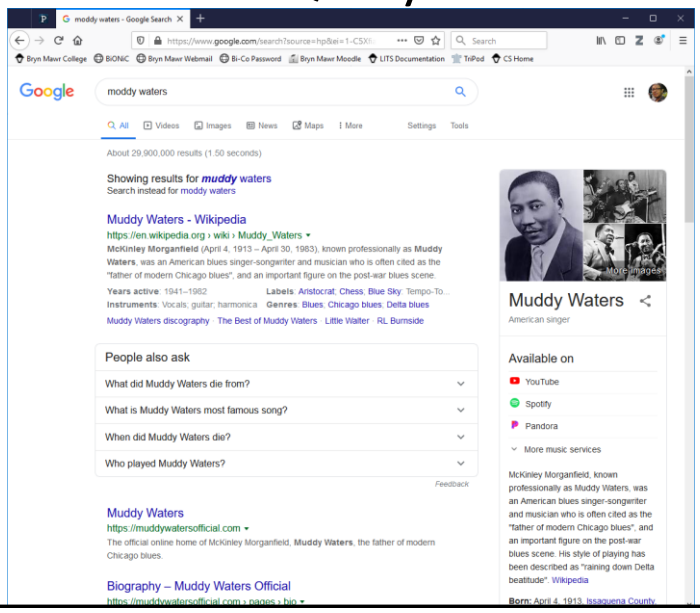
Information Retrieval

Deepak Kumar

Information Retrieval

Searching within a document collection for a particular needed information.

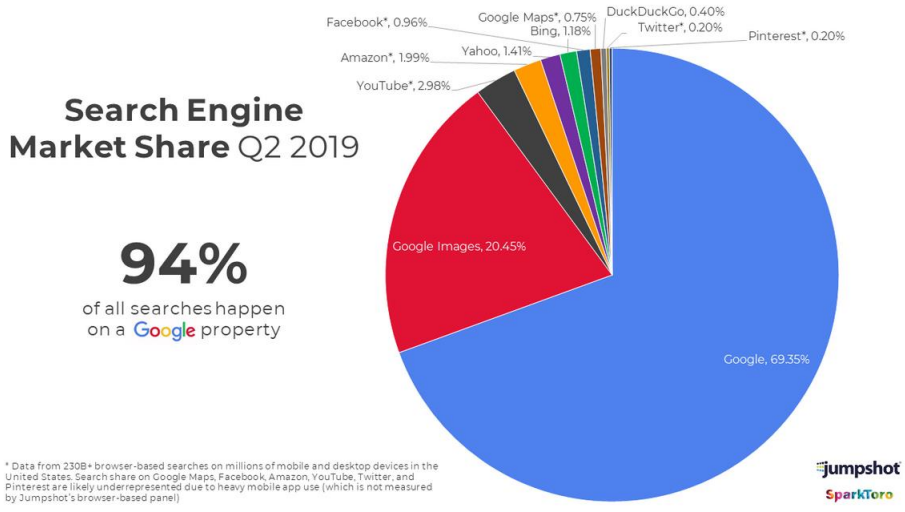
Query

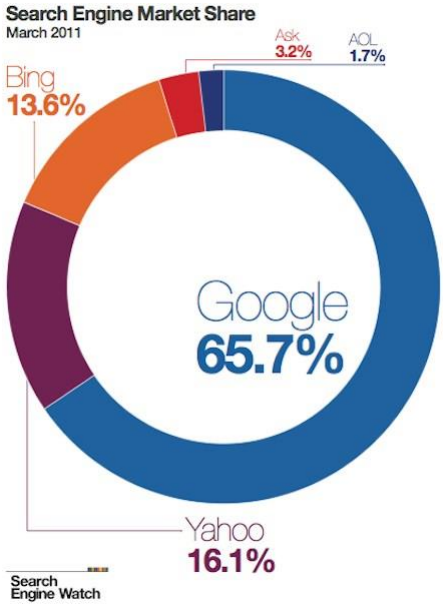


Search Engines…

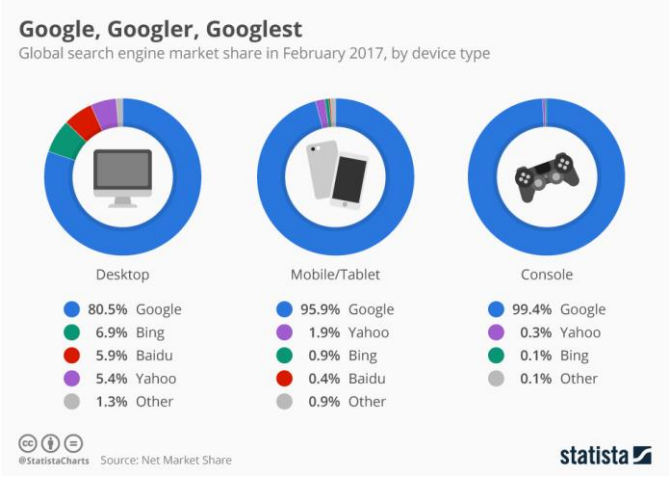
Altavista
Ask
Baidu
Bing
Blekko
ChaCha
Dogpile
Daum
Dmoz
Du
Egerin
ckDuckGo
Entireweb
Excite
Faroo
Info.com
Fireball
Gigablast
Google
Go
Goo
Hakia
HotBot
Leapfish
Lycos
Maktoob
Miner.hu
Monster Crawler
Naver
Omgili
Rediff
Scrub The Web
Seznam
Sogou
Soso
Spezify
Stinky Teddy
Stumpdedia
Swisscows
Teoma
Walla
WebCrawler
Yahoo!
Yandex
Yippy
Youdao

Search Engine Marketshare 2019

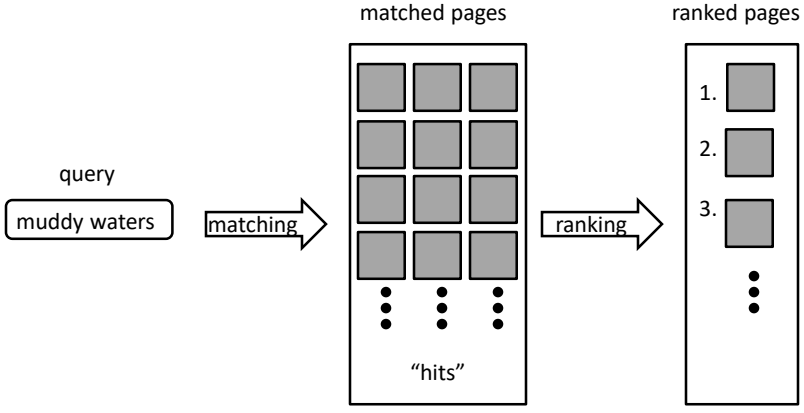




Search Engine Marketshare 2017



Matching & Ranking



Index

Inverted Index

- A mapping from content (words) to location.
- Example:

1 the cat sat on the mat

2 the dog stood on the mat

3 the cat stood while a dog sat

Inverted Index

1 the cat sat on the mat

2 the dog stood on the mat

3 the cat stood while a dog sat

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

Inverted Index

1 the cat sat on the mat

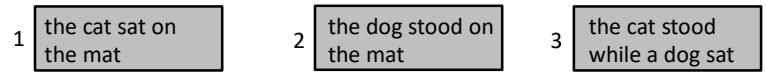
2 the dog stood on the mat

3 the cat stood while a dog sat

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

Every word in every web page is indexed!

Searching

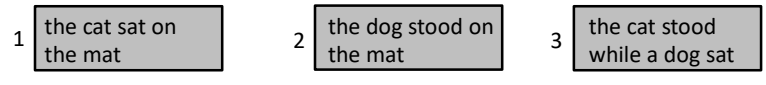


query

cat

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

Searching

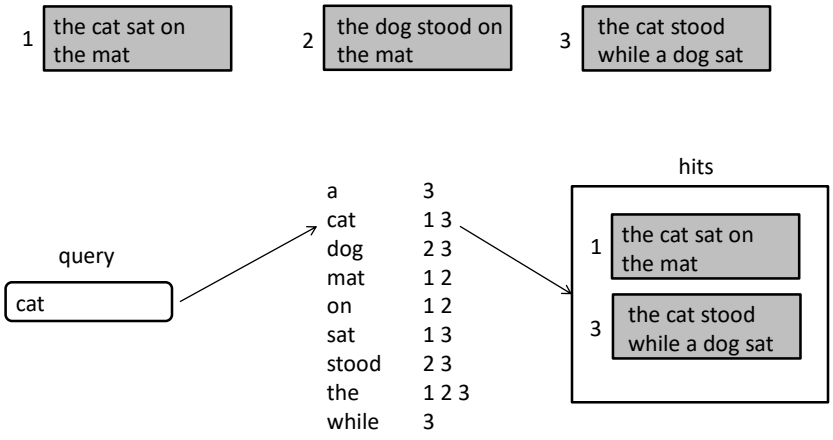


query

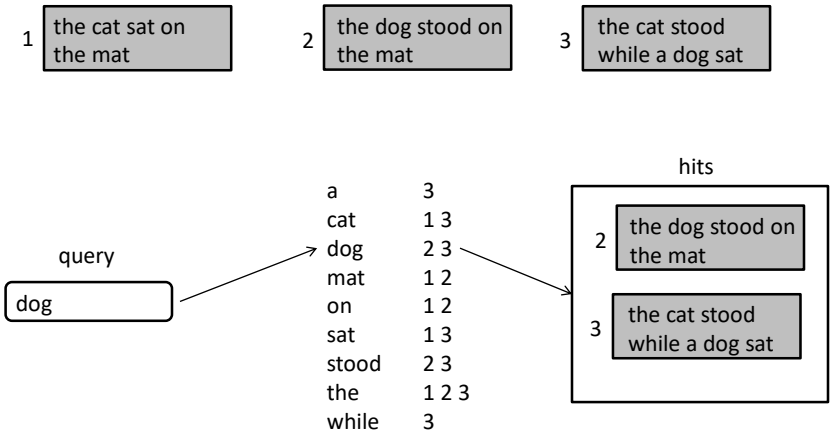
cat

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

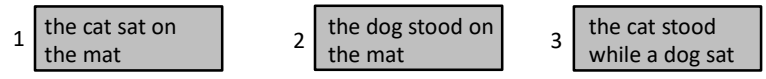
Searching



Searching



Searching

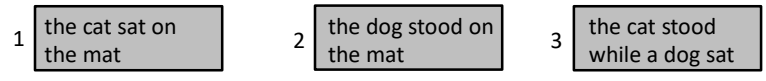


query

cat dog

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

Searching

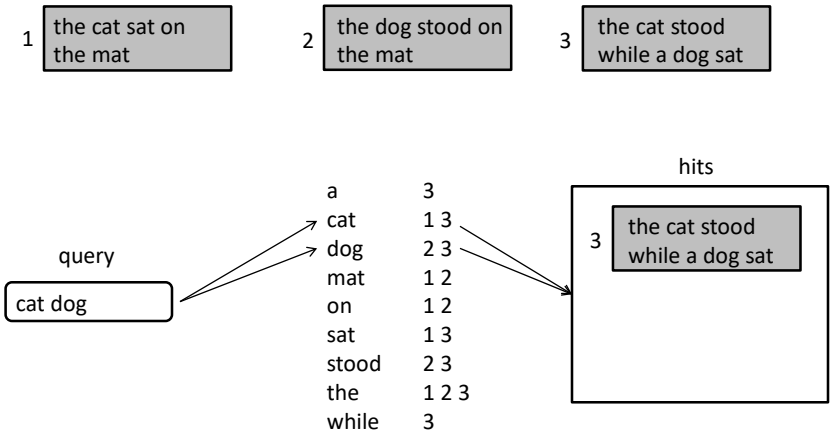


query

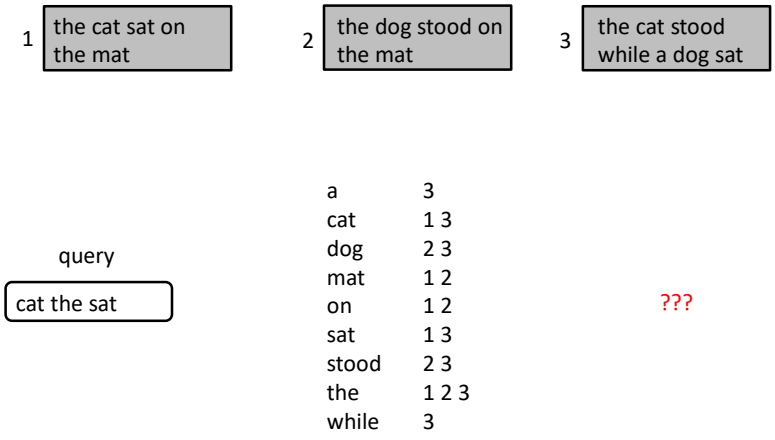
cat dog

a	3
cat	1 3
dog	2 3
mat	1 2
on	1 2
sat	1 3
stood	2 3
the	1 2 3
while	3

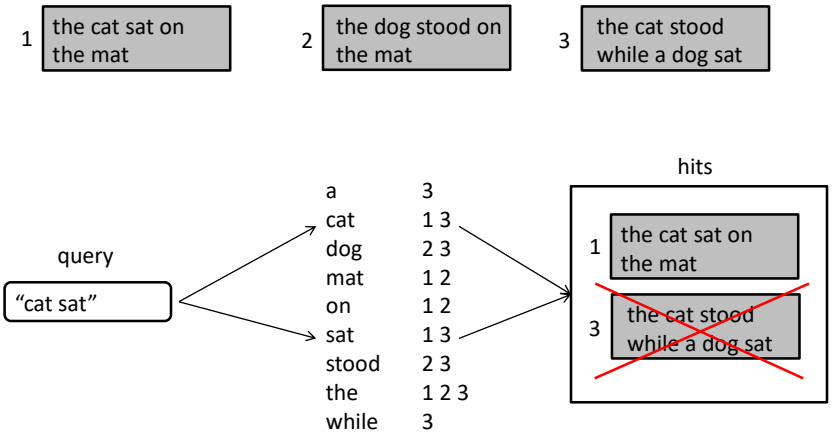
Searching



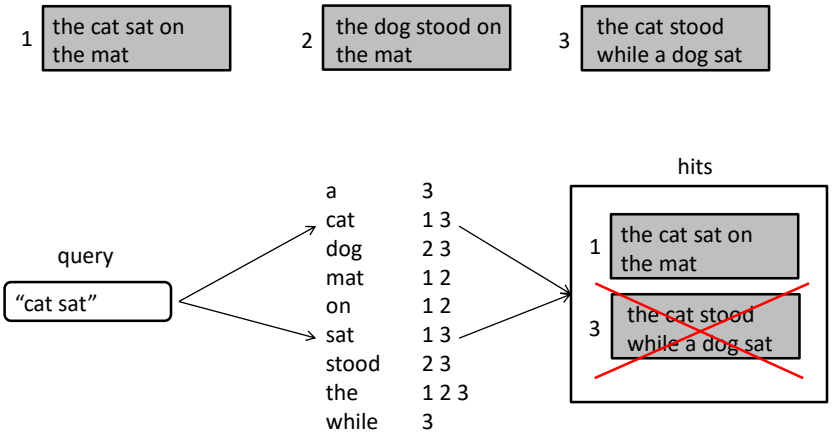
Searching



Phrase Queries



Phrase Queries



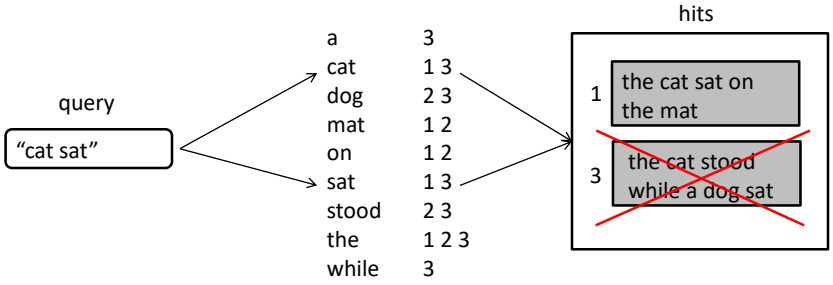
How to tell if two words occur next to each other?

Phrase Queries

1 the cat sat on the mat

2 the dog stood on the mat

3 the cat stood while a dog sat



How to tell if two words occur next to each other? **EFFICIENTLY???**

Inverted Index with Location

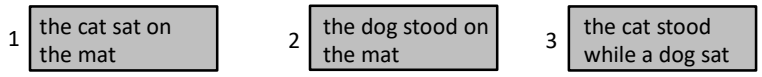
1 the cat sat on the mat

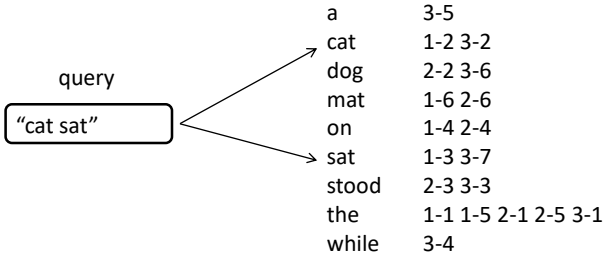
2 the dog stood on the mat

3 the cat stood while a dog sat

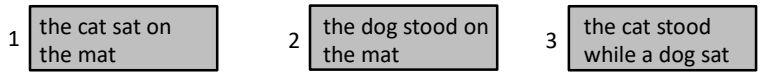
a	3-5
cat	1-2 3-2
dog	2-2 3-6
mat	1-6 2-6
on	1-4 2-4
sat	1-3 3-7
stood	2-3 3-3
the	1-1 1-5 2-1 2-5 3-1
while	3-4

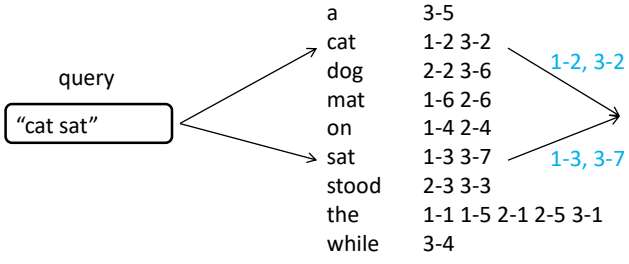
Inverted Index with Location



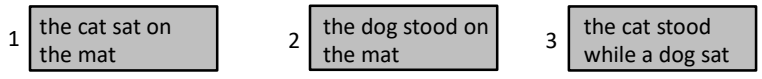


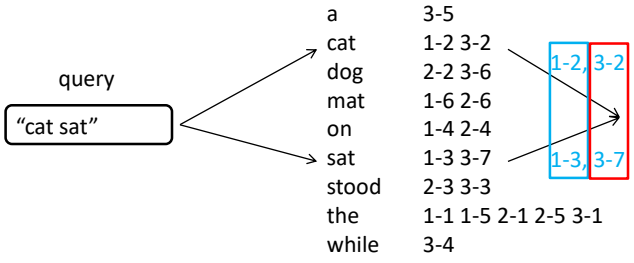
Inverted Index with Location



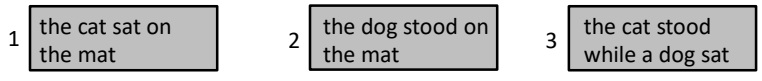


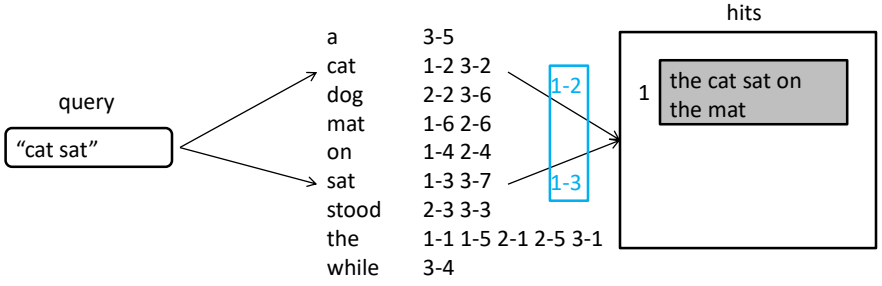
Inverted Index with Location



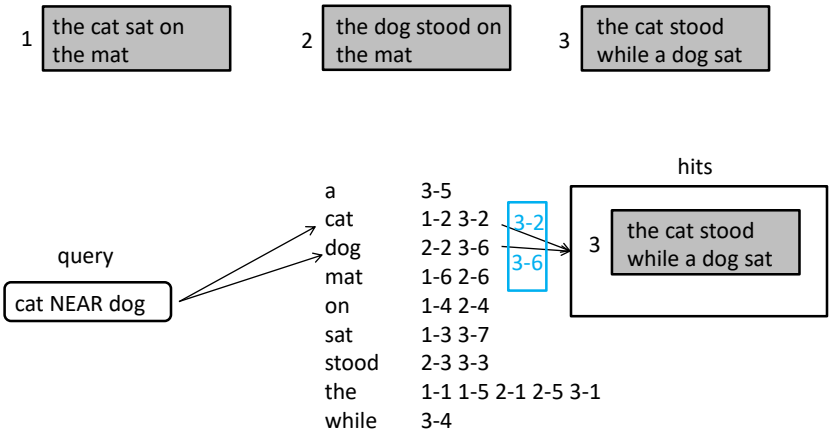


Inverted Index with Location



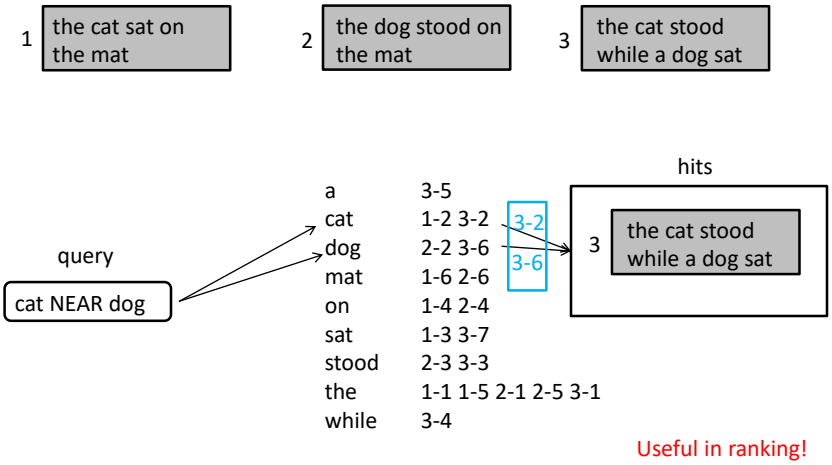


NEAR* Queries



*NEAR: distance <= 5

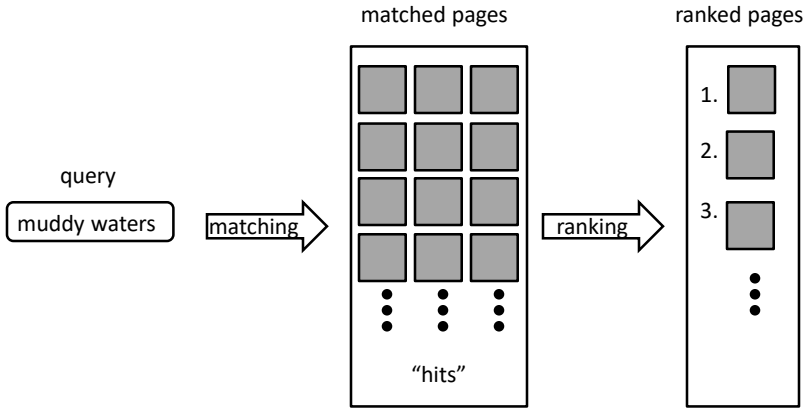
NEAR* Queries



Useful in ranking!

*NEAR: distance <= 5

Matching & Ranking



Ranking & Relevance

1 By far the most common cause of malaria is being bitten by an infected mosquito, but there are also other ways to contract the disease.

2 Our cause was not helped by the poor health of the troops, many of whom were suffering from malaria and other tropical diseases.

Ranking & Relevance

1 By far the most common cause of malaria is being bitten by an infected mosquito, but there are also other ways to contract the disease.

2 Our cause was not helped by the poor health of the troops, many of whom were suffering from malaria and other tropical diseases.

also	1-19
…	
cause	1-6 2-2
…	
malaria	1-8 2-19
…	
whom	2-15

Ranking & Relevance

1 By far the most common cause of malaria is being bitten by an infected mosquito, but there are also other ways to contract the disease.

2 Our cause was not helped by the poor health of the troops, many of whom were suffering from malaria and other tropical diseases.

query

malaria cause

also	1-19
…	
cause	1-6 2-2
…	
malaria	1-8 2-19
…	
whom	2-15

Ranking & Relevance

1 By far the most common cause of malaria is being bitten by an infected mosquito, but there are also other ways to contract the disease.

2 Our cause was not helped by the poor health of the troops, many of whom were suffering from malaria and other tropical diseases.

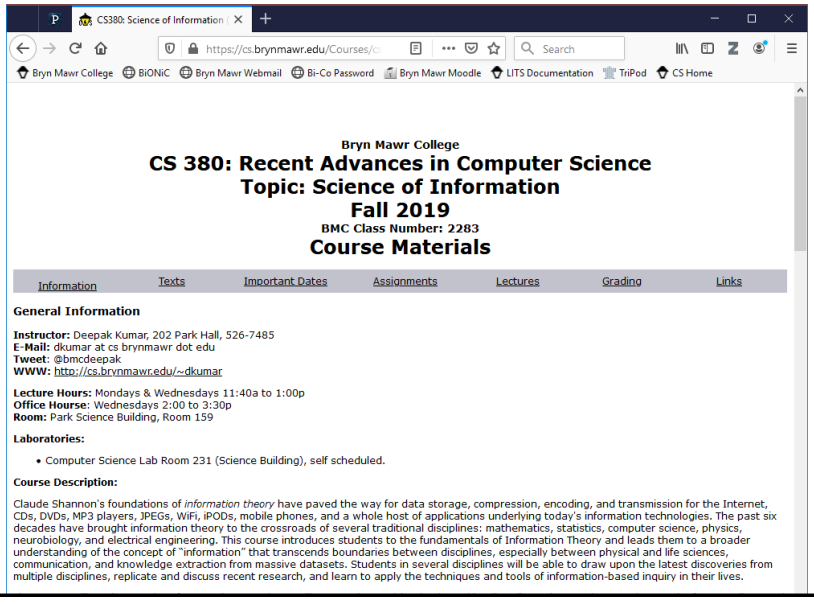
query

malaria cause

also	1-19
…	
cause	1-6 2-2
…	
malaria	1-8 2-19
…	
whom	2-15

Nearness can resolve the ranking!

Using Metadata



Using Metadata

```
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"http://www.w3.org/TR/html4/loose.dtd">
<html>
  <head> <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
    <title>CS380: Science of Information (Course Page)</title> …
  </head>
<body>
  <P>
  <CENTER>
  <h3>Bryn Mawr College<BR>
  <B><FONT SIZE="+2">CS 380: Recent Advances in Computer Science
  <br> Topic: Science of Information Fall 2019</FONT>
  </B>
  <br> BMC Class Number: 2283
  <BR>
  <B><FONT SIZE="+2">Course Materials</FONT></B>
…
```
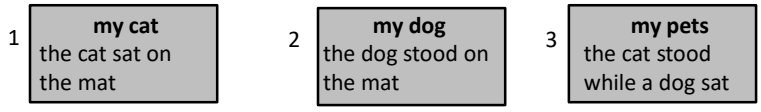

Metadata



Metadata

1 **my cat**
the cat sat on the mat

2 **my dog**
the dog stood on the mat

3 **my pets**
the cat stood while a dog sat

1 <title>my cat </title> <body> the cat sat on the mat </body>

2 <title>my dog </title><body> the dog stood on the mat</body>

3 <title>my pets </title><body>th e cat stood while a dog sat

Metadata

1 <title>my cat </title> <body> the cat sat on the mat </body>

2 <title>my dog </title><body> the dog stood on the mat</body>

3 <title>my pets </title><body>th e cat stood while a dog sat

a	3-10
cat	1-3 1-7 3-7
dog	2-3 2-7 3-11
mat	1-11 2-11
my	1-2 2-2 3-2
on	1-9 2-9
pets	3-3
sat	1-8 3-12
stood	2-8 3-8
the	1-6 1-10 2-6 2-10 3-6
while	3-9
<body>	1-5 2-5 3-5
</body>	1-12 2-12 3-13
<title>	1-1 2-1 3-1
</title>	1-4 2-4 3-4

Structure Queries

query

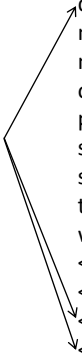
intitle: dog

a	3-10
cat	1-3 1-7 3-7
dog	2-3 2-7 3-11
mat	1-11 2-11
my	1-2 2-2 3-2
on	1-9 2-9
pets	3-3
sat	1-8 3-12
stood	2-8 3-8
the	1-6 1-10 2-6 2-10 3-6
while	3-9
<body>	1-5 2-5 3-5
</body>	1-12 2-12 3-13
<title>	1-1 2-1 3-1
</title>	1-4 2-4 3-4

Structure Queries

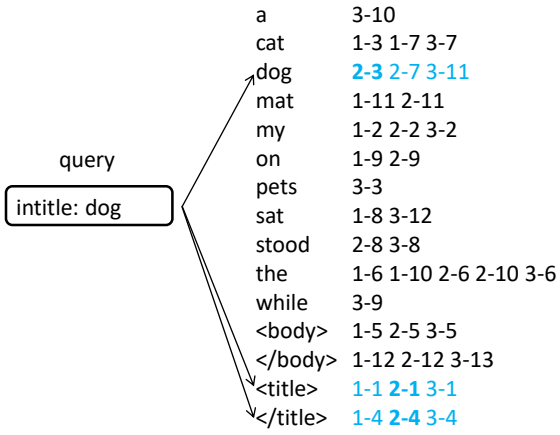
query

intitle: dog

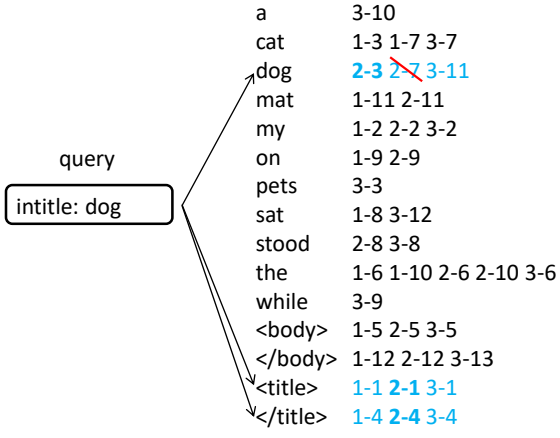


a	3-10
cat	1-3 1-7 3-7
dog	2-3 2-7 3-11
mat	1-11 2-11
my	1-2 2-2 3-2
on	1-9 2-9
pets	3-3
sat	1-8 3-12
stood	2-8 3-8
the	1-6 1-10 2-6 2-10 3-6
while	3-9
<body>	1-5 2-5 3-5
</body>	1-12 2-12 3-13
<title>	1-1 2-1 3-1
</title>	1-4 2-4 3-4

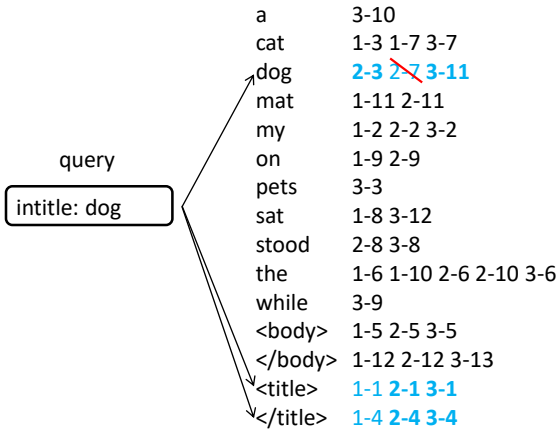
Structure Queries



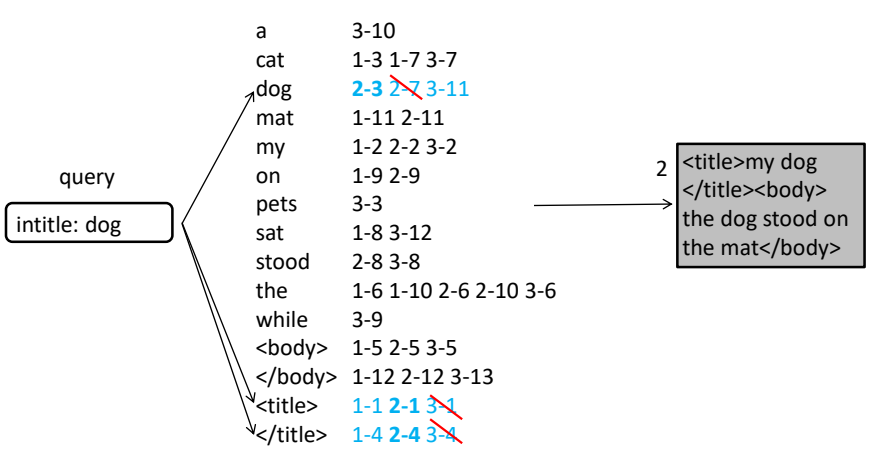
Structure Queries



Structure Queries



Structure Queries



Web Information Retrieval

- Search Engines
- Queries
  phrase queries
  structure queries (NEAR, intitle:, …)
- Matching
- Inverted Index
  page number
  location
- Ranking & Relevance
- Metadata

Web Information Retrieval

- Search Engines
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  phrase queries
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- Matching
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  page number
  location
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- Metadata

Efficient matching is only one half the story.

The other grand challenge is how to *rank* the matching pages

References

- *Google's PageRank and Beyond*, Amy N. Langville and Carl D. Meyer, Princeton University Press, 2006.
- *Nine Algorithms That Changed The Future*, John MacCormick, Princeton University Press, 2012.
- *Learning Computing with Robots*, Deepak Kumar, IPRE 2011.