Paraphrasing Using Word2Vec

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Abstract

Finding semantic similarity touches wide range of problems in real life scenarios. It may be used to summarize the news articles, to find similarities in the reviews of some product so as to get pros and cons of a product, etc. For doing semantic similarity, the problem with Indian language is that there is no proper parser available for the Indian languages. Hence we proceed through WordVector implementation.

This project employs sentence similarity of short texts based on the word order similarity which we get from the Word2Vec. We aim to exploit this sentence similarity to merge the news articles which are clustered as per topic.

Related Works

Finding sentence similarity has a huge impact on text-related research. This has been a consistent topic since last 4 years in SemEval events. Each of the papers submitted in these tasks have its own advantages and disadvantages. But most of them work on usage of parsers to preprocess the input.
Motivation

No proper parser available for Indian language.
Local language user makes up to large user base on the internet.

Dataset

Hindi news dataset of about 300 news articles

Methodology

The approach is similar to Yuhua Li et al[1] for Sentence Similarity Based on Semantic Nets and Corpus Statistics.
Get hierarchical knowledge base by using Word2Vec and then getting a raw word similarity based on common synsets.
We take the joint word set of the two sentences that we have to compare then we make an ndimensional vector each for sentence
T1 and T2 where n is the sum of number of words in T1 and T2 followed by calculating weights of each dimension as:

\[
S_1(w) = \begin{cases} 
1 & \forall w \in T_1 \cup T_2, w \in T_1 \\
\text{similarity score} & \forall w \in T_1 \cup T_2, w \in T_2 
\end{cases} \tag{1}
\]

\[
S_2(w) = \begin{cases} 
1 & \forall w \in T_1 \cup T_2, w \in T_2 \\
\text{similarity score} & \forall w \in T_1 \cup T_2, w \in T_1 
\end{cases} \tag{2}
\]

We need to normalize the semantic vectors in the sentence by multiplying the scores by the associative info of the words. Associative info a word(I(w)) can be calculated as:

\[
I(w) = 1 - TFIDF(w) \tag{3}
\]

Then we can get normalized semantic vectors as:

\[
(w) = S_1(w) * I(w) * I(\bar{w}) \quad \bar{w}=\text{similar word}(w) \tag{4}
\]

\[
(w) = S_2(w) * I(w) * I(\bar{w}) \quad \bar{w}=\text{similar word}(w) \tag{5}
\]

Semantic similarity can then be calculated as:

\[
S_s = \frac{S_1 S_2}{\|S_1\| \|S_2\|} \tag{6}
\]
But getting just the semantic vectors is not sufficient to find similarity.
Consider the example:

"Fox jumped over the dog"
and
"Dog jumped over the fox"
The above pair of words are considerably dissimilar than each other.
But as we are considering only the semantic vector at this point of time and considering only the amount of similar words, the above pair will result in a high similarity. Reason being the words of one sentence are just jumbled to get next sentence.
To overcome this problem, we can exploit the ordering of words in the sentence.
So, we define "word order vectors" for both the sentences:

\[
R_1(w) = \begin{cases} 
\text{index}(w \in T_1) & \forall w \in T_1 \cup T_2, w \in T_1 \\
\text{index}(\text{similar word} \in T_2) & \forall w \in T_1 \cup T_2, w \notin T_1
\end{cases}
\] (7)

\[
R_2(w) = \begin{cases} 
\text{index}(w \in T_1) & \forall w \in T_1 \cup T_2, w \in T_2 \\
\text{index}(\text{similar word} \in T_2) & \forall w \in T_1 \cup T_2, w \notin T_2
\end{cases}
\] (8)

Word order similarity can then be calculated as:

\[
S_r = 1 - \frac{\|R_1 - R_2\|}{\|R_1 + R_2\|}
\] (9)
And finally overall similarity as:-

\[ S(T_1, T_2) = \delta S_s + (1 - \delta) S_r \]  

(10)

Once we have the results, recognize the threshold to classify similar and dissimilar by ROC curve. The binary classifier can then be used to merge the news articles based on what are similar and dissimilar sentences in the articles.

![Figure 2: Process for deriving the Semantic Vector](image)

Figure 2: Process for deriving the Semantic Vector
Experimental Results

Conclusions

An approach was given to calculate sentence similarity score with the help of Word2Vec. Sentences having similar words tend to give more score irrespective of the overall sentence meaning, hence considered the impact of word order on sentence meaning. However, still without proper word disambiguation, similarity score was much higher than human score in some cases like in example 5 and vice-versa as in example 6. However in real life scenarios, sentences having many similar words tend to convey same meaning most of the time.
References


Sentence Similarity Based on Semantic Nets and Corpus Statistics

IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, VOL. 18, NO. 8, AUGUST 2006

[2] Userbase information1

[3] Userbase information2