5 — TF-IDF: A Traditional Approach to Feature Extraction in NLP using Python

Aysel Aydin · Follow

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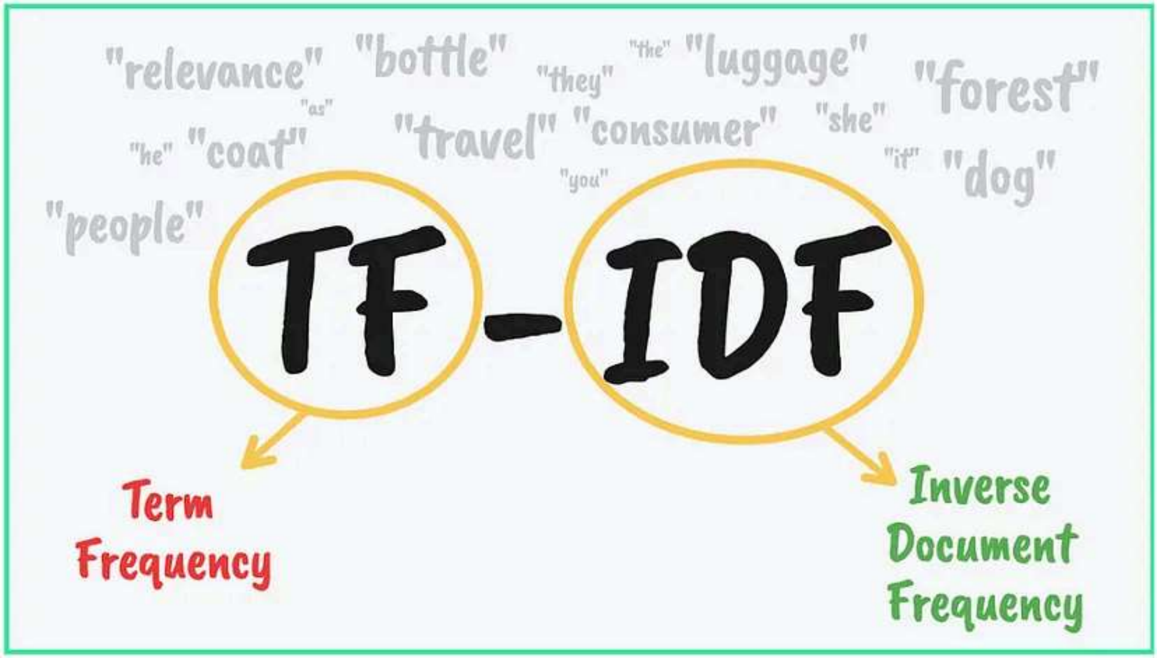

In the last article, we covered the topic of Bag of Words, a Natural Language Processing strategy used to convert a text document into numbers that can be used by ML.

The BoW method is simple and works well, but it creates a problem because it treats all words equally. As a result, we can't distinguish very common words or rare words when BoW is used. TF-IDF comes into play at this stage, to solve this problem.

Unlike the bag of words model, the TF-IDF representation takes into account the importance of each word in a document. The term **TF** stands for **term frequency**, and the term **IDF** stands for **inverse document frequency**.

To understand TF-IDF, firstly we should cover the two terms separately:

- Term frequency (TF)
- Inverse document frequency (IDF)

Term Frequency (TF)

Term frequency refers to the frequency of a word in a document. For a specified word, it is defined as the ratio of the number of times a word appears in a document to the total number of words in the document.

$$TF(t, d) = \frac{\text{number of times t appears in d}}{\text{total number of words in d}}$$

— t is the word or token.

— d is the document.

Inverse document frequency (IDF)

Inverse document frequency measures the importance of the word in the corpus. It measures how common a particular word is across all the documents in the corpus.

$$\mathrm{IDF}(t) = \log \frac{\text{Total number of documents}}{\text{number of documents that contain t}}$$

TF-IDF Score

The TF-IDF score for a term in a document is calculated by multiplying its TF and IDF values. This score reflects how important the term is within the context of the document and across the entire corpus. Terms with higher TF-IDF scores are considered more significant.

$$\text{TF-IDF}(t, d) = \mathrm{TF}(t, d) \times \mathrm{IDF}(t)$$

Let’s take an example to understand this concept in depth.

Let’s examine the example we gave for bag of words in our previous article with TF-IDF.

Imagine a social media platform that aims to analyze customer reviews and understand the popularity of services among users. This platform decides to employ the **TF-IDF** method for processing customer reviews.

Step 1: Data Preprocessing

```
from nltk.stem import WordNetLemmatizer
import re
import nltk
from sklearn.feature_extraction.text import TfidfVectorizer
from nltk.corpus import stopwords

def preprocessing_text(text):
    lemmatizer = WordNetLemmatizer()
    emoji_pattern = r'^(?:[\u2700-\u27bf]|(?:\ud83c[\udde6-\uddff]){1,2}|(?:\ud8

    text= text.lower()
    text = text.split()
    text = [lemmatizer.lemmatize(word) for word in text if not word in set(stopw
    text = ' '.join(text)
    text = re.sub(r'[0-9]+', '', text)
    text = re.sub(r'[^\w\s]', '', text)
    text = re.sub(emoji_pattern, '', text)
    text= re.sub(r'\s+', ' ', text)

    return text

comments = """I am really disappointed this product.
I would not use it again. It has really bad feature.
I love this product! It has some good features"""

sentences_list = nltk.sent_tokenize(comments)

corpus = [preprocessing_text(sentence) for sentence in sentences_list]

print(corpus)
```

Output:

```
[
'really disappointed product',
'would use again',
'really bad feature',
'love product',
'good feature'
]

Unique Word List:
['again' 'bad' 'disappointed' 'feature' 'good' 'love' 'product' 'really'
 'use' 'would']
```

Step 2: Calculating Product of Term Frequency & Inverse Document Frequency

```python
from sklearn.feature_extraction.text import TfidfVectorizer
import pandas as pd

corpus = [
    'really disappointed product',
    'would use again',
    'really bad feature',
    'love product',
    'good feature'
]

tfidf_vectorizer = TfidfVectorizer()

tfidf_matrix = tfidf_vectorizer.fit_transform(corpus)

terms = tfidf_vectorizer.get_feature_names_out()

df = pd.DataFrame(tfidf_matrix.toarray(), columns=terms)

print(df)
```

Output:

Comments	again	bad	disappointed	feature	good	love	product	really	use	would
really disappointed product	0	0	0.659118	0	0	0	0.531772	0.531772	0	0
would use again	0.57735	0	0	0	0	0	0	0	0.57735	0.57735
really bad feature	0	0.659118	0	0.531772	0	0	0	0.531772	0	0
love product	0	0	0	0	0	0.778283	0.627914	0	0	0
good feature	0	0	0	0.627914	0.778283	0	0	0	0	0

> *The TF-IDF calculated in Scikit-learn's TfidfTransformer and TfidfVectorizer is slightly different from the standard calculation. A constant 1 is added to the numerator and denominator of the IDF as if an extra document was seen containing every term in the collection exactly once, which prevents zero divisions. The standard calculation present doesn't have the constant 1.*
>
> *(Github: Scikit-Learn)*

Scikit Learn

$$\bullet\ IDF(t) = \log \frac{1 + n}{1 + df(t)} + 1$$

Standard calculation

$$\bullet\ IDF(t) = \log \frac{n}{df(t)}$$

Conclusion

Through this article, we have explained Term Frequency — Inverse Document Frequency (TF-IDF) and how to use with Python and NLP techniques.

> *In the next article, we will create a word cloud using NLP and TF-IDF in Python.*

I hope it will be a useful article for you. If you stayed with me until the end, thank you for reading! Happy coding 🤞

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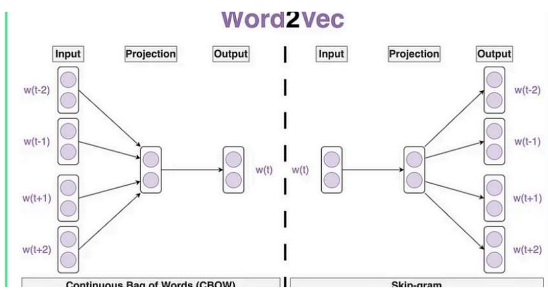

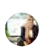

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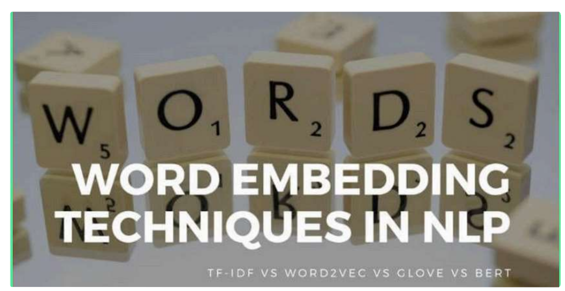

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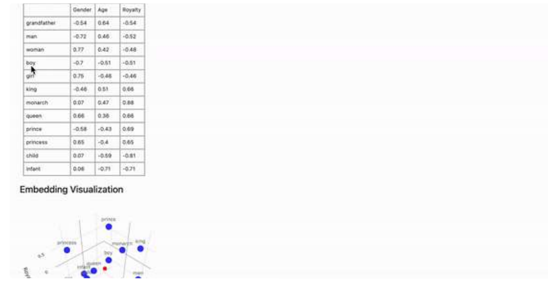

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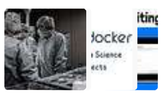

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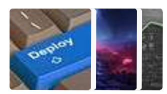

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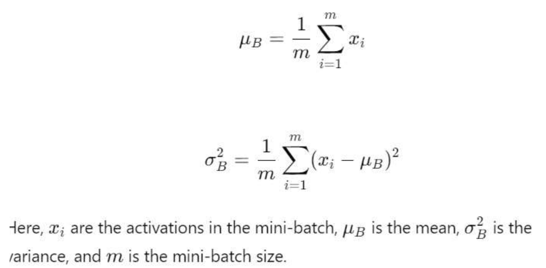

$$\mu_B = \frac{1}{m}\sum_{i=1}^{m} x_i$$

$$\sigma_B^2 = \frac{1}{m}\sum_{i=1}^{m}(x_i - \mu_B)^2$$

Here, x_i are the activations in the mini-batch, μ_B is the mean, σ_B^2 is the variance, and m is the mini-batch size.

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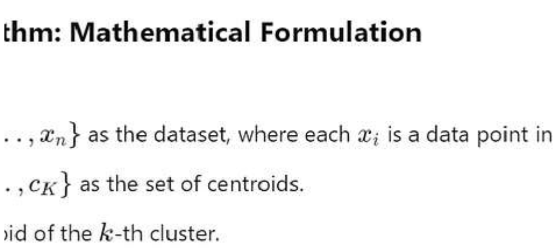

thm: Mathematical Formulation

. . , $x_n\}$ as the dataset, where each x_i is a data point in

. , $c_K\}$ as the set of centroids.

oid of the k-th cluster.

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