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Text Technologies for Data Science

INFR11145

Definitions

Instructor:
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23-Sep-2026

1

Lecture Objectives

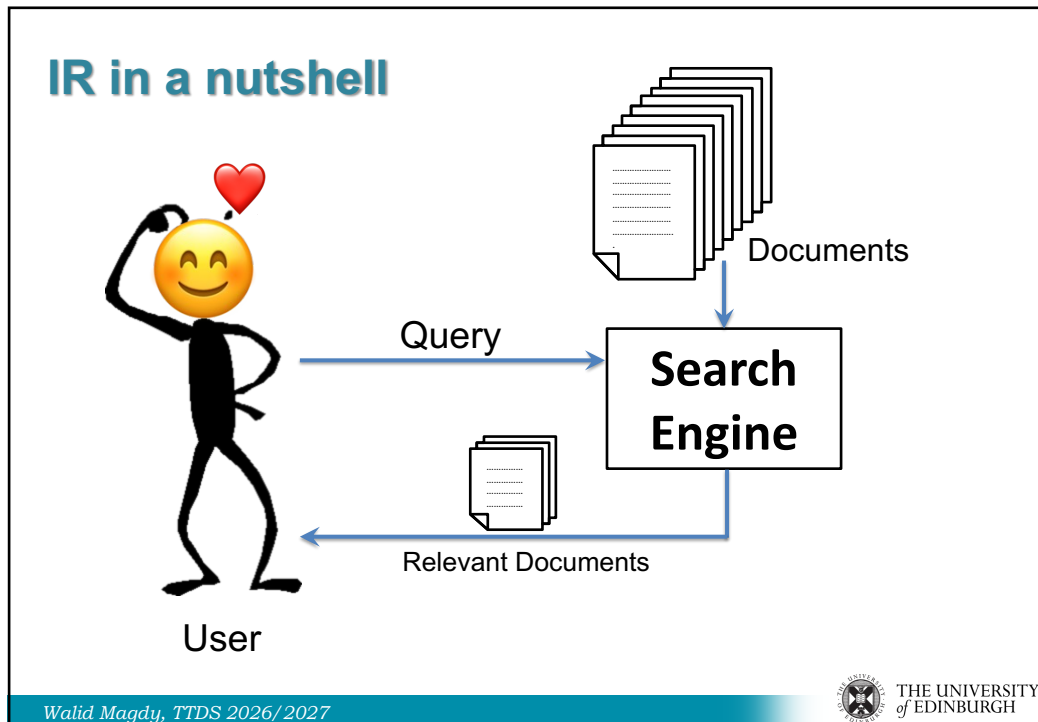
- Learn about main concepts in IR
 - Document
 - Information need
 - Query
 - Index
 - BOW

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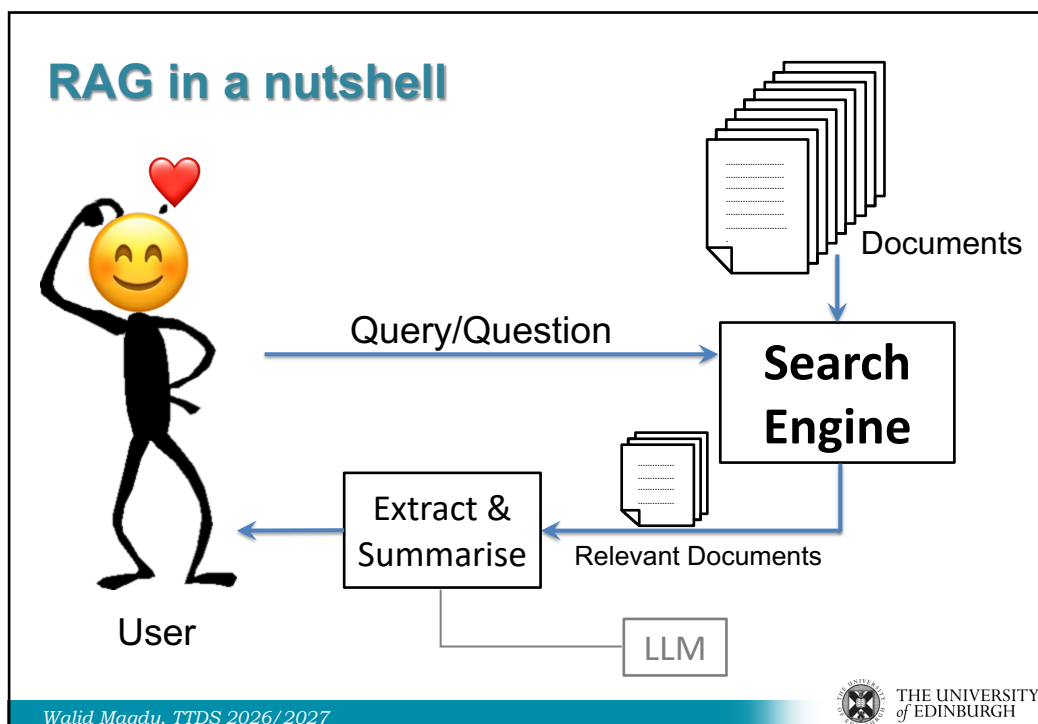


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2



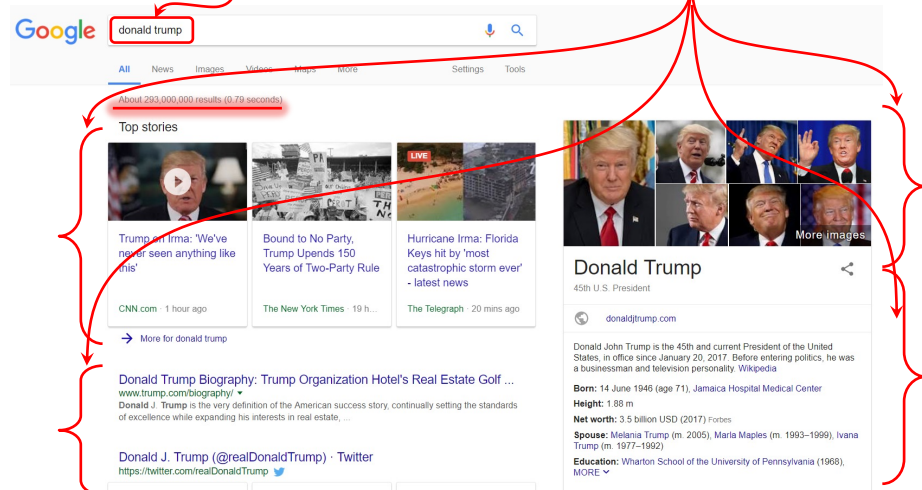
3



4

IR, basic form

- Given Query **Q**, find relevant documents **D**



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5

Two main Issues in IR

About 293,000,000 results (0.79 seconds)

- Effectiveness
 - need to find **relevant** documents
 - needle in a haystack
 - very different from relational DBs (SQL)
- Efficiency
 - need to find them quickly
 - vast quantities of data (100's billions pages)
 - thousands queries per second (Google, ~250,000)
 - data constantly changes, need to keep up
 - compared with other NLP areas, IR is **very fast**

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6

IR main components

- Documents
- Queries
- Relevant documents

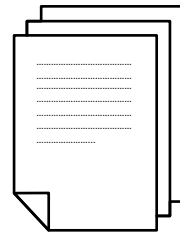
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7

Documents

- The element to be retrieved
 - Unstructured nature
 - Unique ID
 - N documents $\rightarrow$ Collection
- web-pages, emails, book, page, sentence, tweets
- photos, videos, musical pieces, code
- answers to questions
- product descriptions, advertisements
- may be in a different language
- may not have words at all (e.g. DNA)



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8

Queries

- Free text to express user's information need
- Same information-need can be described by multiple queries
 - Latest news on the hurricane in the US
 - North Carolina storm
 - Florence
- Same query can represent multiple information needs
 - Apple
 - Jaguar



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9

Queries – different forms

- Web search → keywords, narrative ...
- Image search → keywords, sample image
- QA → question
- Music search → humming a tune
- Filtering/recommendation → user's interest/history
- Scholar search → structured (author, title ..)
- Advanced search
 - #wsyn**(0.9 **#field** (title, **#phrase** (homer,simpson)) 0.7 **#and** (**#>** (pagerank,3), **#ow3** (homer,simpson)) 0.4 **#passage** (homer, simpson, dan, castellaneta))

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10

Relevance

- At an abstract level, IR is about:
 - does item *D* **match** item *Q*? ...or...
 - is item *D* **relevant** to item *Q*?
- Relevance a tricky notion
 - will the user like it / click on it?
 - will it help the user achieve a task?
(satisfy information need)
 - is it novel (not redundant)?
- *Relevance = what is the topic about?*
 - i.e. *D, Q* share similar “meaning”
 - about the same topic / subject / issue

What is the challenge in relevance?

- No clear semantics, contrast:
 - “William Shakespeare”
 - Author history’s? list of plays? a play by him?
- Inherent ambiguity of language:
 - synonymy: “Edinburgh festival” = “The fringe”
 - polysemy: “Apple”, “Jaguar”
- Relevance highly subjective
 - Relevance: yes/no
 - Relevance: perfect/excellent/good/fair/bad
- On the web: counter SEOs / spam

Relevant Items are Similar

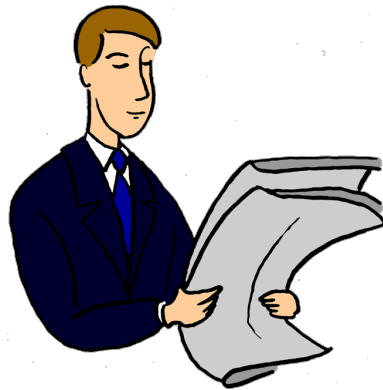
- Key idea:
 - Use similar vocabulary → similar meaning
 - Similar documents relevant to same queries
- Similarity
 - String match
 - Word overlap
 - $P(D|Q) \rightarrow$ retrieval model

IR vs. DB

	Databases	IR
What we're retrieving	Structured data. Clear semantics based on a formal model.	Mostly unstructured. Free text with some metadata.
Queries we're posing	Formally-defined (relational algebra, SQL). Unambiguous.	Free text ("natural language"), Boolean
Results we get	Exact (always "correct")	Imprecise (need to measure relevance)
Interaction with system	One-shot queries.	Interaction is important.

Tamer Elsayed, QU

How IR sees documents?



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15

Bag-of-words trick

- Can you guess what this is about:
 - per is salary hour €25,000 Ronaldo's
 - obesity French is of full cause and fat fries
- Re-ordering doesn't destroy the topic
 - individual words – “building blocks”
 - “bag” of words: a “composition” of “meanings”

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16

Bag-of-words trick

- Most search engines use BOW
 - treat documents, queries as bags of words
- A “bag” is a set with repetitions
 - match = “degree of overlap” between **D**, **Q**
- Retrieval models
 - statistical models (function) that use words as features
 - decide which documents most likely to be relevant
- What should be the top results for **Q**?
 - BOW makes these models tractable

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17

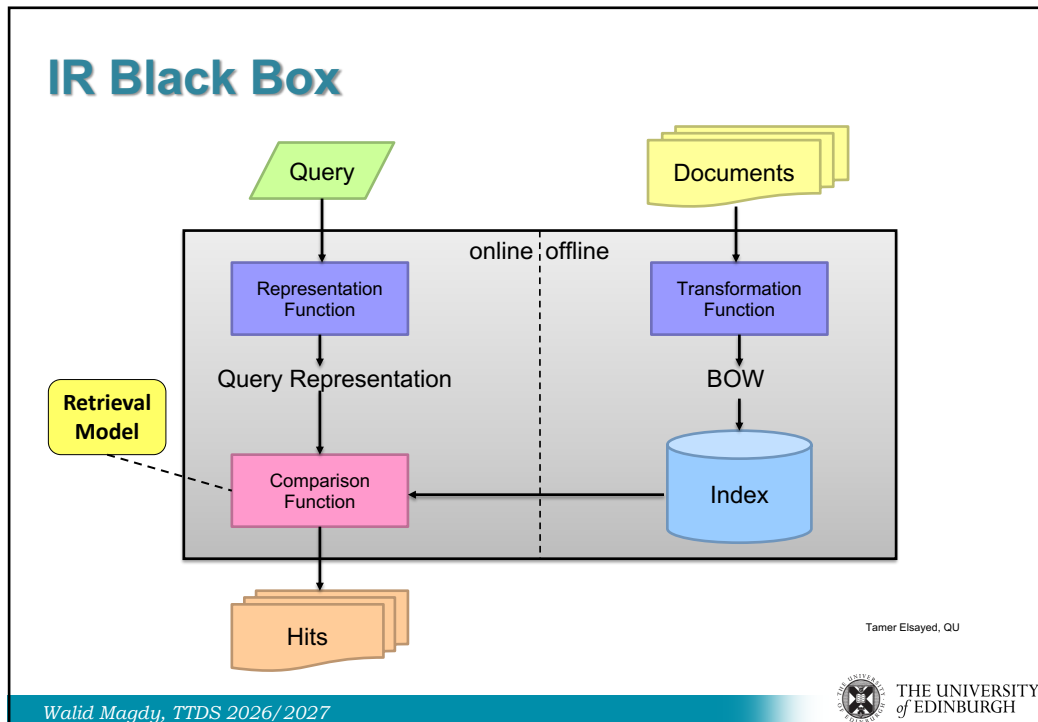
Bag-of-words: Criticism

- word meaning lost without context
 - True, but BOW doesn't really discard context
- what about negations, etc.?
 - {no, climate change is real} vs. {climate change is no real}
- does not work for all languages
 - No natural “word” unit for Chinese, images, music
 - Solve by “segmentation” or “feature induction”

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18



19

Systems perspective on IR

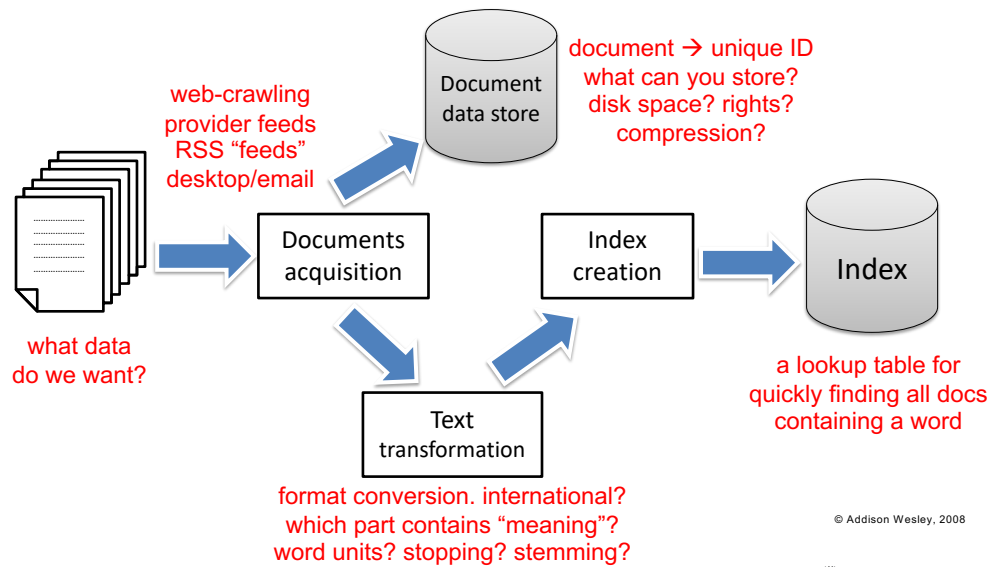
- Indexing Process: *(offline)*
 - get the data into the system
 - acquire the data from crawling, feeds, etc.
 - store the originals (if needed)
 - transform to BOW and “index”
- Search (retrieval) Process: *(online)*
 - satisfy users' requests
 - assist user in formulating query
 - retrieve a set of results
 - help user browse / re-formulate
 - log user's actions, adjust retrieval model

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20

Indexing Process



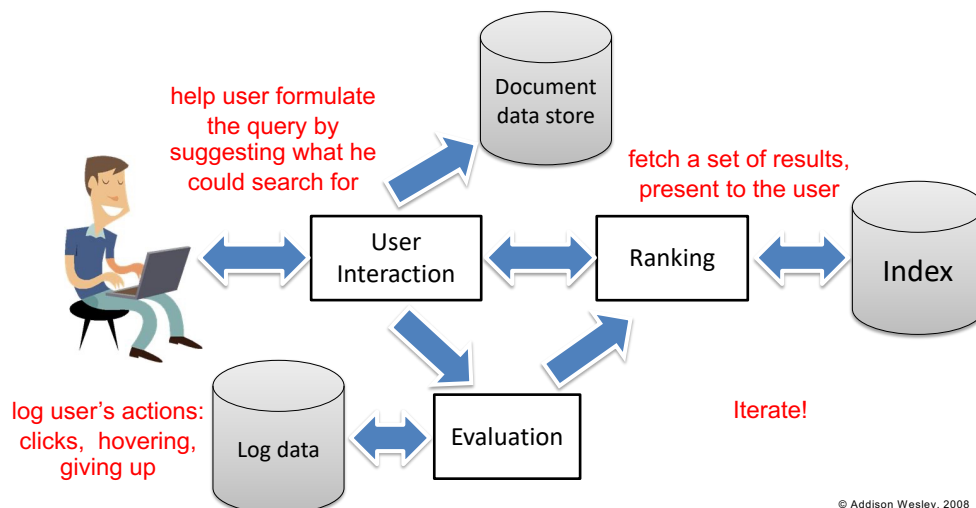
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21

Search Process



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22

Summary

- Information Retrieval (IR): core technology
 - selling point: IR is very fast, provides context
- Main issues: effectiveness and efficiency
- Documents, queries, relevance
- Bag-of-words trick
- Search system architecture:
 - indexing: get data into the system
 - searching: help users find relevant data

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23

Resources

- Search Engines: Information Retrieval in Practice, chapter 1 & 2
- [How Google Search works \(in 5 mins\)](#)
 - 5 mins YouTube video (will be expanded to 10 lectures)
- Lab 0:
 - You have to be confident doing it!
 - If you have trouble finishing it, think twice before committing to the course



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24

Questions

- Next time:
 - Laws of text (Zipf)
 - Vector space models
- Skill to learn by next time:
 - Read text file from disk
 - Read word by word
- Videos:
 - The Zipf Mystery, Vsauce
- Tools:
 - Regular expressions:
 - https://www.w3schools.com/python/python_regex.asp

