Preprocessing: Stopwords, Stemming and Lemmatisation

COMP3009J: Information Retrieval

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Preprocessing

- **Aim:**
  - Examine some common commonly-applied preprocessing techniques.
  - Observe some tradeoffs – in “solving” one problem, can we sometimes create others?

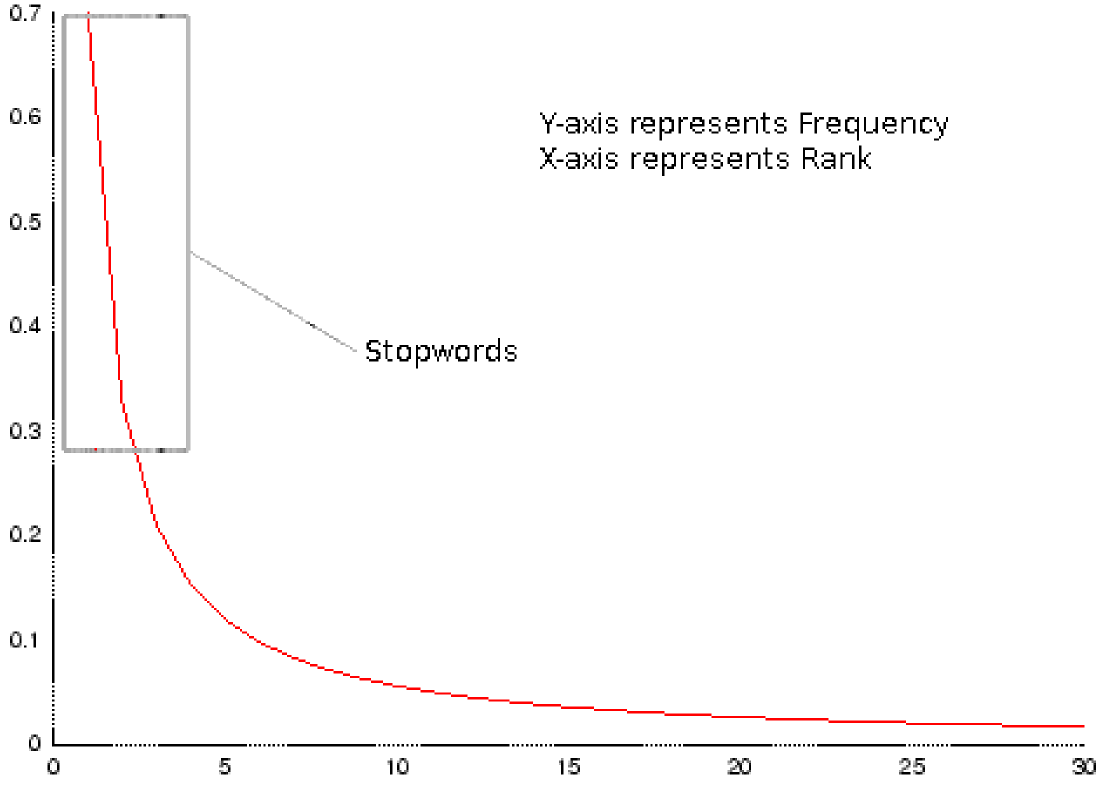
Stopword Removal

- A **stopword** is a commonly occurring term that appears in so many documents that it does not add to the meaning of the document, and appear in most English texts (except for very short ones).
- For example, in English, terms such as *the*, *and*, *of*, etc. tell a reader nothing about what the document is about.
- They are so common that they appear in almost all documents, and of little use when differentiating between documents.
- The fact that they are so common also means that more processing power is required to deal with these terms than others that are less common.
- This additional processing, combined with their relative lack of usefulness means that they are often removed from the documents at the preprocessing stage.

Stopword Removal

- Stopwords can be estimated using **Zipf's Law**.
- George Kingsley Zipf analysed the statistical occurrence of words (terms) in text.
- He noted that while only a few terms are used very often, more are used only rarely.
- If we rank terms from the most commonly used to the least commonly-used in a large text collection, the second term is approximately ½ as common as the first, the third is approximately ⅓ as common as the first, etc.
- We use this to identify what terms count as stopwords in various languages.

Stopword Removal: Zipf's Law



Y-axis represents Frequency
X-axis represents Rank

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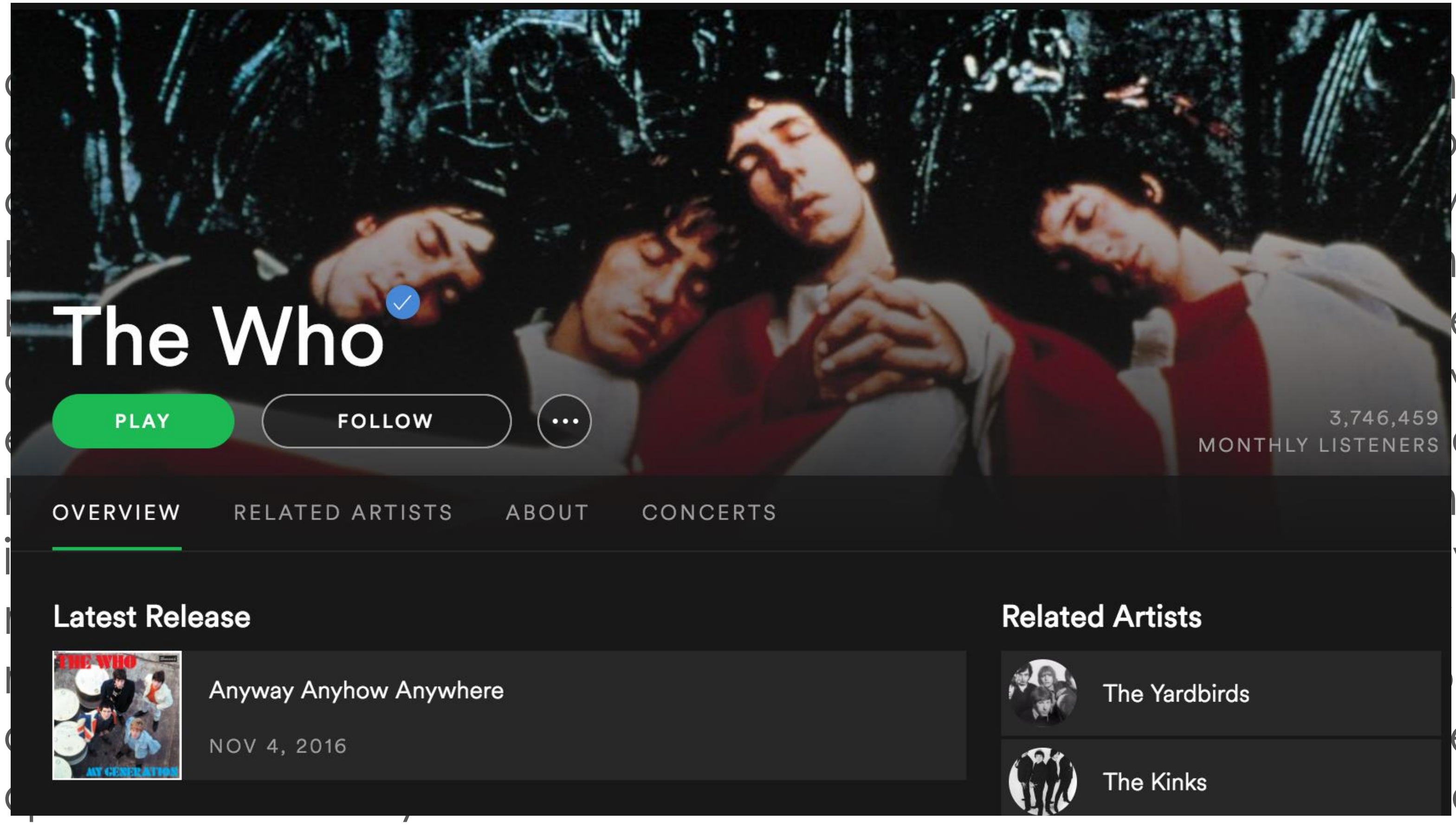

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Stopword Removal

- There is a **tradeoff** required when using stopwords.
- The trend is away from removing them:
  - Good compression means that space required is small.
  - Good optimisation means processing them takes little time.
- Some queries will become impossible if all stopwords are removed.
  - Phrases: “King **of** Denmark”
  - Song titles, etc. “Let **it be**”, “**To be or not to be**”
  - Relational queries: “Flights **to** London”
- Some solutions:
  - Don’t remove stopwords. Use all words as terms.
  - Recognise when combinations of stopwords are meaningful, and include these as terms in the index.

Stemming

- Many terms in natural language appear different to a computer, but represent the same concept.
- In English, terms such as “connect”, “connecting”, “connects”, “connected”, etc. represent a similar concept.
- Many IR systems believe that a search for “computing” should also include documents that contain the word “computer”, for example.
- **Stemming** is the process that maps these terms to a **common root**.
  - e.g. “computing”, “computer” → “comput”
  - Note: a stem does not need to be a real word.
- The end of a term is called a **suffix** (-er, -s, -ing, -ed, etc.)
- Hence stemming is also known as **suffix stripping**.

Stemming

- While there have been many algorithms to accomplish stemming, the most famous (for English text) is **Porter's Stemming Algorithm**.
- The rules that the follows are detailed in:
  - Martin Porter, An Algorithm for Suffix Stripping, Program, 14 no. 4, pp. 130-137, July 1980.
- Numerous implementations are available at:
  - http://tartarus.org/~martin/PorterStemmer
- It should be noted that Porter's stemming algorithm is not necessarily the most accurate, though it is the most widely used. Snowball and Porter2 are often considered to be more effective.

Stemming Algorithms

- Stemming Example: each of the following news headlines include words with a common stem:
  - accept: FAI decides to **accept** rescue deal.
  - acceptable: FAI deems rescue deal **acceptable**.
  - acceptance: Owens pleased after rescue deal **acceptance**.
  - accepted: The FAI has **accepted** the government rescue deal.
  - accepts: FAI **accepts** rescue deal.
- Clearly, these would be relevant to the same query.
  - The stem for all of these is "**accept**".
- If stemming is applied to the documents, it is also applied to queries, so a user can find these documents using any term related to the stem **accept** (accept, acceptable, acceptance, accepted, accepts, etc.)

Stemming: Problems

- Sometimes suffixes can be removed from words that are **not related**, but that end up being the same afterwards.
- This is known as **overstemming**.
- Stemming is a very useful process to help words of similar meanings to be matched, but it is not a perfect process.
- **Example:** consider the words “general” and “generate”
- Both stem to "gener", even though they are not related.
- Using a dictionary can help avoid this type of problem

Stemming: Problems

- Although not specifically a problem with stemming, there is also an issue with words that do not have the same meaning, but are spelled the same (known as **homographs**).
    - At the Battle of Waterloo, Napoleon's forces were **routed**.
        - The army was heavily defeated in battle.
    - The cars were **routed** off the motorway.
        - The cars were sent in a different direction.
- It is very difficult to tell the difference between these without using Natural Language Processing, which is a much slower process that often needs to see the word in context.

Lemmatisation

- Lemmatisation is a Natural Language Processing (NLP) technique for converting words into **lemmas** (i.e. base words found in dictionaries).
  - Unlike a **stem**, a **lemma** is always a real word.
- This is slower than stemming, but is usually more effective, because it can deal with words that stemming can't handle.
- To find the right lemma, a lemmatiser will often need to know the **part of speech** that the word is being used as (verb, noun, etc.). This requires more text analysis than stemming.

Lemmatisation vs. Stemming

Verbs

Word	Lemma	Stem
running	run	run
runs	run	run
ran	run	ran
be	be	be
am	be	am
are	be	ar
brought	bring	brought
brings	bring	bring

Nouns

Word	Lemma	Stem
wolves	wolf	wolv
wolf	wolf	wolf
church	church	church
churches	church	church
mouse	mouse	mous
mice	mouse	mice
radius	radius	radiu
radii	radius	radii