmental factors (like an inner-city neighborhood), he must seek to assert his manhood and reconcile the psychological tension, or cognitive dissonance he feels (Vigil 37-8, Anderson et. al, 19). The violence and aggression suggested in the gender role model plus the pressures of the machismo attitude are often the gateway for males to join the gang, as it satisfies their desire to be masculine. In an environment where their masculinity is not always visible, any instance to show their strength and power is welcome and often taken advantage of, regardless of the associated risks.

The strict gender roles and the overwhelmingly difficult environmental conditions create psychological conditions that are alleviated through gang membership. The inability to fulfill such gender roles creates a situation presented by Leon Festinger called cognitive dissonance. This phenomenon states that when one's beliefs or attitudes contradict their actual behavior, they must change one to match the other in order to avoid psychological strain

Clear Preview

Next

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Anonymouth

Documents | Features | Classifiers | Editor

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a_05_3.txt	/Users/robotcaptain/Dow...
a_07_3.txt	/Users/robotcaptain/Dow...
a_08_3.txt	/Users/robotcaptain/Dow...
a_10_3.txt	/Users/robotcaptain/Dow...
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Clear Preview

Next

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Anonymouth

Documents | Features | Classifiers | Editor

Feature Set: 9 feature-set

Add Feature Set | Import from XML... | Export to XML... | New Feature Set

Feature Set Name: 9 feature-set

Feature Set Description: 9 features used by Brennan and Greenstadt.

Features

- Unique Words Count
- Complexity
- Sentence Count
- Average Sentence Length
- Average Syllables in Word
- Gunning-Fog Readability Index
- Character Space
- Letter Space
- Flesch Reading Ease Score

Remove

Feature Name

Feature Description

	Tools	Configuration
Feature Extractor		
Text Pre-Processing		
Feature Post-Processing		

Normalization

Factor

Back | Next

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Anonymouth

Documents | Features | Classifiers | Editor

Available WEKA Classifiers

- weka
  - classifiers
    - bayes
      - NaiveBayes
      - NaiveBayesMultinomial
    - functions
      - Logistic
      - MultilayerPerceptron
      - SMO
    - lazy

Selected WEKA Classifiers

weka.classifiers.functions.SMO

Classifier Arguments

-K weka.classifiers.functions.supportVector.PolyKernel -C 250007 -E 1.0 -M

Add

Classifier Arguments

Remove

Classifier Description

that case the coefficients in the output are based on the normalized data, not the original data --- this is important for interpreting the classifier.)

Multi-class problems are solved using pairwise classification (1-vs-1 and if logistic models are built pairwise coupling according to Hastie and Tibshirani, 1998).

To obtain proper probability estimates, use the option that fits logistic regression models to the outputs of the support vector machine. In the multi-class case the predicted probabilities are coupled using Hastie and Tibshirani's pairwise coupling method.

Note: for improved speed normalization should be turned off when operating on SparseInstances.

For more information on the SMO algorithm, see

J. Platt: Fast Training of Support Vector Machines using Sequential Minimal Optimization. In B. Schoelkopf and C. Burges and A. Smola, editors, Advances in Kernel Methods - Support Vector Learning, 1998.

S.S. Keerthi, S.K. Shevade, C. Bhattacharyya, K.R.K. Murthy (2001). Improvements to Platt's SMO Algorithm for SVM Classifier Design. Neural Computation. 13(3):637-649.

Trevor Hastie, Robert Tibshirani: Classification by Pairwise Coupling. In: Advances in Neural Information Processing Systems, 1998.

Back | Next

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Anonymouth

Documents | Features | Classifiers | Editor

Original

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Results of this Document's Classification (% probability of authorship per author)

d	~* you *~	b	c
11.66	53.84	11.42	23.08
Actual Author:	~* you *~		

Unfortunately, your document seems to have been written by: ~* you *~

Suggestion

Feature Name:

Present Value: null

Target Value: null

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
6	AVERAGE_SYLLABLES_IN_WORD
7	GUNNING_FOG_READABILITY_...
8	LETTER_SPACE
9	FLESCH_READING_EASE_SCORE

Editing Progress...

Re-process | Clear Highlights | Dictionary | Verbose | Save... | Exit

(send bug reports, suggestions, questions to awm32@drexel.edu)

Anonymouth

Documents | Features | Classifiers | Editor

Original | Original->1

All these feelings of inadequacy and neglect, as stated, push children to seek emotional and social needs elsewhere, as well as to find a place where they feel a sense of security in an environment where security is not always guaranteed day-to-day (Vigil 23). These negative feelings, that are a result of the social order, work in the same way in which traditional Hispanic gender roles push males into gang membership. In order to protect themselves, whether it be physically, emotionally, or psychologically, gang members are constantly playing a demented game of survival of the fittest, finding the gang to be their best chance for survival (Emmer 30).

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No Changes Needed

The present value of the 'COMPLEXITY '
feature falls within its optimal target range for anonymization purposes.
No further changes should be made to intentionally alter the value of this feature.
However, since further changes to other features will inevitably change this feature's value,
it is recommented to re-visit this feature later on.

OK

Results of **Last** Document's Classification (% probability of authorship per author)

d	~* you *~	b	c
11.66	53.84	11.42	23.08
Actual Author:	~* you *~		

Unfortunately, your document seems to have been written by: ~* you *~

Suggestion

It Appears as if the present value of this feature in your document is within the acceptable range of potential target values. However, because of the interrelated nature of stylometic features, it may be useful to re-visit this feature after you have made changes to other features.
Note: because of the clustering algorithm and method to choose the optimal target value used, it at that a feature will into this catagory.

Value: 0.498

alue: 0.498

stions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
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8	LETTER_SPACE
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Editing Progress...

Re-process | Clear Highlights | Dictionary | Verbose | Save... | Exit

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Suggestion

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Note: because of the clustering algorithm and method to choose the optimal target value used, it is possible that that a feature will naturally fall into this catagory.

CHARACTER_SPACE :

Present Value: 3161.0

Target Value: 3161.0

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
6	AVERAGE_SYLLABLES_IN_WORD
7	GUNNING_FOG_READABILITY_...
8	LETTER_SPACE
9	FLESCH_READING_EASE_SCORE

Editing Progress...

Re-process | Clear Highlights | Dictionary | Verbose | Save... | Exit

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Anonymouth

Documents | Features | Classifiers | Editor

Original | Original->1

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UNIQUE_WORDS_COUNT :

Present Value: 249.0

Target Value: 249.0

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
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Editing Progress...

Re-process | Clear Highlights | Dictionary | Verbose | Save... | Exit

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Actual Author:	~* you *~		

Unfortunately, your document seems to have been written by: ~* you *~

Suggestion

The present value of this feature is: '19.0' and it should be increased to '27.27890990577991'. Helpful insights (and possibly highlighting) that will aid in accomplishing this task are (or will soon be) in the works.

SENTENCE_COUNT :

Present Value: 19.0

Target Value: 27.2789

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
6	AVERAGE_SYLLABLES_IN_WORD
7	GUNNING_FOG_READABILITY_...
8	LETTER_SPACE
9	FLESCH_READING_EASE_SCORE

Editing Progress...

Re-process | Clear Highlights | Dictionary | Verbose | Save... | Exit

(send bug reports, suggestions, questions to awm32@drexel.edu)

Anonymouth

Documents | Features | Classifiers | Editor

Original | Original->1

All these feelings of inadequacy and neglect, as stated, push children to seek emotional and social needs elsewhere, as well as to find a place where they feel a sense of. security in an environment where security is not always guaranteed day-to-day (Vigil 23). These negative feelings, that are a result of the social order, work in the same way in which traditional Hispanic gender roles push males. into gang membership. In order to protect themselves, whether it be physically, emotionally, or psychologically, gang members are constantly playing a demented game of survival of the fittest, finding the gang to be their best chance for survival (Emmer 30).

The inner-city, ethnic neighborhoods. that are breeding grounds for street gang formation are the perfect conditions to create the gender role strain-conflict in many males (Vigil 48). Many aspects of a gang member's life prior to joining the gang are not prime conditions to create a healthy self-image of one's self, especially when attempting to fill traditional gender roles. This model suggests that males will engage in negative masculine acts, like violence and aggression, if they are not able to assert their masculinity in traditional male roles, like the roles of provider or protector (Vigil 24). In the case of many. male members of the Latin Kings, they are unable to assert their masculinity as their culture dictates. In places like an inner-city neighborhood where finances are often a troubling aspect of life, males may struggle to care for. their families financially and protect them from the violence inner-city life often contains.

Machismo, sometimes classified as a psychological trait, at its simplest, is the belief of male superiority. Machismo is meant to be acted out. as a positive ideal, focusing on the protection of women, children, and those less fortunate (Vigil 37). In Hispanic culture, machismo is a defining aspect of a male's identity (Brezinka). Most men view this as a source of pride and honor, but Vigil suggests that when a man's basic function, as defined by machismo, is threatened by environmental factors (like an inner-city neighborhood), he must seek to assert his manhood and reconcile the psychological tension, or cognitive dissonance he feels (Vigil 37-8, Anderson et. al, 19). The violence and aggression suggested in the gender role model plus the positives of the machismo attitude are often the gateway for males to join the gang, as it. satisfies their desire masculine. In an environment where their masculinity is not always visible, any instance. to show their strength power is welcome and often taken

Results of this Document's Classification (% probability of authorship per author)

d	~* you *~	b	c
6.59	15.91	41.33	36.16
Actual Author:	~* you *~		

Your document appears as if 'b' wrote it!

Suggestion

The present value of this feature is: '19.0' and it should be increased to '26.58081363101645'. Helpful insights (and possibly highlighting) that will aid in accomplishing this task are (or will soon be) in the works.

Feature Name:

Present Value: null

Target Value: null

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	CHARACTER_SPACE
3	UNIQUE_WORDS_COUNT
4	SENTENCE_COUNT
5	AVERAGE_SENTENCE_LENGTH
6	AVERAGE_SYLLABLES_IN_WORD
7	GUNNING_FOG_READABILITY_...
8	LETTER_SPACE
9	FLESCH_READING_EASE_SCORE

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Two years later, in November of 1964, Hoover held a rare press conference in which he called King "the most notorious liar in the country," creating a public relations debacle. In fact, he had also called King "'one of the lowest characters in the country'" and "gave an affirmative response" to a question regarding the rumored links between King and communism. This led to a meeting between Hoover and King in early December at King's request, where publicly they appeared to resolve their differences and emerge in a tenuous state of cooperation. While King emerged feeling as though he was simply talked at, Hoover's subordinates actively sought to meet with other African American leaders to discuss replacing King. The news article discussing the meeting notes that Johnson had waived the mandatory retirement age of 70 that Hoover was soon approaching. Hoover had been in power for decades with no plans of retiring, and even though Johnson had waived the rule Hoover saw his position as the weakest in years, perhaps helping to explain his willingness to make public amends with his foremost enemy at the time.

While the public's knowledge of the activities of Hoover and King in 1964 and 1965 was limited to this and other minor comments in the press, this was the year when Hoover switched tactics and tried to destroy King personally instead of only through linking him to communism. The wiretapping revealed little about King's ties with communists, but did record King's sexual promiscuity in detail. In a January 1964 memo, Hoover ordered surveillance in Milwaukee although his agents believed visible police presence would dissuade King from engaging in sexual activity, reasoning, "I don't share the conjecture. King is a 'tom cat' with obsessive degenerate sexual urges." Hoover believed that evidence of King's immoral behavior would discredit him, ending the threat. Threats and blackmail related to an individuals private behavior, particularly when it came to immorality or, worse yet, homosexuality, was both an often-used and effective tool for Hoover. One oft-cited rumor surrounding Hoover was that he himself might be homosexual, the evidence for this being his unusual relationship with his number two at the FBI, Clyde Tolson. However, none of his usual news sources were interested in using the information, and it did not have the desired effect on other civil rights leaders or public figures.

The culmination of the personal attacks, while most likely not directly involving Hoover though there was little in the FBI he was unaware of, was a particularly ominous package sent by the FBI, under Sullivan's orders, to King in November 1964. Opened on January 5th, 1965, by King's wife Coretta, the package contained a spliced-

Results of **Last** Document's Classification (% probability of authorship per author)

d	~* you *~	b	c
12.12	78.86	8.02	1.0
Actual Author:	~* you *~		

Unfortunately, your document seems to have been written by: ~* you *~

Suggestion

The highlighted words represent the top two groups of words with a syllable count greater than, or equal to, '1' You should make an effort to break up as many of these words as possible (e.g. instead of 'intelligently' use 'in a smart way').

AVERAGE_SYLLABLES_IN_WORD :

Present Value: 1.7729

Target Value: 1.5736

List of Suggestions

No.	Feature Name
1	COMPLEXITY
2	AVERAGE_SENTENCE_LENGTH
3	CHARACTER_SPACE
4	SENTENCE_COUNT
5	GUNNING_FOG_READABILITY_...
6	UNIQUE_WORDS_COUNT
7	RAGE_SYLLABLES_IN_WORD
8	LETTER_SPACE
9	FLESCH_READING_EASE_SCORE

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Anonymouth Challenges

- Features are often not independent.
  - Increasing the number of complex words will also increase average syllable count.
  - Reducing the number of times a specific word occurs will also affect the lexical density.
- How can we create an algorithm for anonymity that generates an obfuscated document with minimal effort and without circular feature modification?

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Anonymouth Dev Goals

- Streamlined suggestion system.
  - Improved automation on applicable features.
  - Improved clustering algorithm to provide optimal path to anonymity.
- Improved editing interface.
  - Increased phrase and word synonym set support.
  - Edit by blocks of text, not simply feature-by-feature.
- Wider set of features and classification methods.
  - Multi-method and feature collection analysis.
- Usability and anonymity user studies.

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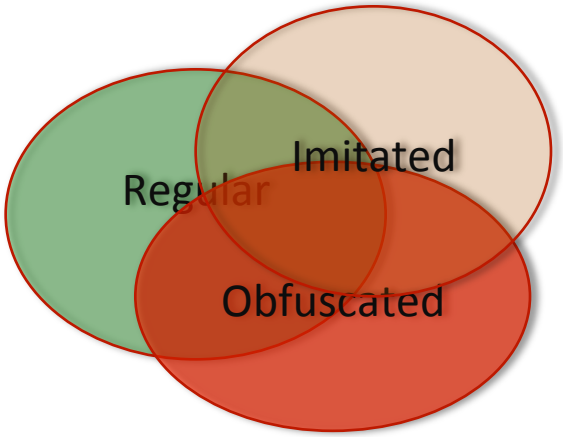
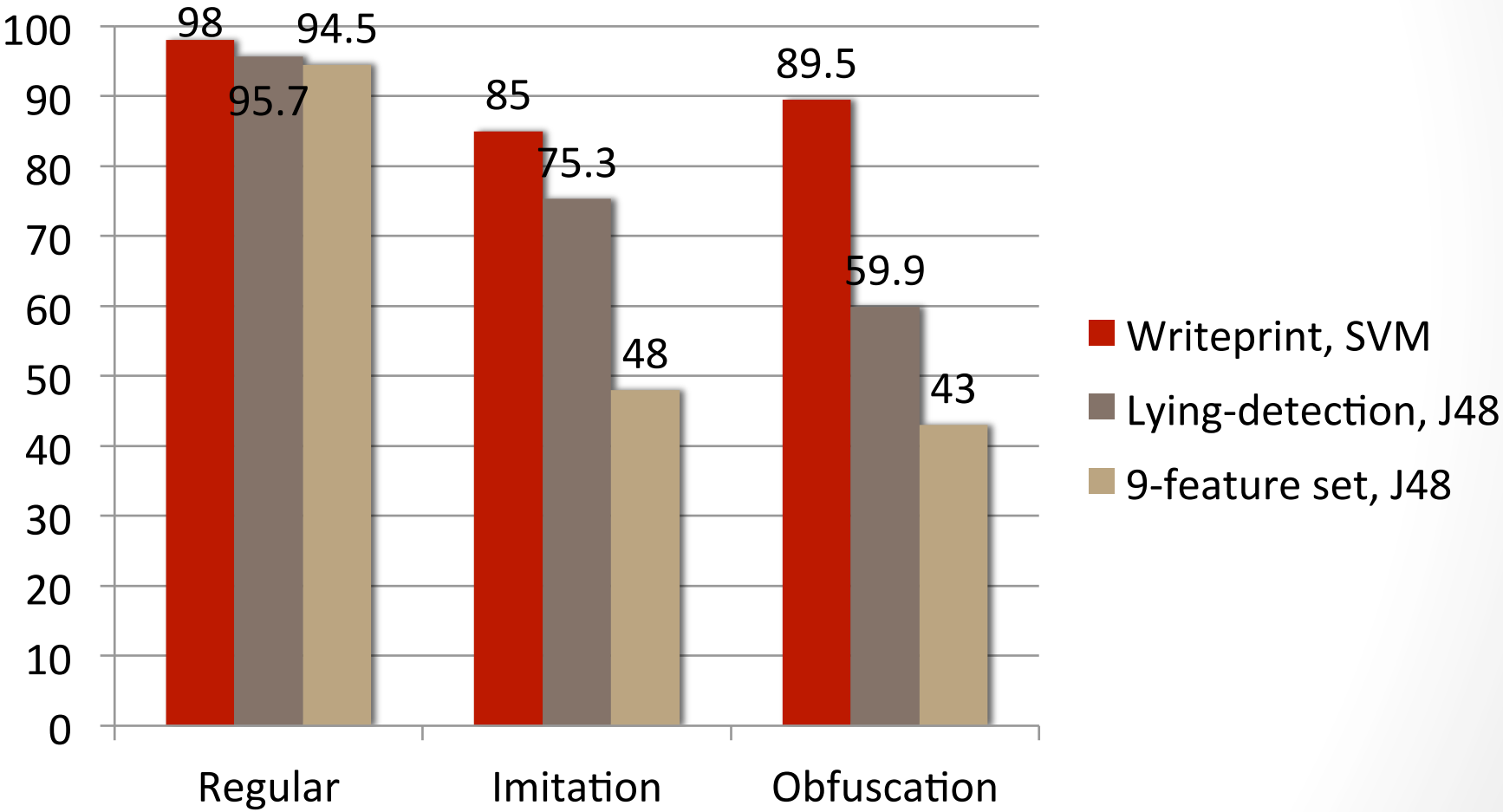
Opening Development

- Project will continue to be developed by PSAL at Drexel, but we welcome collaboration and participation.
- We are interested in…
  - Linguistic Experts
  - Security Advisors
  - UI Experts

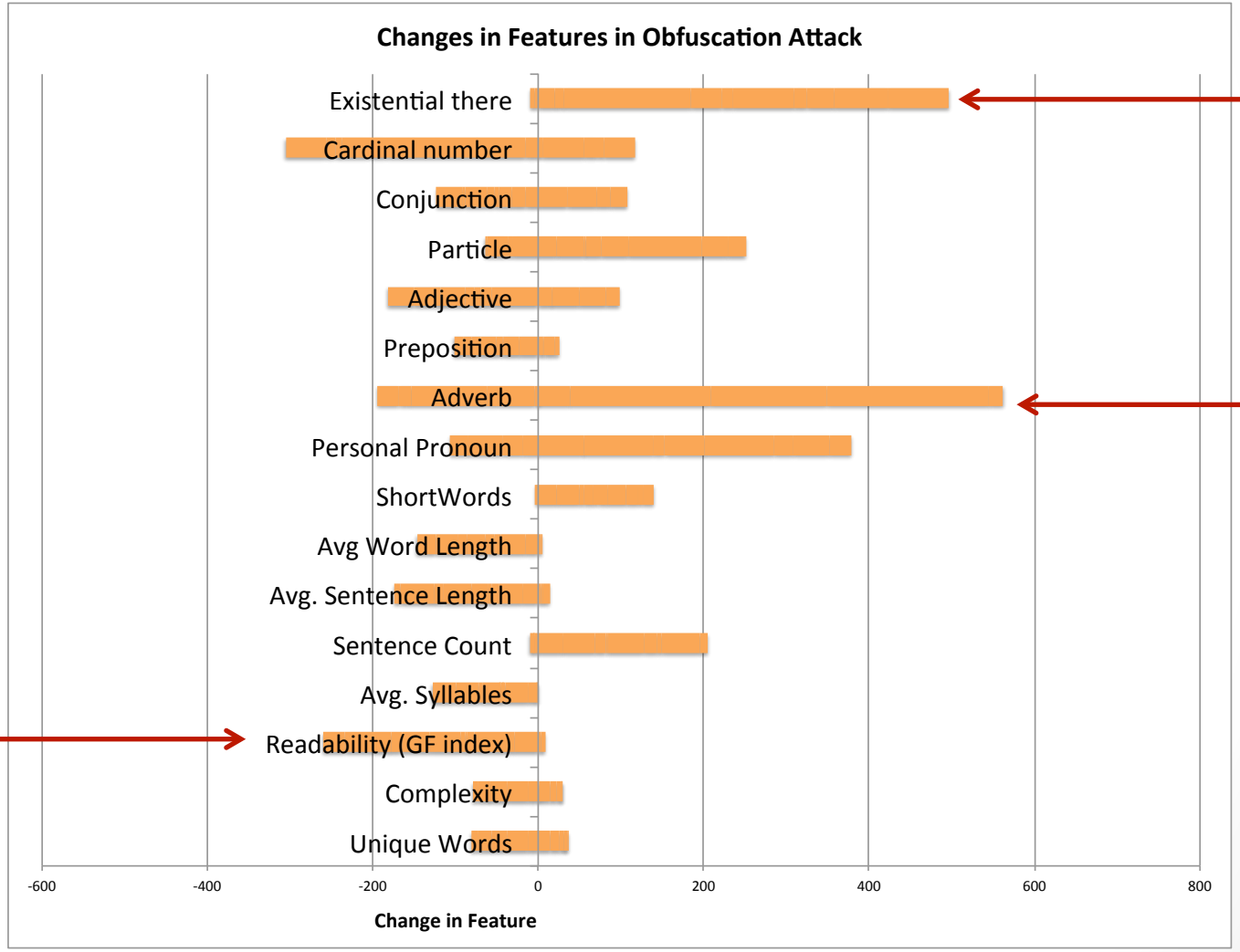
Can we detect stylistic deception?



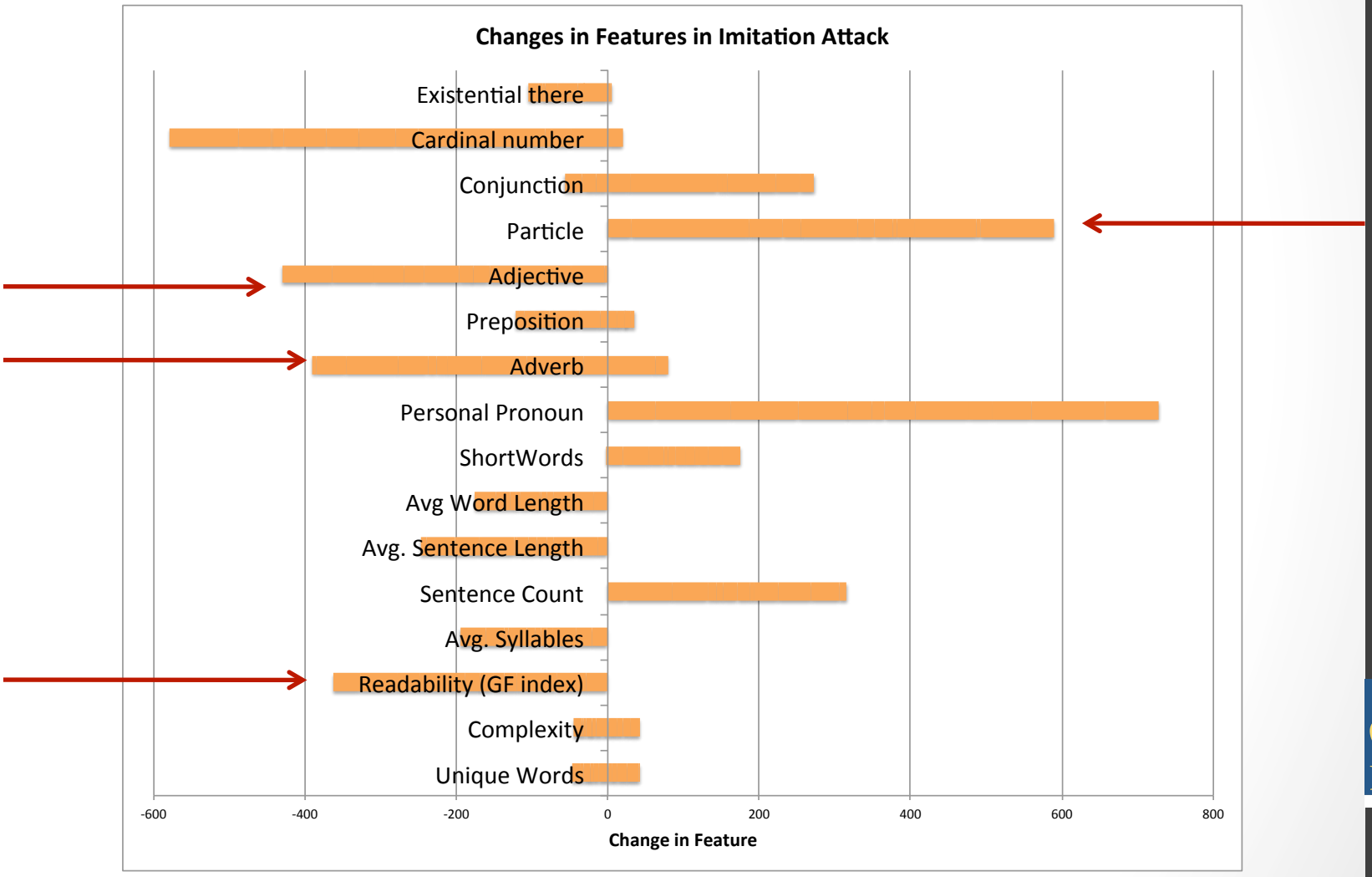
Detecting stylistic deception is possible



Feature Changes in Obfuscated Passages

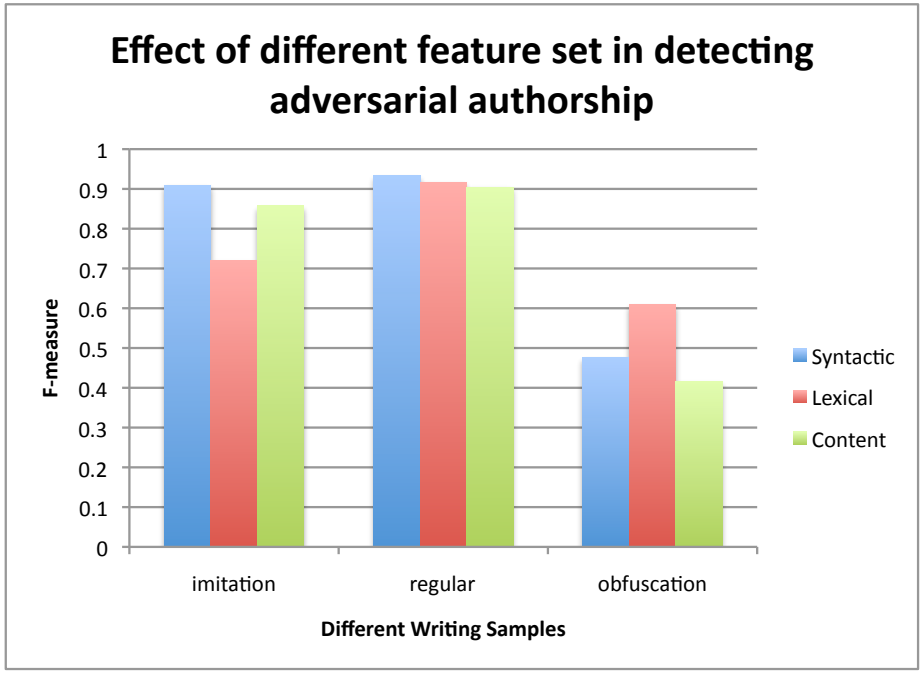


Feature Changes in Imitated Passages



Problem with the dataset: Topic Similarity

- All the deceptive documents were of same topic.
- Non-content-specific features have same effect as content-specific features.



Hemingway-Faulkner Imitation Corpus

- Articles from the International Imitation Hemingway Contest (2000-2005)
- Articles from the Faux Faulkner Contest (2001-2005)
- Original excerpts of Ernest Hemingway and William Faulkner

Deception detection is possible even when the topic is not similar

- 81.2% accurate in detecting imitated documents.

Long term deception

- A Gay Girl In Damascus blog:
  - Original author was a 40-year old American citizen, Thomas MacMaster.
  - Pretended to be a Syrian gay woman, Amina Arraf.
  - The author worked for at least 5 years to create a new style.

Long term deception is hard to detect

- None of the blog posts were found to be deceptive.
- But regular authorship recognition can help.
- We tried to attribute authorship of the blog posts using Thomas (as himself), Thomas (as Amina), Britta (Thomas's wife).
- 54.3% of the blog posts were attributed to Thomas (as himself)

Recap

- Available Now:
  - Brennan-Greenstadt Adversarial Stylometry Corpus (12 Authors)
  - Drexel AMT Adversarial Stylometry Corpus (45 Authors)
  - JStylo Alpha Release
  - Anonymouth Alpha Release
- Future Work:
  - Beta releases of JStylo and Anonymouth
  - Academic publication of new results
  - Continued analysis of deception detection and short message classification
  - Continued research on improving partially automated anonymization

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Thanks.

- We want to hear from you.
  - Mike Brennan (mb553@drexel.edu)
  - Rachel Greenstadt (greenie@cs.drexel.edu)
  - Ariel Stolerman, JStylo Lead (ariels@drexel.edu)
  - Andrew McDonald, Anonymouth Lead (ams23@drexel.edu)
  - Sadia Afroz, Deception Detection Lead (sa499@drexel.edu)
  - Aylin Caliskan, Translation & Stylometry (ac993@drexel.edu)
- PSAL: https://psal.cs.drexel.edu
- **We are looking for interested grad students and post-docs!**

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Addendum Slides

Research Questions, Practical Implications.

- Our upcoming research questions have substantial practical implications.
- How do you anonymize a document sufficiently in a reasonable period of time?
  - What is *sufficient*? What is *reasonable*?
- Can Anonymouth be used to successfully imitate other authors?
- Can Anonymouth maintain long-term deception? Can its usage be detected?
- JStylo vs. Anonymouth – who wins?
  - Based on JStylo, Anonymouth will have everything it needs to help evade detection by the methods it contains.

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Two Tools?

- Aren't we creating a tool that enables surveillance and de-anonymization?
  - Anonymouth can't exist without JStylo. But it also shows that you can't necessarily depend on stylometry to assign authorship.
  - JStylo allows for easier use of authorship recognition tools, but is extensible and open-source. Implementing a method in JStylo will enable counter-attacks in Anonymouth.
- JStylo vs. Anonymouth – who wins?
  - Based on JStylo, Anonymouth will have everything it needs to help evade detection by the methods it contains.
    - Note that nothing prevents others from plugging in proprietary stylometric methods into their version of JStylo.

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