INFORMATION RETRIEVAL-
INTRODUZIONE AL CORSO -

Corsi di Laurea in Informatica
Università di Roma, Tor Vergata
(a.a. 2020-2021)

Giorgio Gambosi, Danilo Croce

Overview

- Information Retrieval: Motivazioni del Corso e prospettive
- Modalità di erogazione del Corso
- Forma e struttura delle prove d'esame
- Testi

How many sites in the Web?

Year (June)	Websites	Change	Internet Users	Users per Website	Websites launched
2018	**1,630,322,579**	-8%			
2017	**1,766,926,408**	69%			
2016	**1,045,534,808**	21%			
2015	**863,105,652**	-11%	3,185,996,155*	3.7	
2014	**968,882,453**	44%	2,925,249,355	3.0	
2013	**672,985,183**	-3%	2,756,198,420	4.1	
2012	**697,089,489**	101%	2,518,453,530	3.6	
2011	**346,004,403**	67%	2,282,955,130	6.6	
2010	**206,956,723**	-13%	2,045,865,660	9.9	Pinterest, Instagram
2009	**238,027,855**	38%	1,766,206,240	7.4	
2008	**172,338,726**	41%	1,571,601,630	9.1	Dropbox
2007	**121,892,559**	43%	1,373,327,790	11.3	Tumblr
2006	**85,507,314**	32%	1,160,335,280	13.6	Twttr
2005	**64,780,617**	26%	1,027,580,990	16	YouTube, Reddit

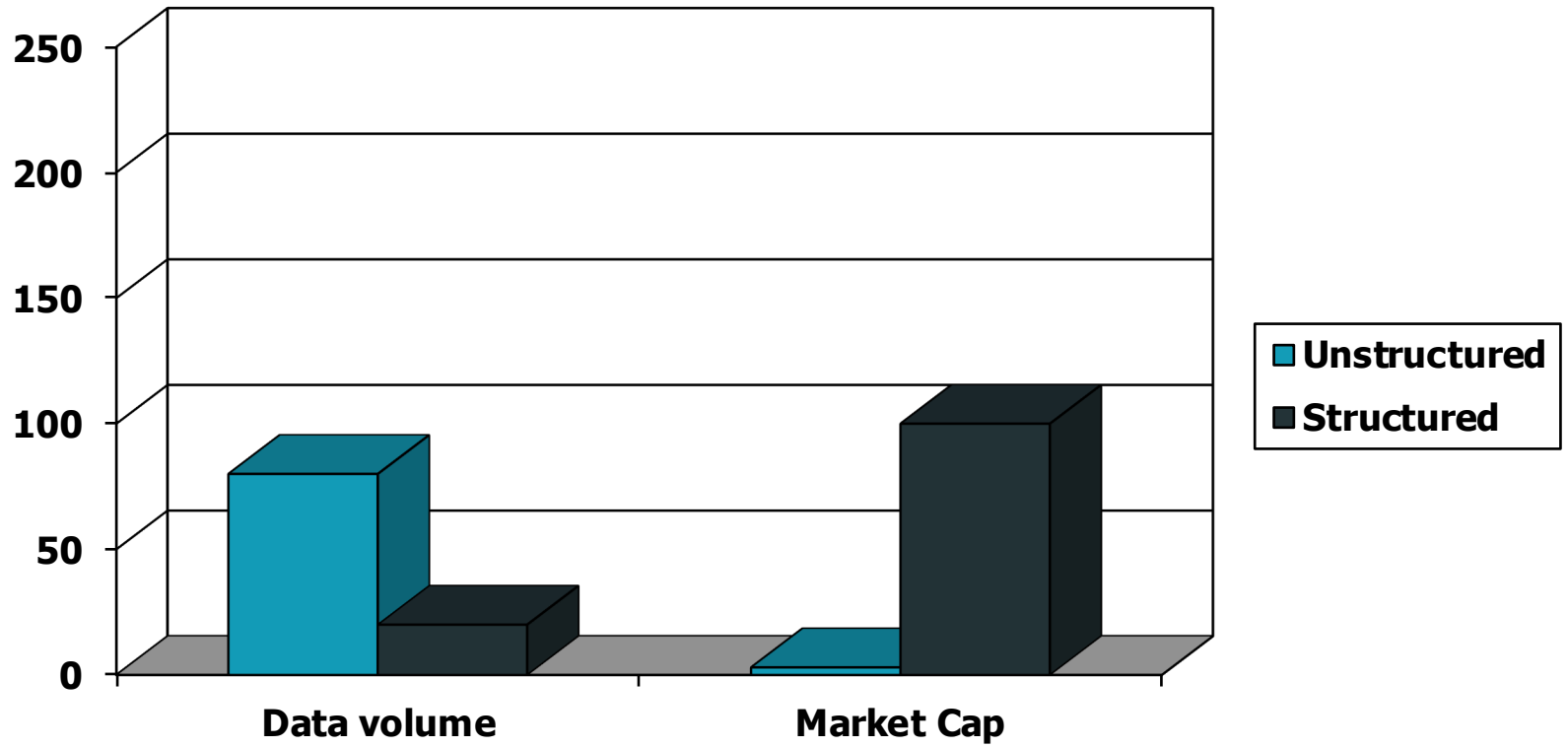
https://www.internetlivestats.com/total-number-of-websites/

Information Retrieval

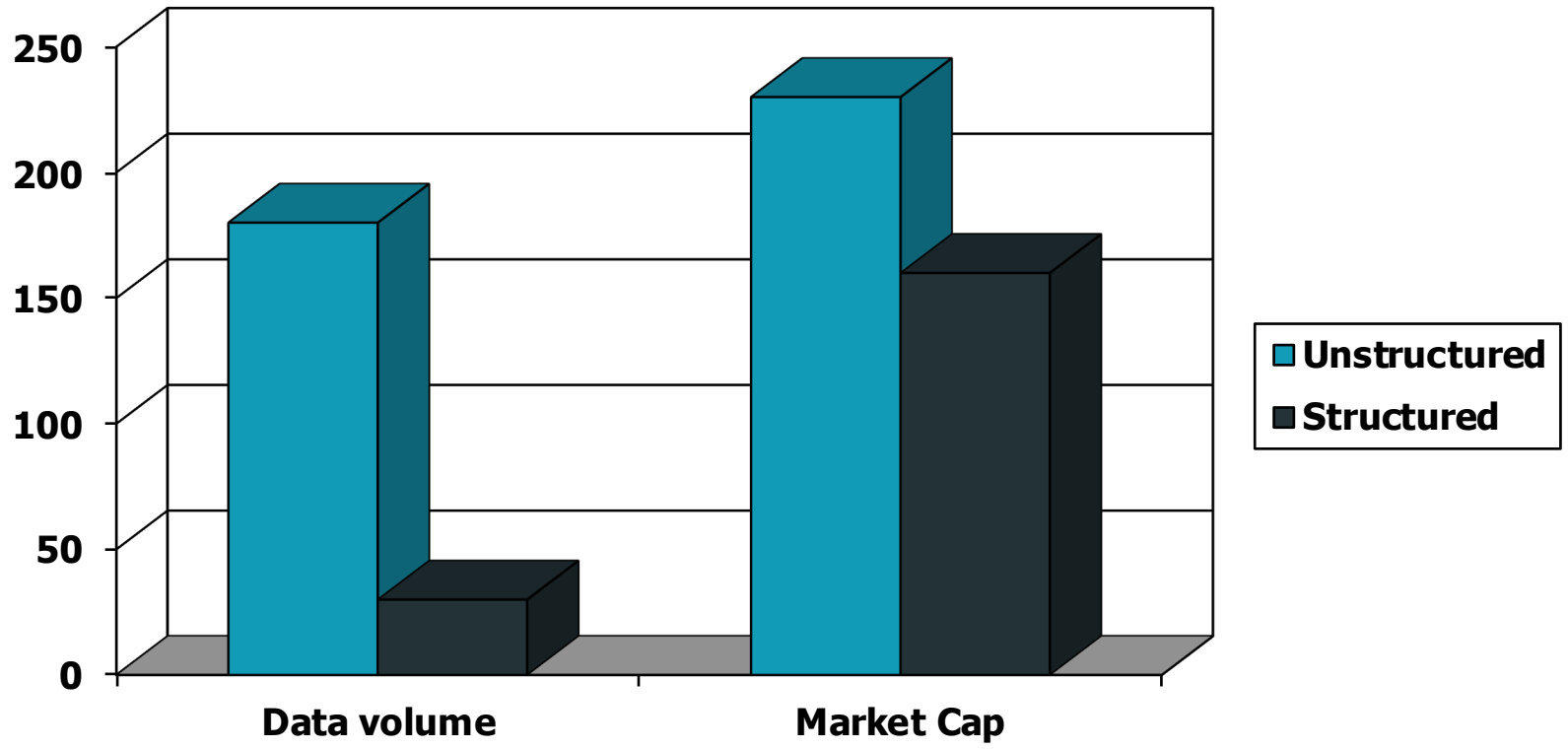
- Information Retrieval (IR) is finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within large collections (usually stored on computers).

- These days we frequently think first of web search, but there are many other cases:
  - E-mail search
  - Searching your laptop
  - Corporate knowledge bases
  - Legal information retrieval

Unstructured (text) vs. structured (database) data in the mid-nineties



Unstructured (text) vs. structured (database) data today



Basic assumptions of Information Retrieval

- Collection: A set of documents
  - Assume it is a static collection for the moment

- Goal: Retrieve documents with information that is relevant to the user's information need and helps the user complete a task

Information Retrieval VS Databases

- A research field traditionally separate from Databases
  - Goes back to IBM, Rand and Lockheed in the 50's
  - G. Salton at Cornell in the 60's
  - Lots of research since then
- DB & IR Products traditionally separate
  - Originally, document management systems for libraries, government, law, etc.
  - Gained prominence in recent years due to web search

IR vs. DBMS: some differences

- Seem like very different beasts:

IR	DBMS
Imprecise Semantics	Precise Semantics
Keyword search	SQL
Unstructured data format	Structured data
Read-Mostly. Add docs occasionally	Expect reasonable number of updates
top *k* results	Generate all answers

- Both support queries over large datasets, use indexing.
  - In practice, you currently have to choose between the two. Not pleasant!

IR's "Bag of Words" Model

- Typical IR data model:
  - Each document is just a bag (multiset) of words ("terms")
  - Bag models a doc just like a BBox models a spatial object.
- Detail 1: "Stop Words"
  - Certain words are considered irrelevant and not placed in the bag
  - e.g., "the"
  - e.g., HTML tags like <H1> [not always a good idea!]
- Detail 2: "Stemming" and other content analysis
  - Using language-specific rules, convert words to their basic form
  - e.g., "surfing", "surfed" --> "surf"

Boolean Search in SQL

- Really only one SQL query in Boolean Search IR:
  - Single-table selects, UNION, INTERSECT, EXCEPT
- relevance () is the “secret sauce” in the search engines:
  - Combos of statistics, linguistics, and graph theory tricks! [computing reputation of pages, hubs and authorities on topics, etc.]
  - Unfortunately, not easy to compute this efficiently using typical DBMS implementation.

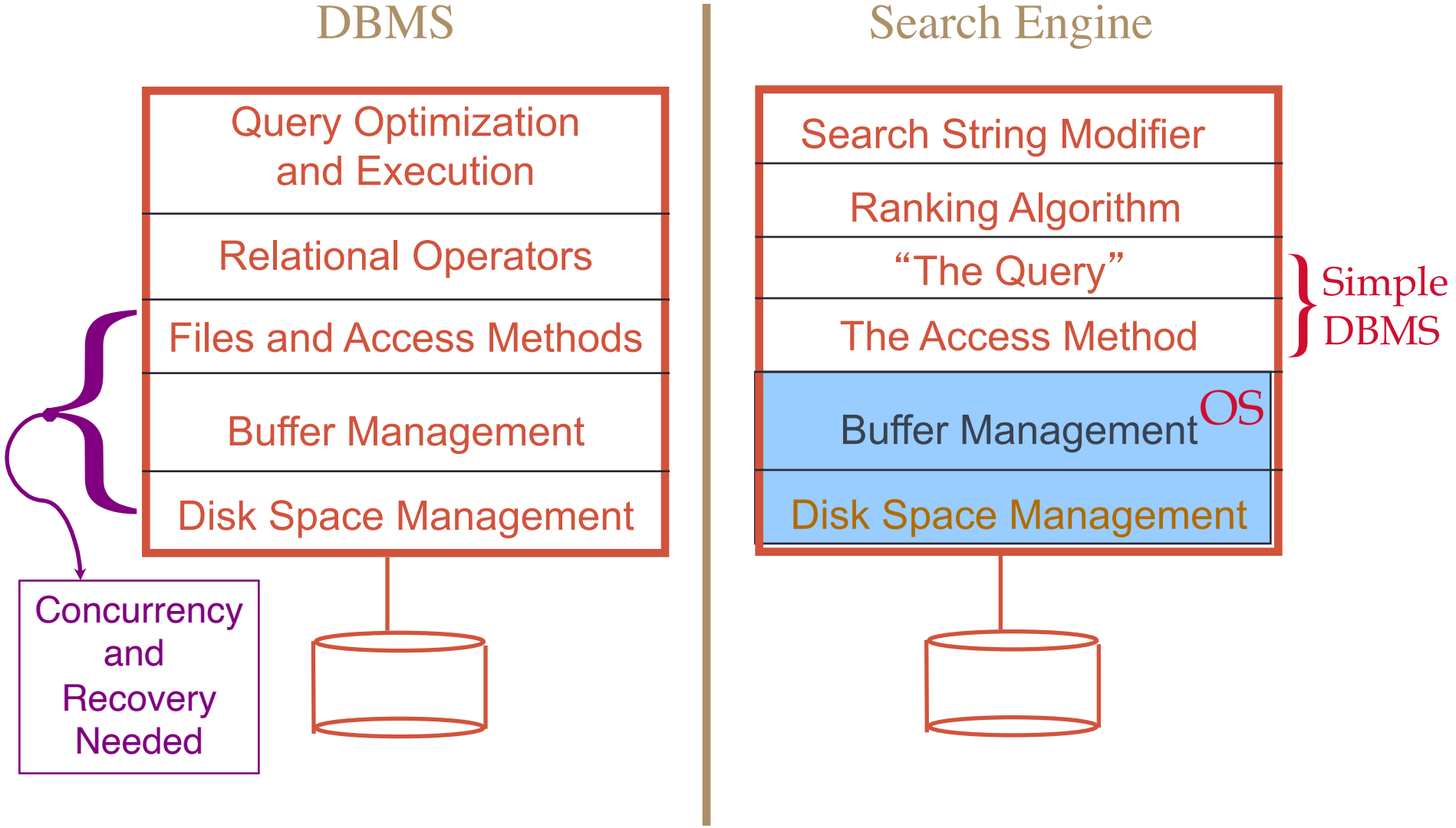
Computing relevance 1/2

- Relevance calculation involves how often search terms appear in doc, and how often they appear in collection:
  - More search terms found in a doc is more relevant
  - Greater importance attached to finding *rare* terms (i.e., search terms, rare in the collection, but appear in this doc.).

Computing relevance 2/2

- Doing this efficiently in current SQL engines is not easy:
  - “Relevance of a doc wrt a search term” is a function that is called once per doc the term appears in (docs found via inv. index):
    - For efficient computation, for each term, we can store the # times it appears in each doc, as well as the # docs it appears in.
    - Must also sort retrieved docs by their relevance value.
    - Also, think about Boolean operators (if the search has multiple terms) and how they affect the relevance computation!

DBMS vs. Search Engine Architecture



IR vs. DBMS Revisited

- Semantic Guarantees
  - DBMS guarantees transactional semantics
    - If inserting Xact commits, a later query *will see* the update
    - Handles multiple concurrent updates correctly
  - IR systems do not do this; nobody notices!
    - Postpone insertions until convenient
    - No model of correct concurrency
- Data Modeling & Query Complexity
  - DBMS supports any schema & queries
    - Requires you to define schema
    - Complex query language hard to learn
  - IR supports only one schema & query
    - No schema design required (unstructured text)
    - Trivial-to-learn query language

IR vs. DBMS, Contd.

- Performance goals
  - DBMS supports general SELECT plus arbitrarily complex queries
    - Plus mix of INSERT, UPDATE, DELETE
    - General purpose engine must always perform “well”
  - IR systems expect only one stylized SELECT
    - Plus delayed INSERT, unusual DELETE, no UPDATE.
    - Special purpose, must run super-fast on “The Query”
    - Users rarely look at the full answer in Boolean Search

Lots More in IR …

- How to “rank” the output? I.e., how to compute relevance of each result item w.r.t. the query?
  - Doing this well / efficiently is hard!
- Other ways to help users paw through the output?
  - Document “clustering”, document visualization
- How to take advantage of hyperlinks?
  - Really cute tricks here! (visibility, authority, page rank, etc.)
- How to use compression for better I/O performance?
  - E.g., making RID lists smaller
  - Try to make things fit in RAM!
- How to deal with synonyms, misspelling, abbreviations?
- How to write a good web crawler?

Obbiettivi del Corso

Il corso si propone di introdurre lo studente agli scopi, alle principali problematiche e ai principali modelli dell'Information Retrieval

Argomenti

- Introduzione al problema dell'Information Retrieval
- Definizione della nozione di Inverted Indices
- Costruzione di Indici per l'Information Retrieval
- Algoritmi per la codifica e compressione dell'Informazione
- Funzione di Ranking documentale
- Introduzione al Vector Space Model
- Modello Probabilistici per l'Information Retrieval
- Valutazione dei Sistemi di IR
- Sviluppo efficiente e su larga scala di sistemi di IR
- Crawling e Detection di risorse duplicate
- Introduzione a IR Engines
- Introduzione a Map Reduce

IR Laboratories

Obiettivo: studio e implementazione di alcuni dei paradigmi di Information Retrieval visti a lezione

- Vector Space Model
- Modelli Probabilistici
- Map Reduce

Verranno assegnati degli esercizi da completare prima della verbalizzazione

Orari

- **MARTEDI', h. 11:30-13:30 (Teams)**
- **VENERDI', h. 16:00-18:00 (Teams)**

Ricevimento: termine della lezione o su appuntamento

Materiale a disposizione dello studente

Registrazioni delle lezioni su Teams

Slides delle lezioni messe a disposizione dal docente

Slides dei laboratori e progetti software sviluppati a lezione

Testi consigliati

Sito del Corso

I materiali pubblicati sono sul sito:

http://sag.art.uniroma2.it/didattica/croce/IR_20_21/

Information Retrieval (a.a. 2019/20)

Elenco dei File nel deposito

Sommario Contenuti

1. Novità
2. Programma del Corso
3. Testi di Riferimento
4. Link Utili
5. Diapositive delle lezioni
6. Progetti ed Esercizi Proposti

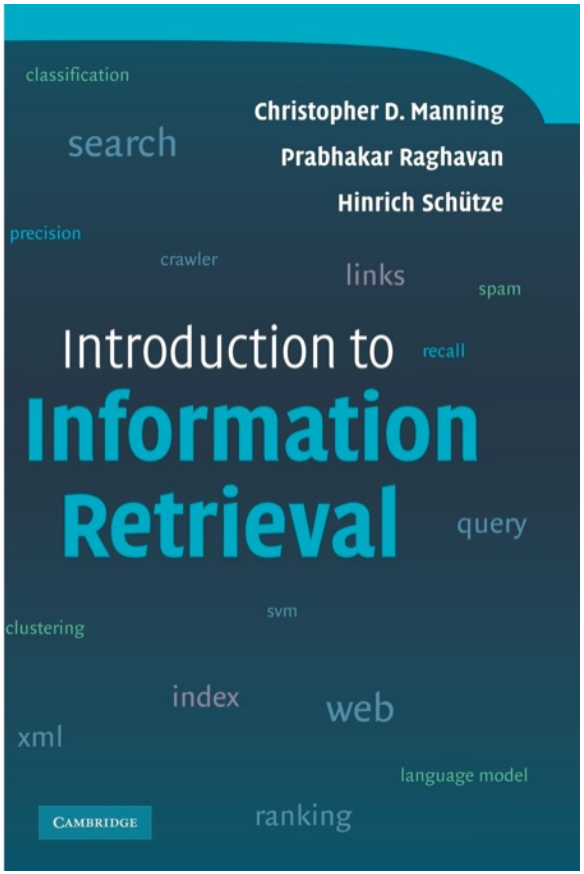
Testi Consigliati

Introduction to Information Retrieval

Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze

Cambridge University Press. 2008.

http://nlp.stanford.edu/IR-book/



Organizzazione: Esami

- La prova scritta è composta da un **Test a Risposte Multiple** e **Domanda Aperta** (**Homework**).
  - Essi verranno articolati in due Test In Itinere oppure in un'unica prova finale.

- La valutazione sarà mediata tra il punteggio ottenuto durante le prove scritte con un punteggio assegnato a valle di una **prova orale**.

- Progetto:
  - Lo studente **potrà** svolgere un progetto che completerà il voto finale per gli esami da **6 CFU**.
  - Il progetto **è obbligatorio** per gli studenti che dovranno sostenere l'esame da **9 CFU**.
  - *La complessità del progetto è legata al numero di CFU*

Domande?

Action List

- Registrarsi al Corso presso Delphi presso :
  - URL: **`https://delphi.uniroma2.it/totem/jsp/`**
- Definire i propri estremi e tipo di Corso (ad es. i CFU e o i Corsi già sostenuti) tramite il campo “Note”
- Verranno pubblicati:
  - Elenchi dei gruppi registrati
  - Progetti
  - Orari ricevimento per gli studenti che non seguono
  - Slide e materiali complementari (*in progress*)