An Information Retrieval Example: Boolean Queries

COMP3009J: Information Retrieval

Dr. David Lillis (david.lillis@ucd.ie)

UCD School of Computer Science
Beijing Dublin International College

Example: the Boolean style query

- William Shakespeare was a famous English playwright. Suppose we want to search for characters in his plays.
- Which plays of Shakespeare contain the words ***Brutus*** *AND* ***Caesar*** but *NOT* ***Calpurnia***?
- As a first attempt, we could read the plays line-by-line to find those that contain ***Brutus*** and ***Caesar*** and then remove those that contain ***Calpurnia***.

Example: the Boolean style query

- *"… we could read the plays line-by-line to find those that contain* ***Brutus*** *and* ***Caesar*** *and then remove those that contain* ***Calpurnia****."*
- Why is that not the answer?
  - Slow (for large corpora)
  - Other operations (e.g., find the word ***Romans*** near ***countrymen***) not feasible.
  - Ranked retrieval not possible (best documents shown first)
    - Later lectures!

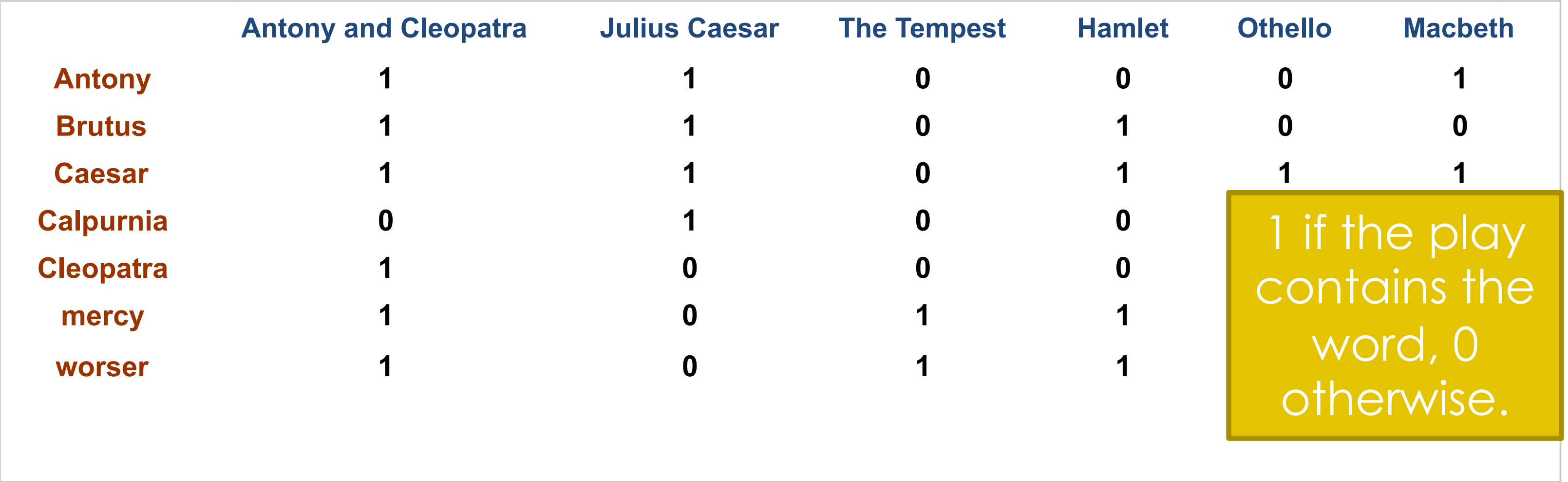
A **corpus** is a collection of documents. The plural is **corpora.**

Example: The Boolean style query Term-document incidence matrix

- Instead, we store the information we need in some sort of data structure. Here is a **term-document incidence matrix** showing some of the words contained in some of Shakespeare's plays.

Plays (Documents)

Words (Terms)

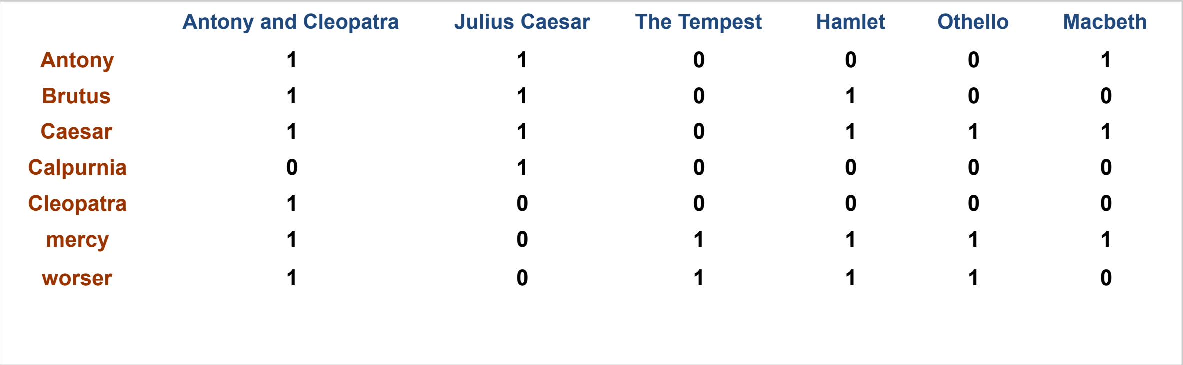


	Antony and Cleopatra	Julius Caesar	The Tempest	Hamlet	Othello	Macbeth
Antony	1	1	0	0	0	1
Brutus	1	1	0	1	0	0
Caesar	1	1	0	1	1	1
Calpurnia	0	1	0	0		
Cleopatra	1	0	0	0		
mercy	1	0	1	1		
worser	1	0	1	1		

1 if the play contains the word, 0 otherwise.

Example: The Boolean style query
Incidence vectors

- So we have an **incidence vector** for each word.
  - It consists of 1s (for the plays it appears in) and 0s (for those it does not appear in).
  - e.g.
    - ***Brutus:*** *110100*
    - ***Caesar****: 110111*
    - ***Calpurnia:*** 010000



	Antony and Cleopatra	Julius Caesar	The Tempest	Hamlet	Othello	Macbeth
Antony	1	1	0	0	0	1
Brutus	1	1	0	1	0	0
Caesar	1	1	0	1	1	1
Calpurnia	0	1	0	0	0	0
Cleopatra	1	0	0	0	0	0
mercy	1	0	1	1	1	1
worser	1	0	1	1	1	0

Example: The Boolean style query Operators

- Our query is: ***Brutus*** *AND* ***Caesar*** *NOT* ***Calpurnia***
- To get "*NOT* ***Calpurnia***", we get the **complement** of the incidence vector for ***Calpurnia*** (using the bitwise NOT operator, which changes all 1s to 0s and all 0s to 1s).
  - 001000 → 110111
- Now we can use the bitwise AND operator to combine our three vectors:
  - 110100 AND 110111 AND 101111 = 100100
- Referring back to the term-document incidence matrix, we see that the answer is: **Antony and Cleopatra, Hamlet**

Bigger collections

- This approach can be effective, but how well does it **scale** to larger collections?
  - Consider N = 1,000,000 documents, each with about 1,000 words.
  - Average 6 bytes per word including spaces and punctuation.
  - 6GB of data in the documents.
  - Say there are M = 500,000 *distinct* terms among these.

Can’t build the matrix

- 500,000 x 1,000,000 matrix has **half-a-trillion** 0s and 1s.
- But it has no more than one **billion** 1’s.
  - matrix is extremely **sparse**.

Why?

- What’s a better representation?
  - We only record the 1 positions, and not the 0s.
  - We will look at this in a later lecture.

Another problem: Ambiguous Queries

- Sometimes it is difficult to figure out what the information need was if we can only see the query: some queries are **ambiguous**.

- For example, if a user searches for “jaguar”, documents that discuss luxury cars may appear to be relevant, but will be of no use to a user who is researching big cats.

- Similarly, a search for “bank” could be:
  A river bank.
  A financial institution.
  A manoeuvre made by an aeroplane.

Questions