Inverted File Index

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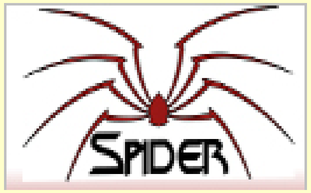
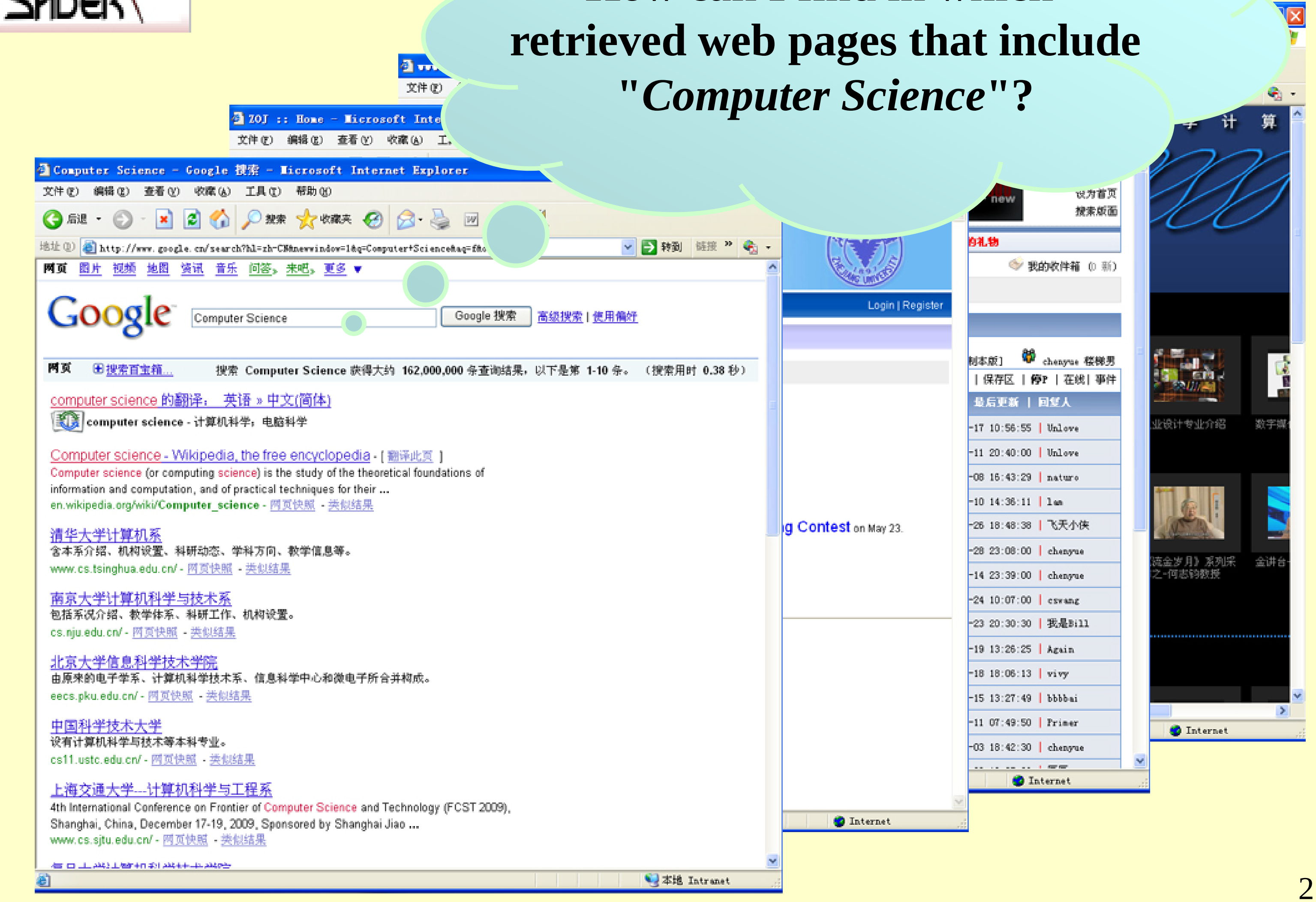


How can I find in which retrieved web pages that include "*Computer Science*"?



Computer Science - Google 搜索 - Microsoft Internet Explorer
文件(F) 编辑(E) 查看(V) 收藏(A) 工具(T) 帮助(H)
后退 搜索 收藏夹
地址(D) http://www.google.cn/search?hl=zh-CN&newwindow=1&q=Computer+Science&aq=f&o
转到 链接
ZOJ :: Home - Microsoft Inte
Login | Register
Internet
本地 Intranet

网页 图片 视频 地图 资讯 音乐 问答 来吧 更多

Google: Computer Science — Google 搜索 · 高级搜索 | 使用偏好

网页 搜索百宝箱... 搜索 Computer Science 获得大约 162,000,000 条查询结果，以下是第 1-10 条。（搜索用时 0.38 秒）

computer science 的翻译： 英语 » 中文(简体)
computer science - 计算机科学；电脑科学

Computer science - Wikipedia, the free encyclopedia - [翻译此页]
Computer science (or computing science) is the study of the theoretical foundations of information and computation, and of practical techniques for their ...
en.wikipedia.org/wiki/Computer_science - 网页快照 - 类似结果

清华大学计算机系
含本系介绍、机构设置、科研动态、学科方向、教学信息等。
www.cs.tsinghua.edu.cn/ - 网页快照 - 类似结果

南京大学计算机科学与技术系
包括系况介绍、教学体系、科研工作、机构设置。
cs.nju.edu.cn/ - 网页快照 - 类似结果

北京大学信息科学技术学院
由原来的电子学系、计算机科学技术系、信息科学中心和微电子所合并构成。
eecs.pku.edu.cn/ - 网页快照 - 类似结果

中国科学技术大学
设有计算机科学与技术等本科专业。
cs11.ustc.edu.cn/ - 网页快照 - 类似结果

上海交通大学---计算机科学与工程系
4th International Conference on Frontier of Computer Science and Technology (FCST 2009), Shanghai, China, December 17-19, 2009, Sponsored by Shanghai Jiao ...
www.cs.sjtu.edu.cn/ - 网页快照 - 类似结果

☞ **Solution 1: Scan each page for the string "Computer Science".**

Wait till your next life !

Have more than 1 billion web pages Indexed

☞ Solution 2: Term-Document Incidence Matrix

〖Example〗 Document sets

Doc	Text
1	Gold silver truck
2	Shipment of gold damaged in a fire
3	Delivery of silver arrived in a silver truck
4	Shipment of gold arrived in a truck

	1	2	3	4
a	0	1	1	1
arrived	0	0	1	1
damaged	0	1	0	0
delivery	0	0	1	0
fire	0	1	0	0
gold	1	1	0	1
of	0	1	1	1
in	0	1	1	1
shipment	0	1	0	1
silver	1	0	1	0
truck	1	0	1	1

silver & truck

☞ Solution 3: Compact Version - Inverted File Index

【Definition】 Index is a mechanism for locating a given term in a text.

【Definition】 Inverted file contains a list of pointers (e.g. the number of a page) to all occurrences of that term in the text.

Doc	Text
1	Gold silv [illegible]
2	Shipment of go [illegible] damaged in a fire
3	Delivery of silver arrived in a silver truck
4	Shipment of gold arrived in a truck

Inverted because it lists for a *term*, all documents that contain the term

Index →

No.	Term	Times; Documents
[illegible]	[illegible]	[illegible] 2,3,4>
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] 1; 3>
5	fire	<1; 2>
6	gold	<3; 1,2,4>
7	of	<3; 2,3,4>
8	in	<3; 2,3,4>
9	shipment	<2; 2,4>
10	silver	<2; 1,3>
11	truck	<3; 1,3,4>

Inverted File Index

Doc	Text
1	Gold silver truck
2	Shipment of gold damaged in a fire
3	Delivery of silver arrived in a silver truck
4	Shipment of gold arrived in a truck

No.	Term	Times; Documents Words
1	a	<3; (2;6),(3;6),(4;6)>
2	arrived	<2; (3;4),(4;4)>
3	damaged	<1; (2;4)>
4	delivery	<1; (3;1)>
5	fire	<1; (2;7)>
6	gold	<3; (1;1),(2;3),(4;3)>
7	of	<3; (2;2),(3;2),(4;2)>
8	in	<3; (2;5),(3;5),(4;5)>
9	shipment	<2; (2;1),(4;1)>
10	silver	<2; (1;2),(3;3,7)>
11	truck	<3; (1;3),(3;8),(4;7)>

Term Dictionary

Posting List

How to easily print the sentences which contain the words and highlight the words?

Why do we keep “times” (frequency)?

Index Generator

```
while ( read a document D ) {
    while ( read a term T in D ) {
        if ( Find( Dictionary, T ) == false )
            Insert( Dictionary, T );
        Get T's posting list;
        Insert a node to T's posting list;
    }
}
Write the inverted index to disk;
```

Token Analyzer
Stop Filter

Vocabulary
Scanner

Vocabulary
Insertor

Memory management

While reading a term ……

✂ ***Word Stemming***

Process a word so that only its stem or root form is left.

〖Example〗

$$\left.\begin{array}{l}\textbf{Process}\\ \textbf{processing}\\ \textbf{processes}\\ \textbf{processed}\end{array}\right\}\ \textbf{process} \qquad \left.\begin{array}{l}\textbf{says}\\ \textbf{said}\\ \textbf{saying}\end{array}\right\}\ \textbf{say}$$

✂ ***Stop Words***

Some words are so common that almost every document contains them, such as “a” “the” “it”. It is useless to index them. They are called *stop words*. We can eliminate them from the original documents.

While accessing a term ……

☞ **Solution 1:** Search trees (*B- trees, B+ trees, Tries, ...*)

☞ **Solution 2:** Hashing

Discussion 3:

What are the pros and cons of using hashing, comparing to using search trees?

While not having enough memory ……

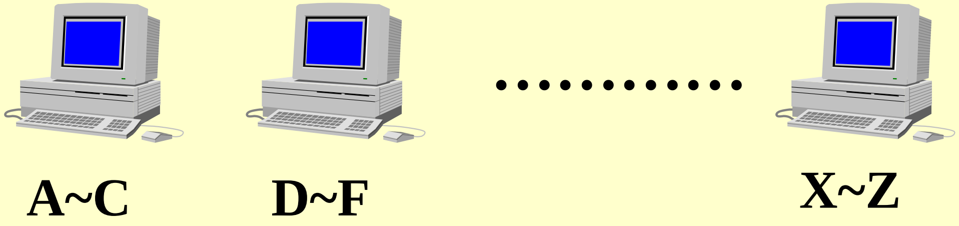
```
while ( read a document D ) {
  while ( read a term T in D ) {
    if ( Find( Dictionary, T ) == false )
      Insert( Dictionary, T );
    Get T's posting list;
    Insert a node to T's posting list;
  }
}
```

Sorted

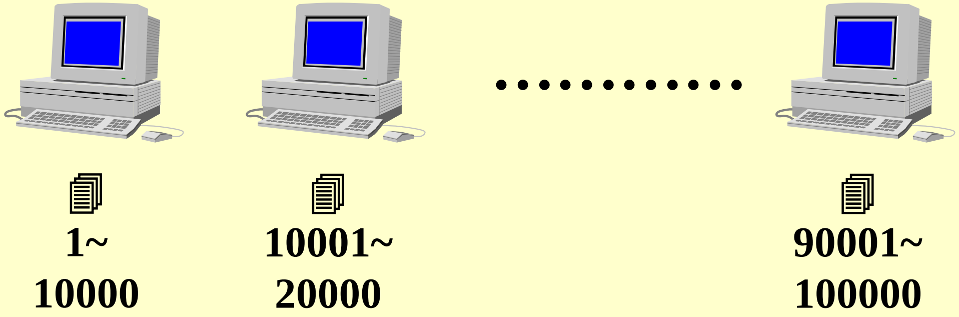
Distributed indexing (for web-scale indexing — don’t try this at home!)

—— Each node contains index of a subset of collection

☞ **Solution 1: Term-partitioned index**



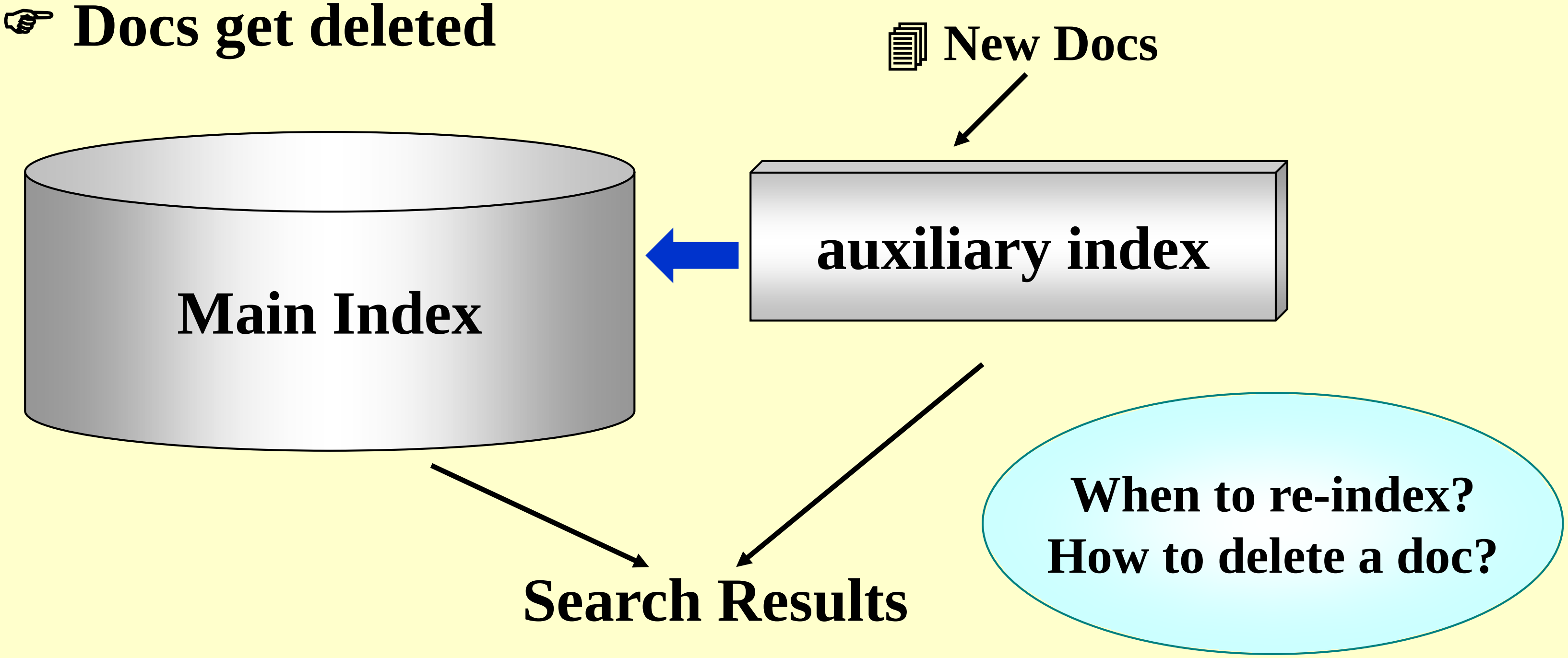
☞ **Solution 2: Document-partitioned index**



Dynamic indexing

- ☞ Docs come in over time
  - postings updates for terms already in dictionary
  - new terms added to dictionary

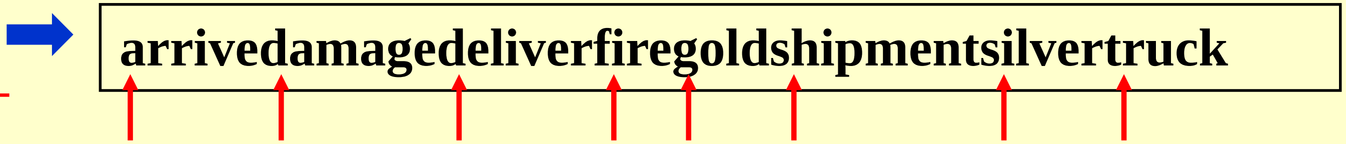
- ☞ Docs get deleted



When to re-index?
How to delete a doc?

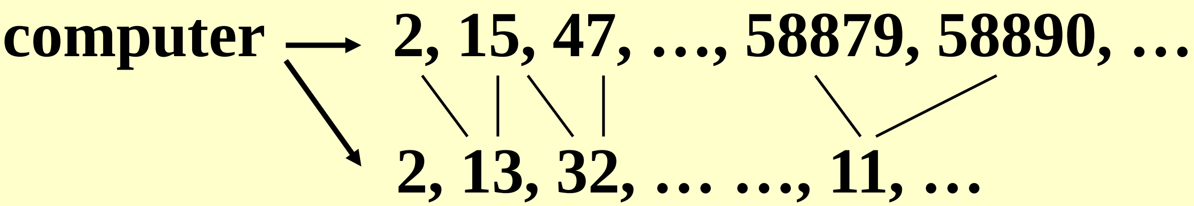
Compression

Term
~~a~~
arrive
damage
deliver
fire
gold
~~of~~
~~in~~
shipment
silver
truck



arrivedamagedeliverfiregoldshipmentsilvertruck

Posting List:



computer → 2, 15, 47, …, 58879, 58890, …

2, 13, 32, … …, 11, …

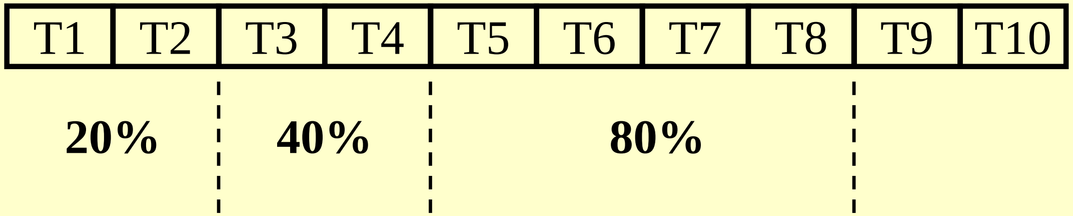
☝ Most gaps can be encoded with far fewer than 20 bits

Thresholding

☞ **Document:** **only retrieve the top *x* documents where the documents are ranked by weight**

- 👎 **Not feasible for Boolean queries**
- 👎 **Can miss some relevant documents due to truncation**

☞ **Query:** **Sort the query terms by their frequency in ascending order; search according to only some percentage of the original query terms**



Measures for a search engine

☞ **How fast does it index**

- **Number of documents/hour**

☞ **How fast does it search**

- **Latency as a function of index size**

☞ **Expressiveness of query language**

- **Ability to express complex information needs**
- **Speed on complex queries**

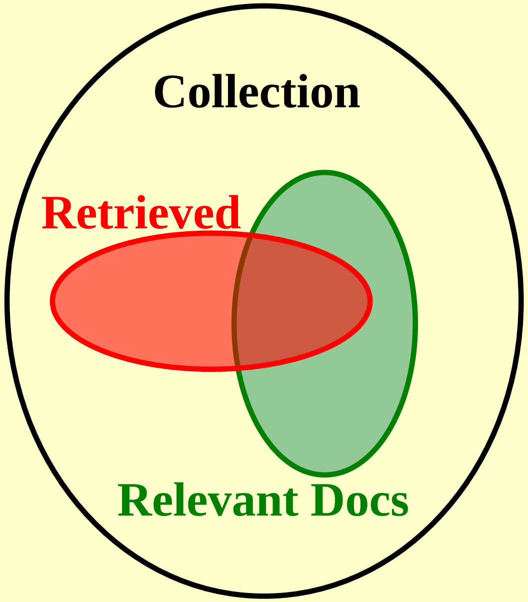
☞ **User happiness ?**

- **Data Retrieval Performance Evaluation (after establishing correctness)**
  - **> Response time**
  - **> Index space**
- **Information Retrieval Performance Evaluation**
  - **> + How *relevant* is the answer set?**

Relevance measurement requires 3 elements:

1. A benchmark document collection
2. A benchmark suite of queries
3. A binary assessment of either Relevant or Irrelevant for each query-doc pair

	Relevant	Irrelevant
Retrieved	R_R	I_R
Not Retrieved	R_N	I_N

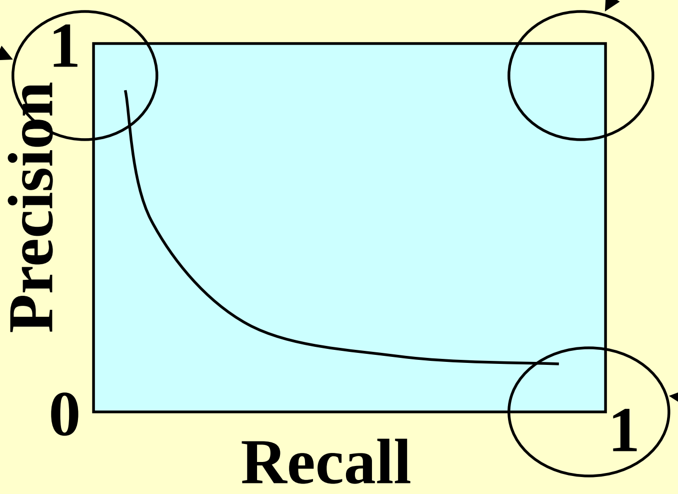


Precision $P = R_R / (R_R + I_R)$

Recall $R = R_R / (R_R + R_N)$

Returns relevant documents but misses many useful ones too

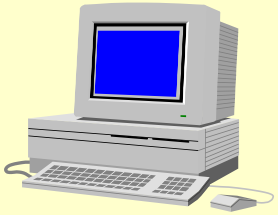
The ideal



Returns most relevant documents but includes lot of junk

Discussion 4:

How to improve the *relevancy* of search results?



Research Project 2

Roll Your Own

Mini Search Engine (26)

In this project, you are supposed to create your own mini search engine which can handle inquiries over “The Complete Works of William Shakespeare” (http://shakespeare.mit.edu/).

You may download the functions for handling stop words and stemming from the Internet.

Detailed requirements can be downloaded from https://pintia.cn/

Reference:

Download “InvertedFileIndex.zip”.

- **The Google File System.pdf**
- **Building an Inverted Index.pdf**
- **Inverted Index Construction(ppt).pdf**
- **Compression.pdf**