

# Beyond Trigram: Learning to Distinguish Fake Article

## 11-761 Project Report

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## Abstract

## 1 Introduction

With the development of Language Technology, people have construct models to formally describe the natural language we are using in daily life. Interestingly, some of the models have been powerful enough to generate fake articles that could even mix the false with the genuine. Three MIT students developed a program called SCIGen<sup>1</sup> that can automatically generate an SCI article. They eventually fooled reviewers in several IEEE conferences with the generated articles. Therefore, a challenge is before us: how can we tell the machine generated articles from human written ones. Finding such methods will not only avoid being fooled, but can also help us build more powerful language model to make fun of the incompetent paper reviewers.

In this project, we have extracted several features, and built several classification models to distinguish the fake generated by trigram models and true articles. According to

our experiment result, we have reached about 90% accuracy in cross validation and development set.

## 2 Feature Generation

### 2.1 Semantic Feature

For semantic features, we've explored features related to content/stop words and the features about word pairs.

#### 1. Features about content/stop words

Stop words are word which are filtered out before or after processing of natural language data. We use a stop words list 98 common stop words.

Content words are words such as nouns, most verbs, adjectives, and adverbs that refer to some object, action, or characteristic. We generate a content word list using the training data according to words' frequency. We retrieved the words ranks top (using a

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<sup>1</sup>website: <https://pdos.csail.mit.edu/archive/scigen/threshold>) and removed stop words.

## 2. Feature about word pairs

We use Yule’s measure of association as measuring the correlation between word pairs.[1] The measure of semantic association will be defined based on the contingency table below. For each word pair,  $C_{11}$  is the

		Word1	
		Yes	No
Word2	Yes	$C_{11}$	$C_{12}$
	No	$C_{21}$	$C_{22}$

count of sentences in the training corpus that contains the word pair;  $C_{12}$  is the subtraction of the count of sentences contains word1 and  $C_{11}$ ;  $C_{21}$  is the subtraction of the count of sentences contains word2 and  $C_{11}$ ;  $C_{22}$  is the total number of sentences subtracting  $C_{11}$ ,  $C_{12}$  and  $C_{21}$ .

Then we calculate the Q-statistics as the correlation value between word pairs:

$$Q = \frac{C_{11}C_{22} - C_{12}C_{21}}{C_{11}C_{22} + C_{12}C_{21}} \quad (1)$$

The higher value of Q, the stronger the correlation between the two words.

Based on the above two categories, we designed our features as:

- The ratio of stop words and content words.
- The general statistics of correlation value of word pairs.

We calculate the mean, variance, maximum, minimum, mean and range of the correlation value of word pairs. Moreover, we created a subgroup of words pairs that only contains distant word pairs (distance  $\geq 5$ ) and calculated the above feature for this group too.

- Percentage of high correlation values.

This features detects the percentage of pairs that have high correlation values. We use a threshold to determine what is the standard of ?high?.

- Percentage of unseen pairs.

Real articles would have a relative stable percentage of unseen pairs while fake articles will have either too high or too low percentage. We believe that this feature can help us distinguish between real and fake.

- Repetition of phrases.

Similar to the previous one, real articles would have a relative stable percentage of phrases repetitions while fake articles will have either too much repetition or little repetitions. We calculate the percentage of repetitions and the length of longest repeated phrases (single words are treated as special phrases too).

- Coherence score.

Coherence score are defined as the average correlation value of distant (distance  $\geq 5$ ) content pairs.

- Latent Semantic Analysis (LSA).

Inspired by the indexing technology, we’ve applied the idea of LSA to create a new feature which we believe can help improving the classification performance.[2] Let  $X_{m \times n}$  be a matrix where element  $X_{ij}$  describes the frequency of  $Word_i$  in  $Sentence_j$ . Now, the dot product of  $A_{n \times n} = X^T X$  contains all the dot products between the word vectors gives the correlation between the term over sentences. By using singular value decomposition (SVD), we can get

$$A = U \Sigma V^T \quad (2)$$

Here,  $\Sigma_{n \times n}$  is the diagonal matrix contains the singular value. Based on LSA, when you select the top  $k$  largest singular values and their corresponding singular vectors from  $U$  and  $V$ , you get the approximation to  $A$ . We use a threshold to select the top  $k$  singular values and calculate the  $A_k$ . We use

$$loss = \|A - A_k\| \quad (3)$$

as the feature which represent the information loss using approximation. For real articles, the loss should be small while fake articles should be relatively large.

## 2.2 Syntactic Feature

## 2.3 Statistical Feature

# 3 Experiments

## 3.1 Data Description

The training set is 1000 articles, 500 real and 500 fake, of varying length. The development set is 200 articles, 100 fake, 100 real. Articles in development set is truncated to meet the length distribution in Table 3.1. Besides these two sets, we also use a 100 million word corpus of Broadcast News articles as external source for generation of specific feature.

## 3.2 Data Preprocessing

Articles from training set are truncated following the document length distribution in Table 3.1. The number of truncated training articles is 10065. Sentence per article distributions of original training set, truncated training set and development set are shown in Figure 1.

#sentence	#article
1	20
2	10
3	10
4	10
5	10
7	10
10	10
15	10
20	10

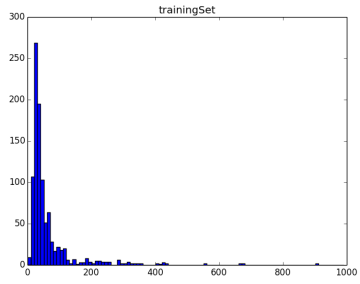
Table 1: Article length distribution of dev set

## 3.3 Classifier Choice

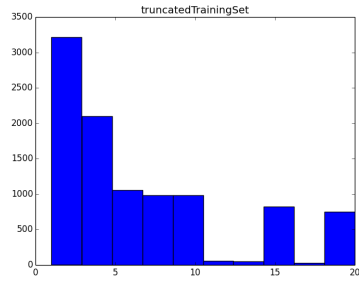
Popular classifiers for binary classification task are chosen as candidates, including KNN, logistic regression, SVM, gradient boosting (xgboost). Testing individual feature on development set and cross validation on training set, xgboost outperforms all the other algorithm by about 5%. Also it is very fast comparing to SVM. So we choose xgboost as the final classier.

## 3.4 Result

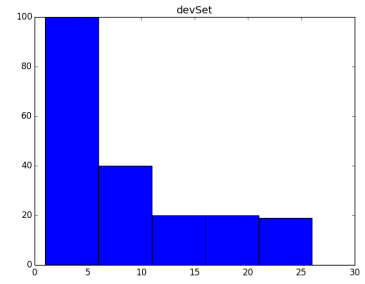
# 4 Conclusions



(a) Training set (original)



(b) Training set (truncated)



(c) Dev set

Figure 1: Article length distribution of different sets