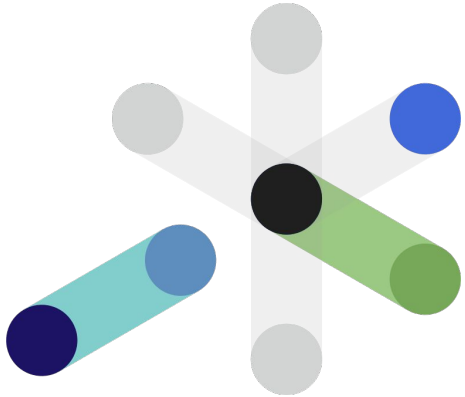
srijan:

Approaching Text Summarization using ML and DNN



RAIT-ACM STTP
25 May 2020

About Me

Mayank Kumar Jha

Data Scientist | Kaggle Competition Expert

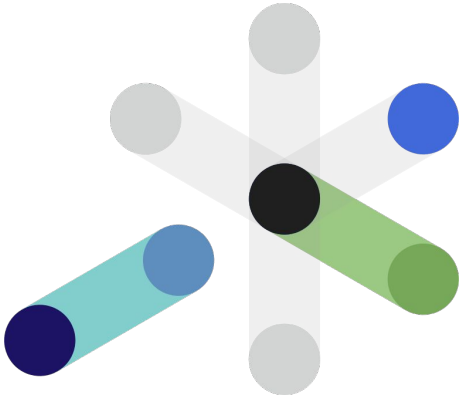
Experience Across
Machine Learning, Deep Learning,
Data Ops, Cloud, Algorithms, Optimization

srijan:

Things to cover

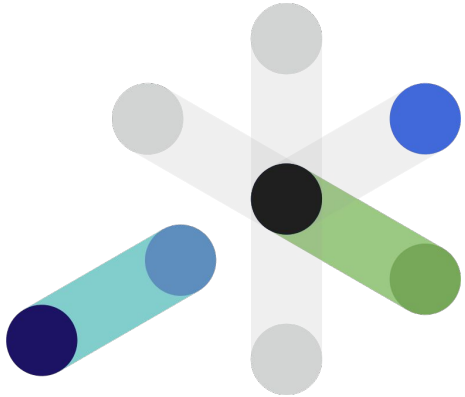
srijan:

- Introduction to Text Summarization
- Various approaches
- Propose possible solutions
- Create a basic solution
- Code Walkthrough
- Query session



What is Text Summarization?

srijan:



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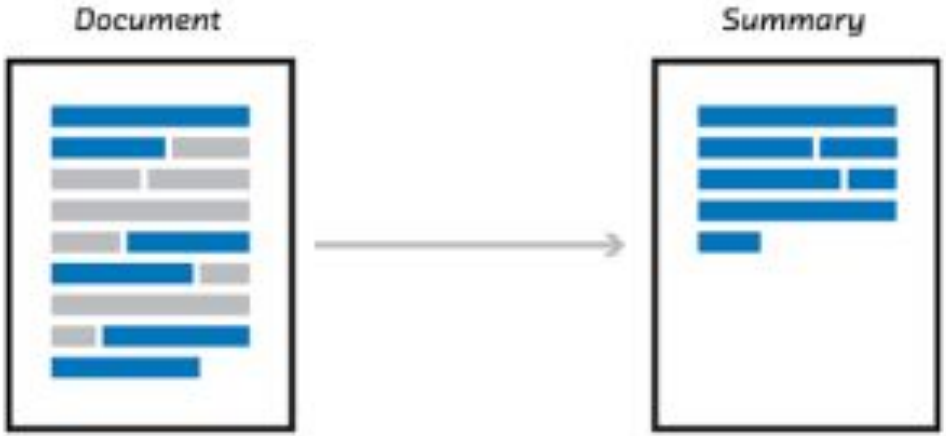
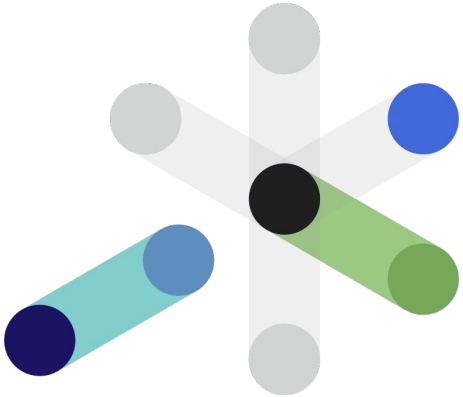


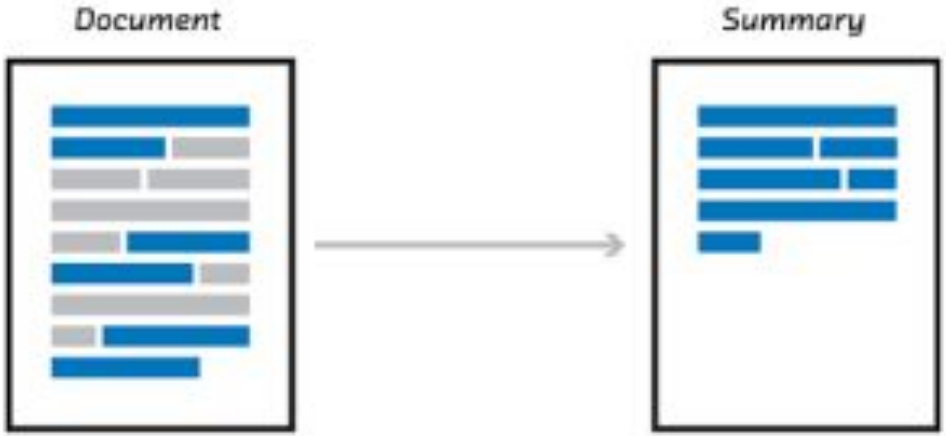


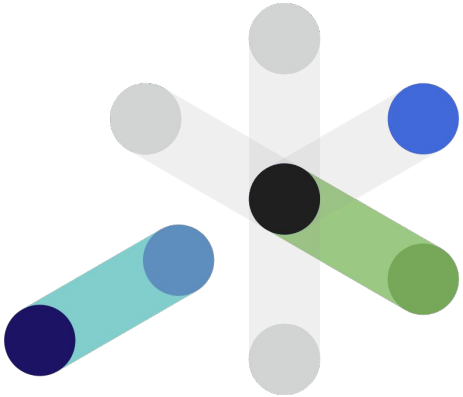
ref: https://medium.com/@ondenyi.eric/extractive-text-summarization-techniques-with-sumy-3d3b127a0a32

What is Text Summarization?

srijan:

- Text summarization is the process of shortening a set of data computationally, to create a subset (a summary) that represents the most important or relevant information within the original content.[wikipedia]
- Text summarization is the technique for generating a concise and precise summary of voluminous texts while focusing on the sections that convey useful information, and without losing the overall meaning.[floydhub]





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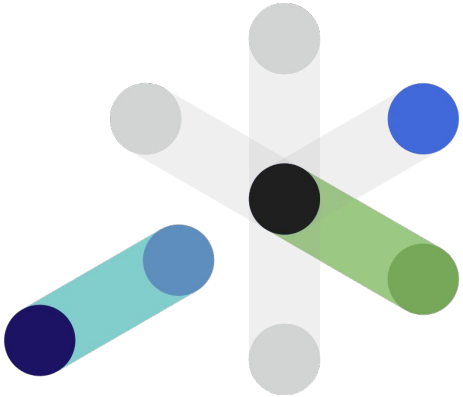
Various approaches for text summarization?

srijan:

- **Extractive Summarization**

- **Abstractive Summarization**



Various approaches for text summarization?

srijan:

- **Extractive Summarization**

Source Text: Peter and Elizabeth took a taxi to attend the night party in the city.

While in the party, Elizabeth collapsed and was rushed to the hospital.

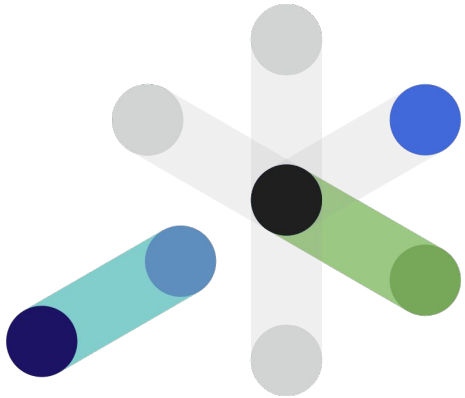
Summary: Peter

- **Abstractive Summarization**

Source Text: Peter and Elizabeth took a taxi to attend the night party in the city.

While in the party, Elizabeth collapsed and was rushed to the hospital.

Summary: Elizabeth was hospitalized after attending a party with Peter.

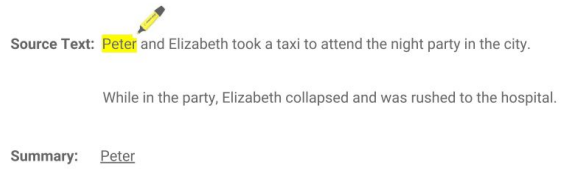


ref: https://blog.floydhub.com/gentle-introduction-to-text-summarization-in-machine-learning/

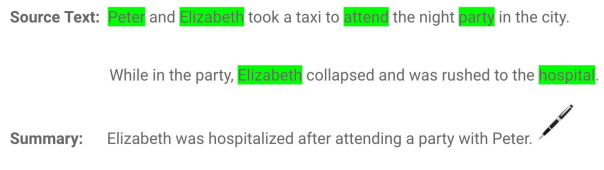
Various approaches for text summarization?

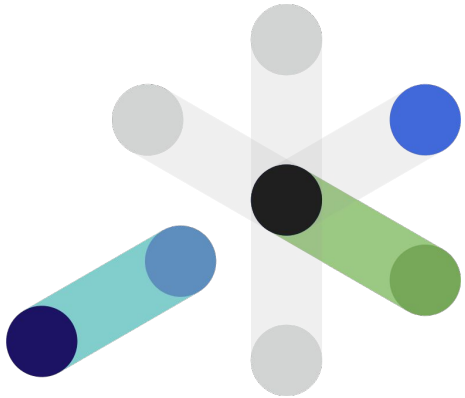
srijan:

- **Extractive Summarization**
  - Extractive summarization means identifying important sections (paragraphs or sentences or even words) of the text and selecting (copy paste) them producing a subset of the text from the original text.



- **Abstractive Summarization**
  - Abstractive summarization is the technique of generating a summary of a text from its main ideas, not by copying verbatim most salient sentences from text.





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Approaching Extractive Summarization?

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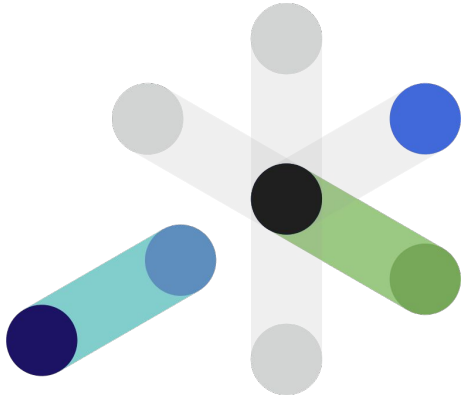

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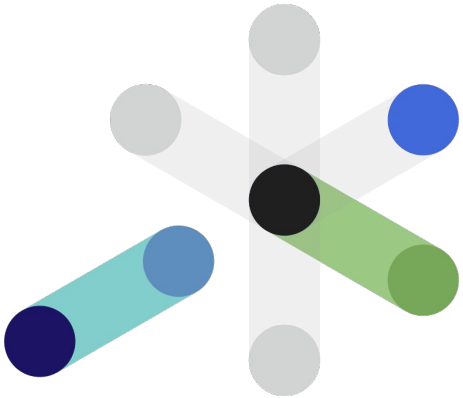
- One approach could be to create a semantic representation of sentences.



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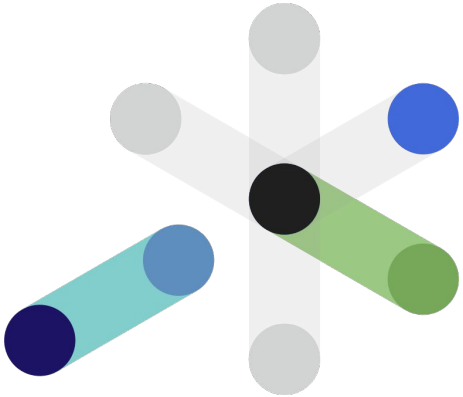
- One approach could be to create a semantic representation of sentences.
- Following can be used to create a semantic representation for texts:
    - Count-based techniques like CountVectorizer, Tf-Idf Vectorizer



Approaching Extractive Summarization?

srijan:

- **What is TF-IDF Vectorizer:**

```
documentA = 'the man went out for a walk'
documentB = 'the children sat around the fire'
```

$$w_{i,j} = tf_{i,j} \times \log\left(\frac{N}{df_i}\right)$$

TF-IDF

Count vectorization

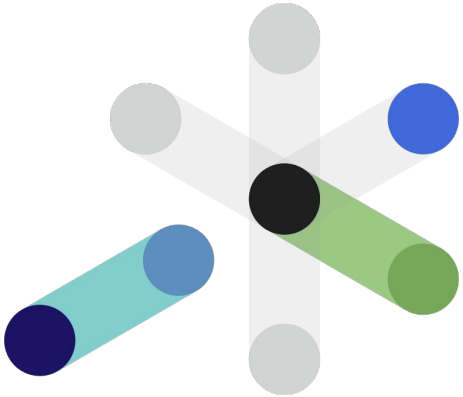
$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{i,j}}$$

	for	sat	around	fire	a	the	man	went	out	walk	children
0	0.142857	0.000000	0.000000	0.000000	0.142857	0.142857	0.142857	0.142857	0.142857	0.142857	0.000000
1	0.000000	0.166667	0.166667	0.166667	0.000000	0.333333	0.000000	0.000000	0.000000	0.000000	0.166667

Inverse Document Frequency (IDF)

$$idf(w) = log(\frac{N}{df_t})$$

	for	sat	around	fire	a	the	man	went	out	walk	children
0	0.099021	0.000000	0.000000	0.000000	0.099021	0.0	0.099021	0.099021	0.099021	0.099021	0.000000
1	0.000000	0.115525	0.115525	0.115525	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.115525



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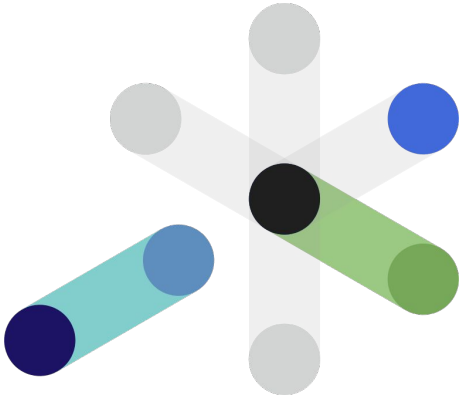

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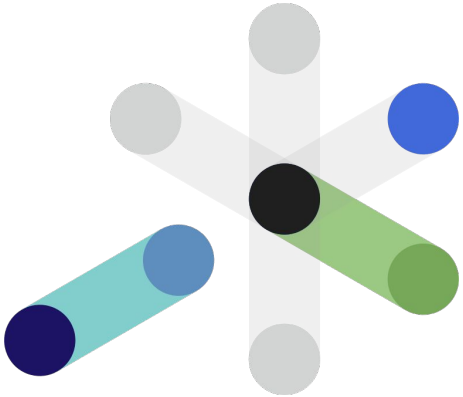
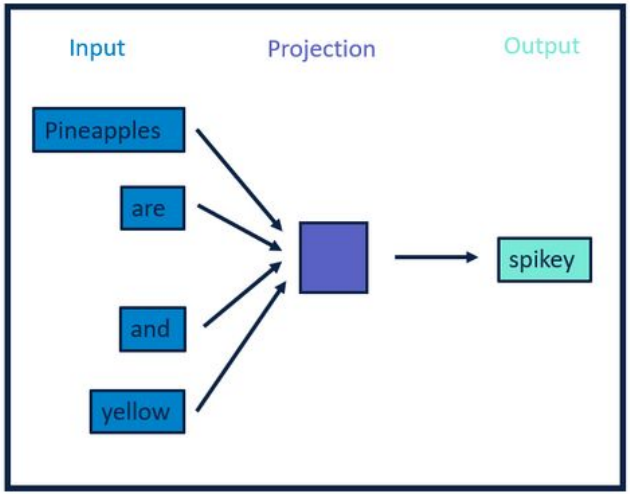


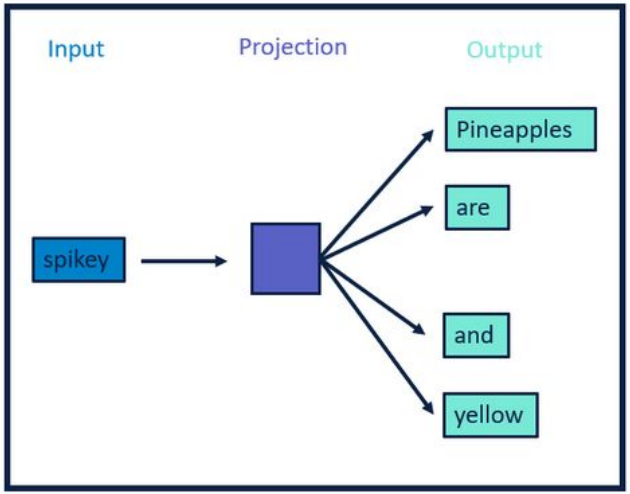
Approaching Extractive Summarization?

srijan:

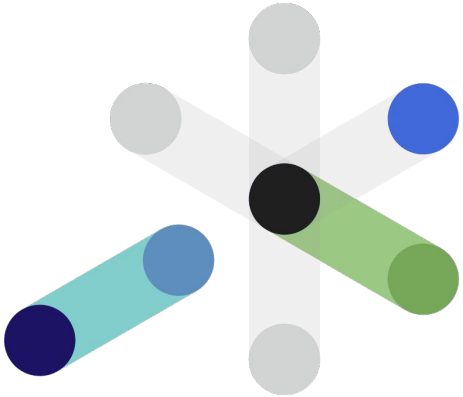
- **What is Word2Vec Vectorizer:**
- Word2vec is a group of related models that are used to produce word embeddings. [wikipedia]
- Word2vec can utilize either of two model architectures to produce a distributed representation of words: continuous bag-of-words (CBOW) or continuous skip-gram.[wikipedia]
- Both of these techniques learn weights which act as word vector representations.



CBOW



Skip-gram



ref: https://community.alteryx.com/t5/Data-Science-Blog/Word2vec-for-the-Alteryx-Community/ba-p/305285

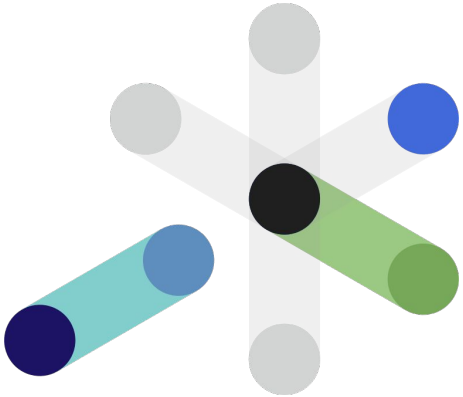
Approaching Extractive Summarization?

srijan:

- **What is CBOW:**
- In the continuous bag-of-words architecture:
  - model predicts the current word from a window of surrounding context words.[wikipedia]
  - The order of context words does not influence prediction (bag-of-words assumption).[wikipedia]

Input	Output
Pineapples	Spikey
are	Spikey
and	Spikey
yellow	Spikey

CBOW



Approaching Extractive Summarization?

srijan:

- **What is SKIP-GRAM:**
- In the continuous skip-gram architecture:
  - model uses the current word to predict the surrounding window of context words. [wikipedia]
  - The skip-gram architecture weighs nearby context words more heavily than more distant context words.[wikipedia]
  - According to the authors' note, CBOW is faster while skip-gram is slower but does a better job for infrequent words.[wikipedia]

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Spikey	Pineapples
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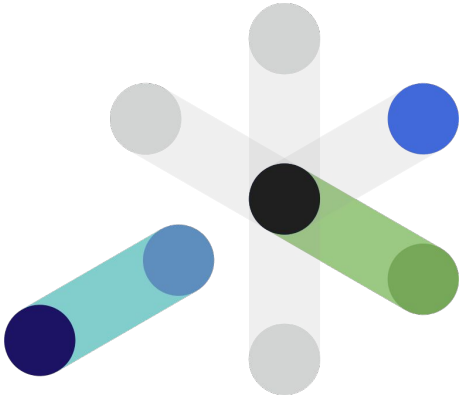
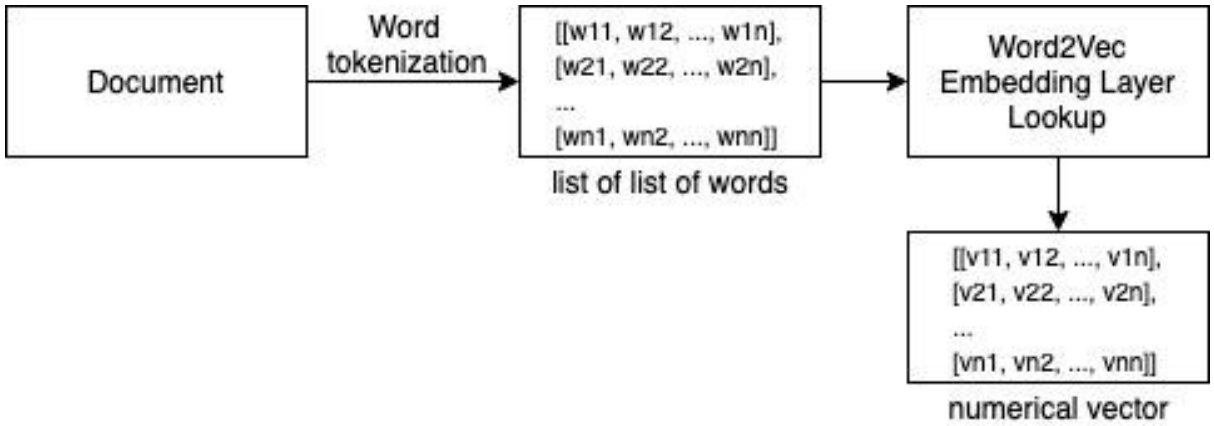
SKIP-GRAM

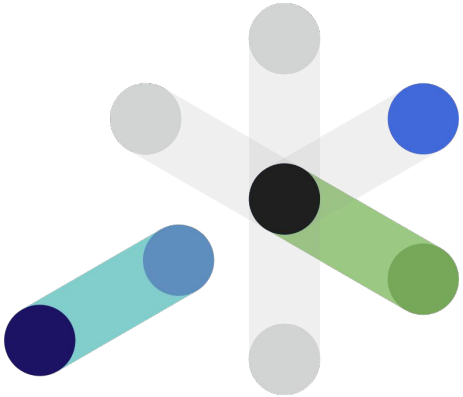


Approaching Extractive Summarization?

srijan:

- **Using Word2Vec Embedding**
  - Embedding is something like key-value pair.
  - For each word in our vocabulary, there will be a learned numerical representation for it.
  - To handle unknown words, we will treat each of them as OOV (Out of vocabulary) words and will use the learned OOV representation
  - Flow would be something like below one:





Using Word2Vec to convert text data to numerical semantic vector

Approaching Extractive Summarization?

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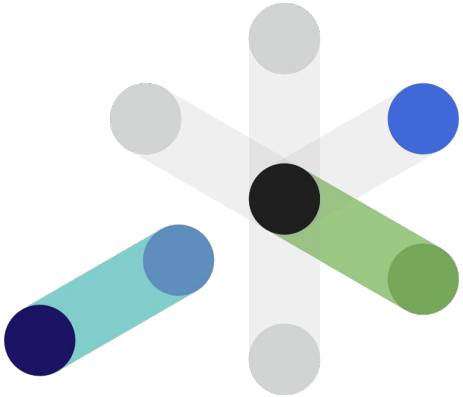

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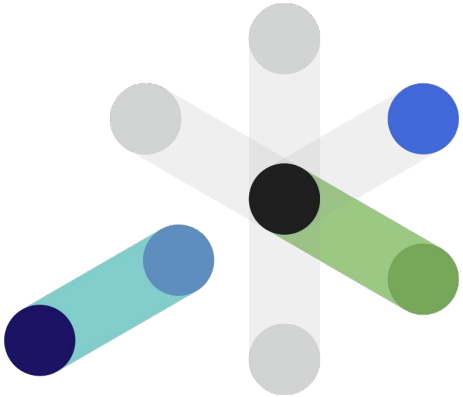
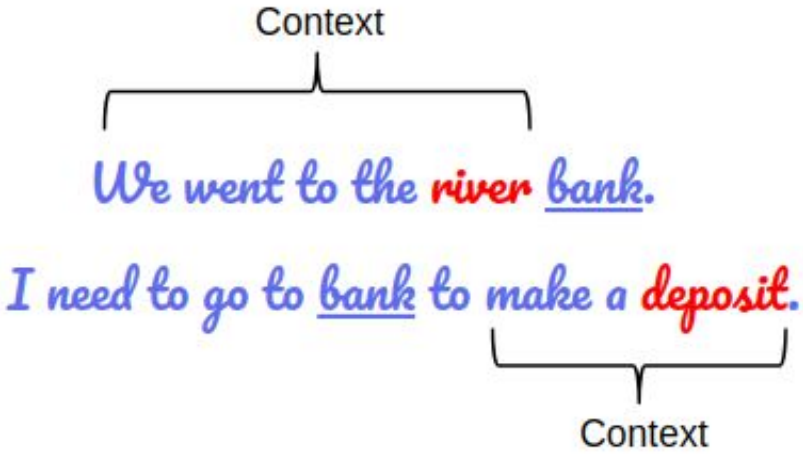
  - Pretrained SOTA transformers like BERT (or its variants) to better capture context as well.

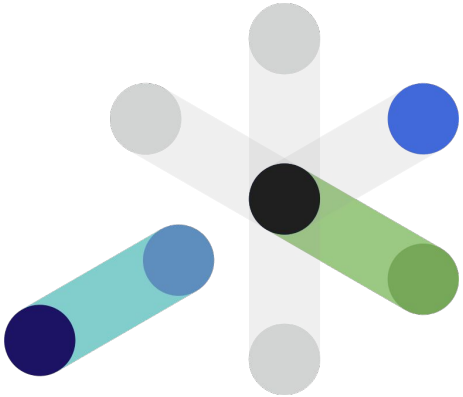


Approaching Extractive Summarization?

srijan:

- **What is BERT:**
  - BERT stands for Bi-directional Encoder Representation from Transformers.
  - It is designed to pre-train deep bidirectional representations from unlabeled text by jointly conditioning on both left and right context.
  - BERT is pre-trained on two NLP tasks:
    - Masked Language Modeling
    - Next Sentence Prediction



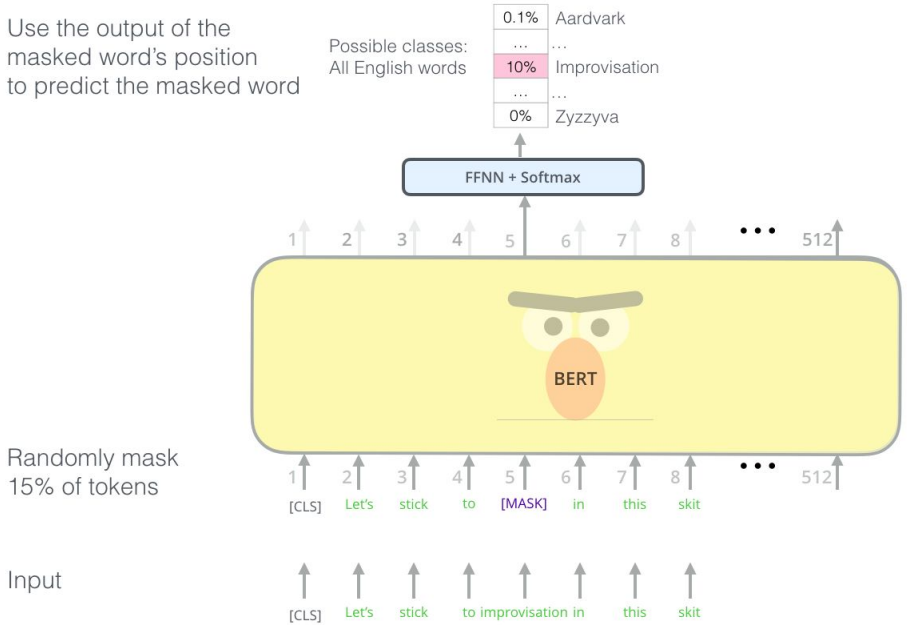


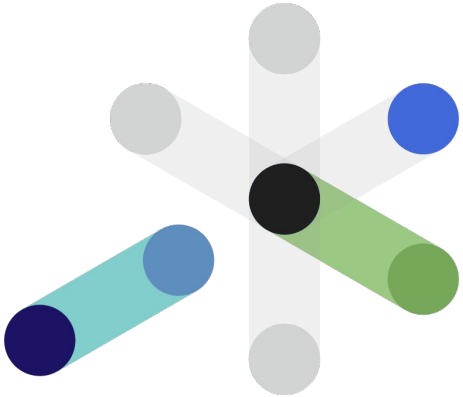
ref: https://www.analyticsvidhya.com/blog/2019/09/demystifying-bert-groundbreaking-nlp-framework/

Approaching Extractive Summarization?

srijan:

- **What is Masked Language Modeling:**





BERT's clever language modeling task masks 15% of words in the input and asks the model to predict the missing word

ref: http://jalammar.github.io/illustrated-bert/

Approaching Extractive Summarization?

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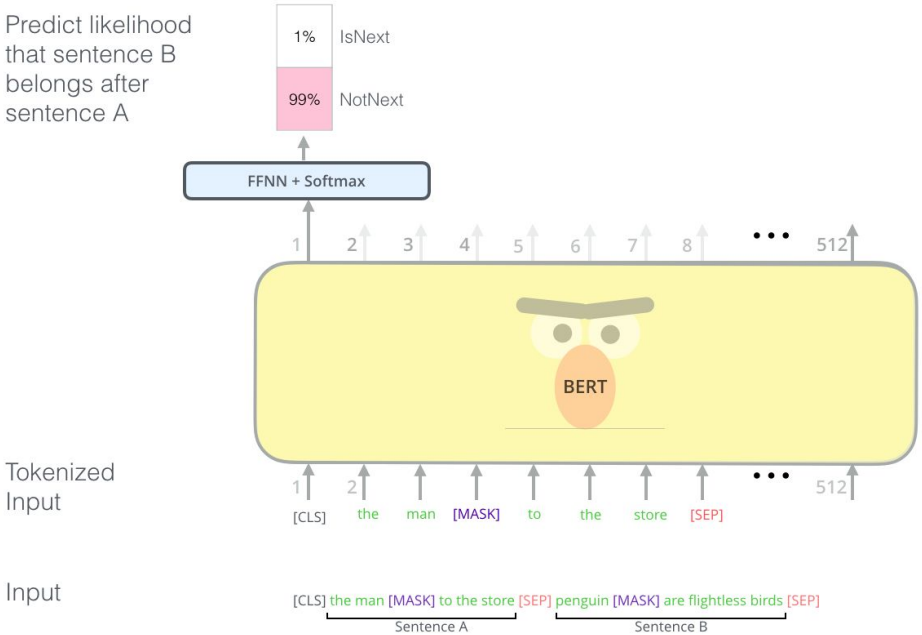
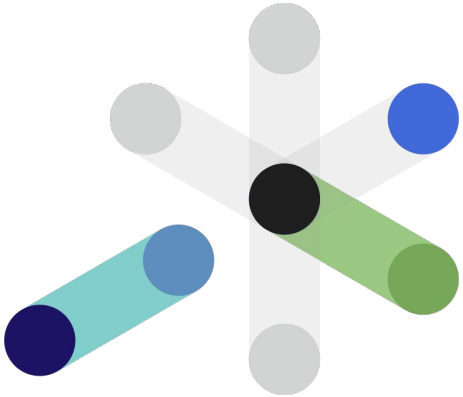
- **What is Next Sentence Prediction:**





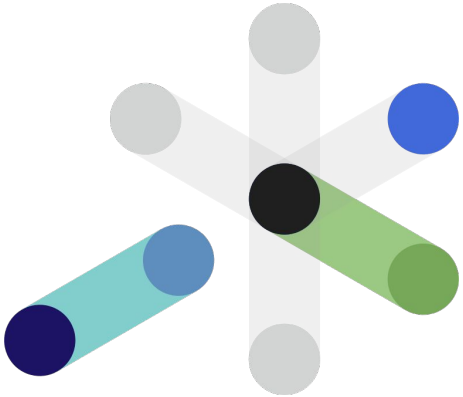
The second task BERT is pre-trained on is a two-sentence classification task. The tokenization is oversimplified in this graphic as BERT actually uses WordPieces as tokens rather than words --- so some words are broken down into smaller chunks.

ref: http://jalammar.github.io/illustrated-bert/

Approaching Extractive Summarization?

srijan:

- **Using BERT for feature extraction**
  - Feed the text to BERT Wordpiece Tokenizer



Approaching Extractive Summarization?

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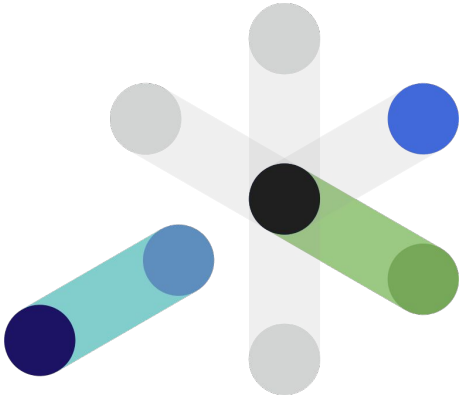
  - BERT tokenizer will split the sentence as well as words incase needed to match vocabulary.



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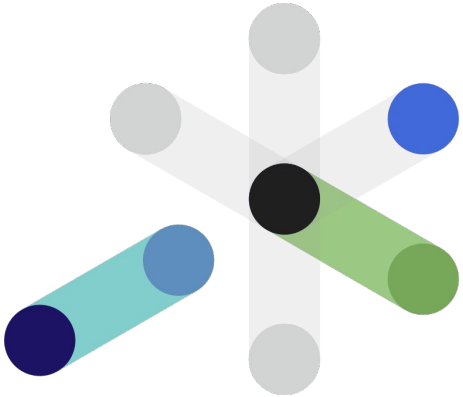

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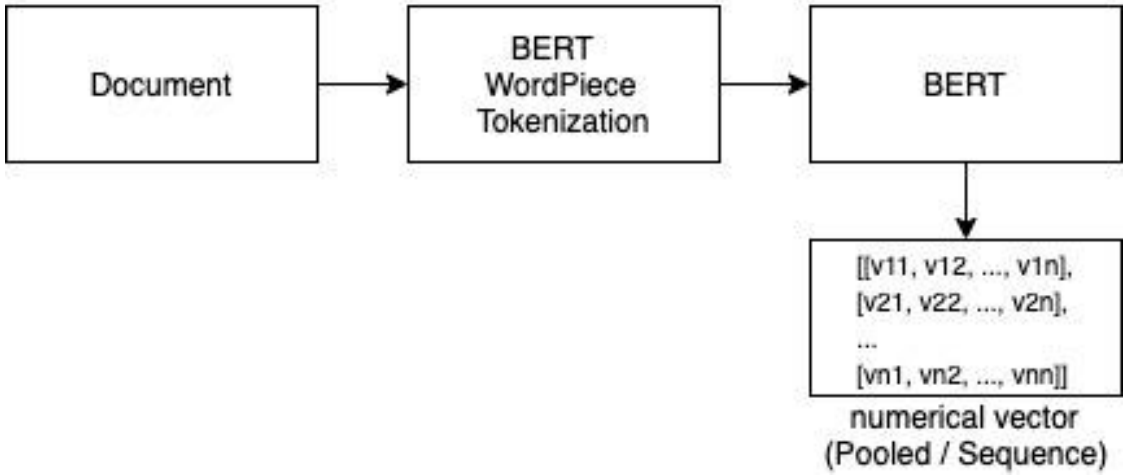
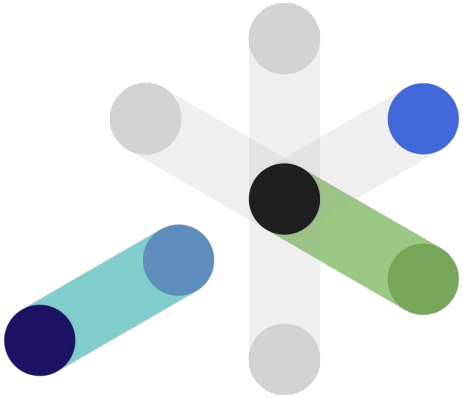


Using BERT to convert text data to numerical vector



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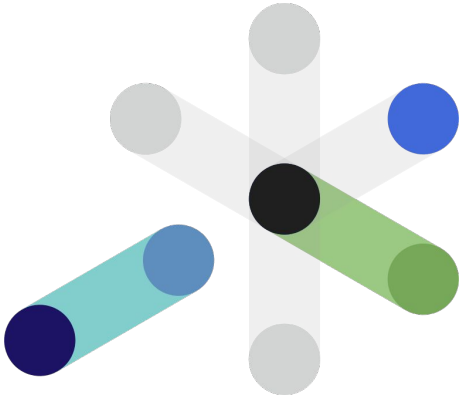

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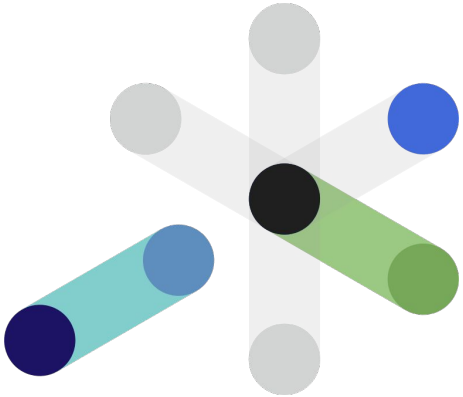
  - Train your own (quite cumbersome :( )



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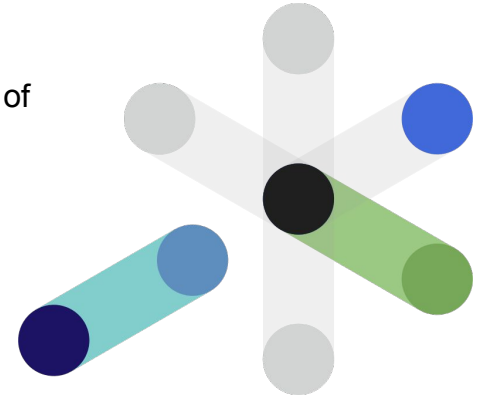
srijan:

- One approach could be to create a semantic representation of sentences.
- Following can be used to create a semantic representation for texts:
  - Count-based techniques like CountVectorizer, Tf-Idf Vectorizer
  - Pretrained word embeddings based techniques like Word2Vec, Glove, fastText
  - Pretrained SOTA transformers like BERT (or its variants) to better capture context as well.
  - Train your own (quite cumbersome :( )
- Now comparison can be done between each sentences as they are no more a sequence of characters and words but a numerical vector now.



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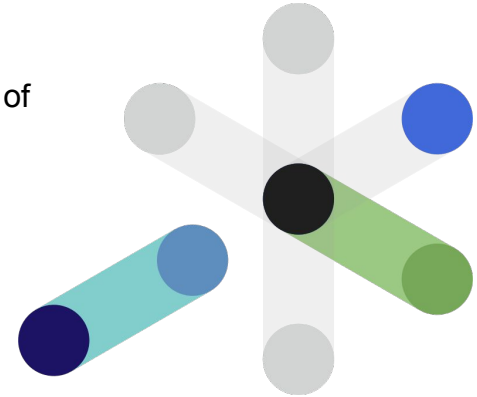

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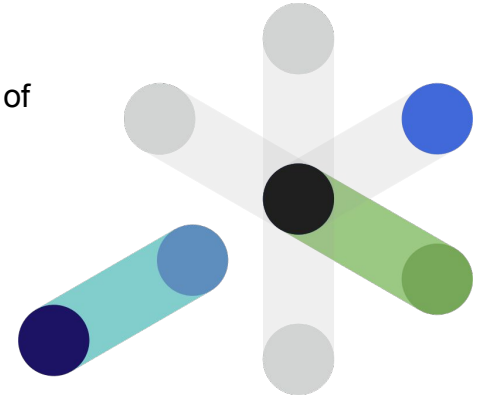
- Scoring technique needs to be intelligent enough to properly evaluate what are the information content of a sentence and thus score it accordingly.



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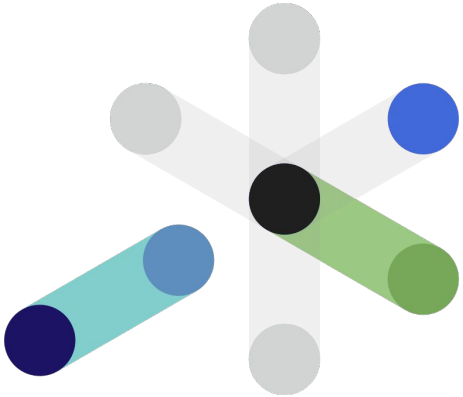
Let’s build our basic Solution



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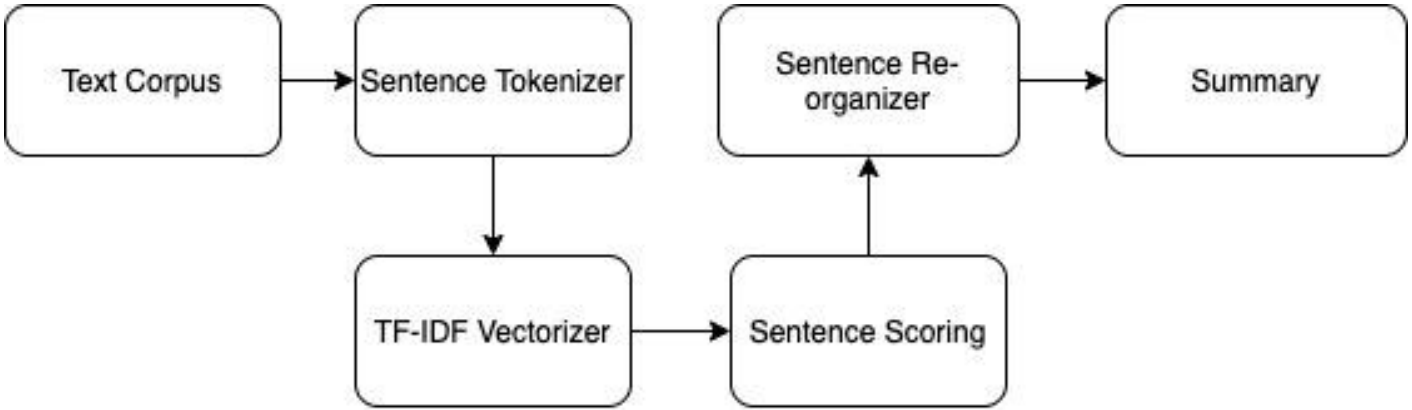
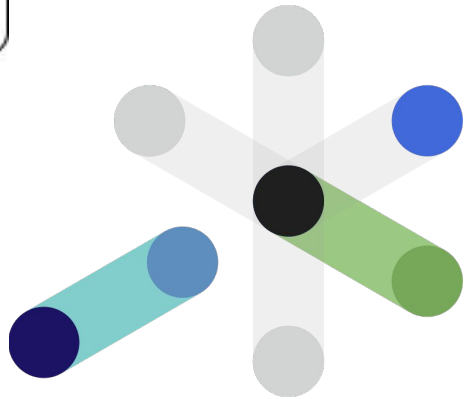


A high level solution for frequency based extractive summarizer



Approaching Extractive Summarization?

srijan:

- **Sentence scoring using TF-IDF:**

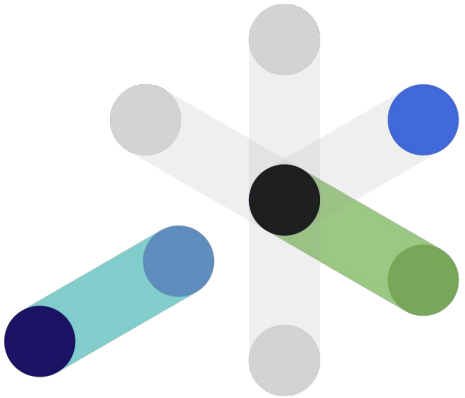
```
documentA = 'the man went out for a walk'
documentB = 'the children sat around the fire'
```

TF-IDF

$$w_{i,j} = tf_{i,j} \times \log\left(\frac{N}{df_i}\right)$$

	for	sat	around	fire	a	the	man	went	out	walk	children
0	0.099021	0.000000	0.000000	0.000000	0.099021	0.0	0.099021	0.099021	0.099021	0.099021	0.000000
1	0.000000	0.115525	0.115525	0.115525	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.115525

TF-IDF



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Adding TF-IDF weights to score each sentence

	for	sat	around	fire	a	the	man	went	out	walk	children	score
0	0.099021	0.000000	0.000000	0.000000	0.099021	0.0	0.099021	0.099021	0.099021	0.099021	0.000000	0.594126
1	0.000000	0.115525	0.115525	0.115525	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.115525	0.462098

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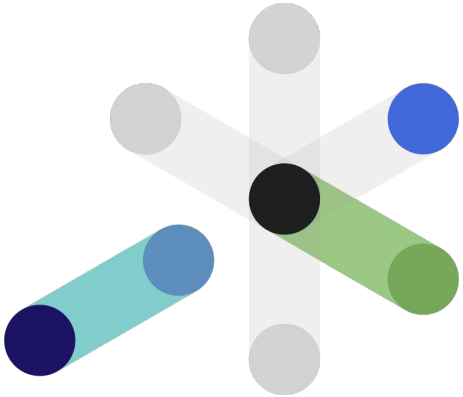

Approaching Extractive Summarization?

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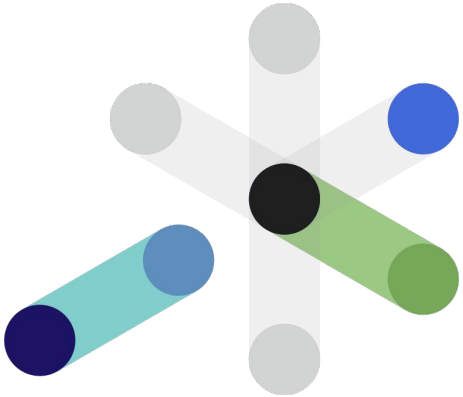
- **What is Sentence Reorganizer:**

Text : Stop Words are words which do not contain important significance to be used in Search Queries. Usually, these words are filtered out from search queries because they return a vast amount of unnecessary information. Each programming language will give its own list of stop words to use.



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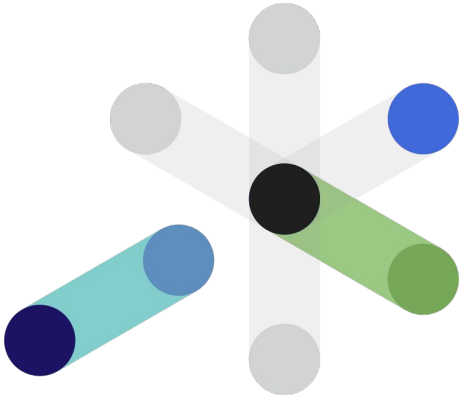
Sentence Order Indexing : { “Stop Words are words which do not contain important significance to be used in Search Queries”: 0,
“Usually, these words are filtered out from search queries because they return a vast amount of unnecessary information”: 1 ,
“Each programming language will give its own list of stop words to use”: 2 }



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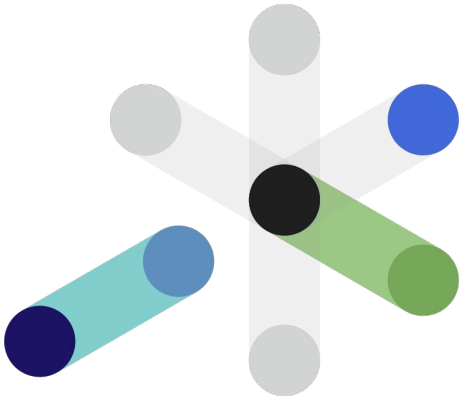
Scored Sentences : { “Each programming language will give its own list of stop words to use”: 1.32 ,
“Stop Words are words which do not contain important significance to be used in Search Queries”: 0.79,
“Usually, these words are filtered out from search queries because they return a vast amount of unnecessary information”: 0.32 }



Result : Stop Words are words which do not contain important significance to be used in Search Queries. Each programming language will give its own list of stop words to use.

Fire up your Notebooks

Any Questions ?

Thank You

srijan: