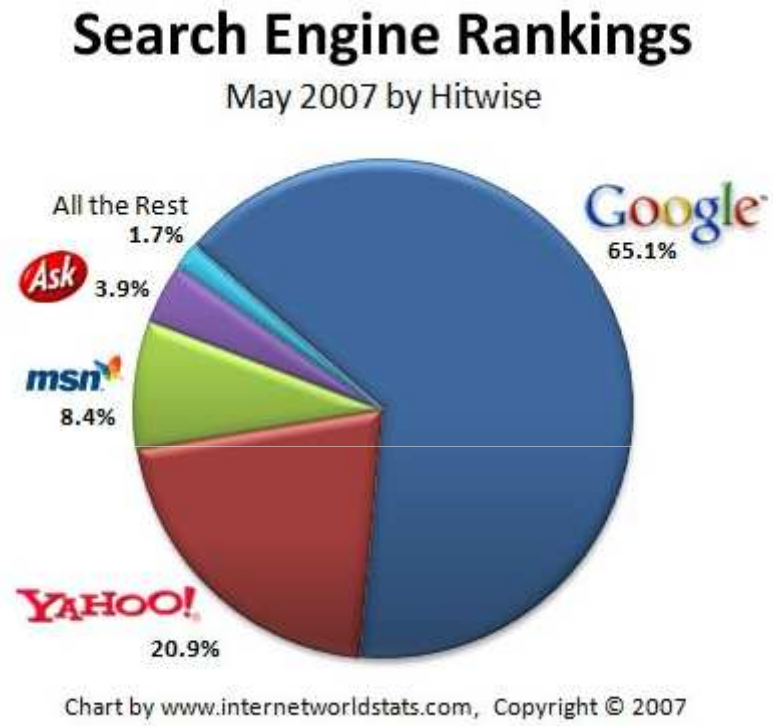
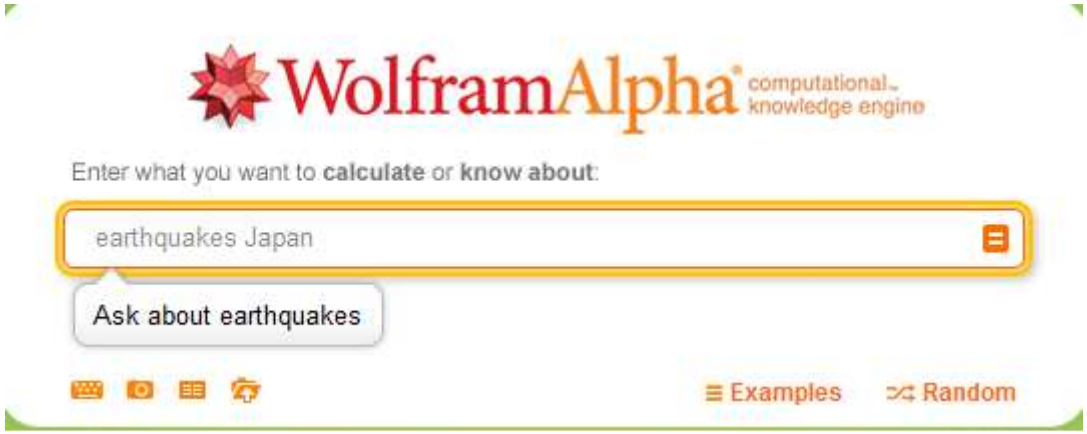
Arsitektur Teknologi Informasi

Arsitektur Search Engine

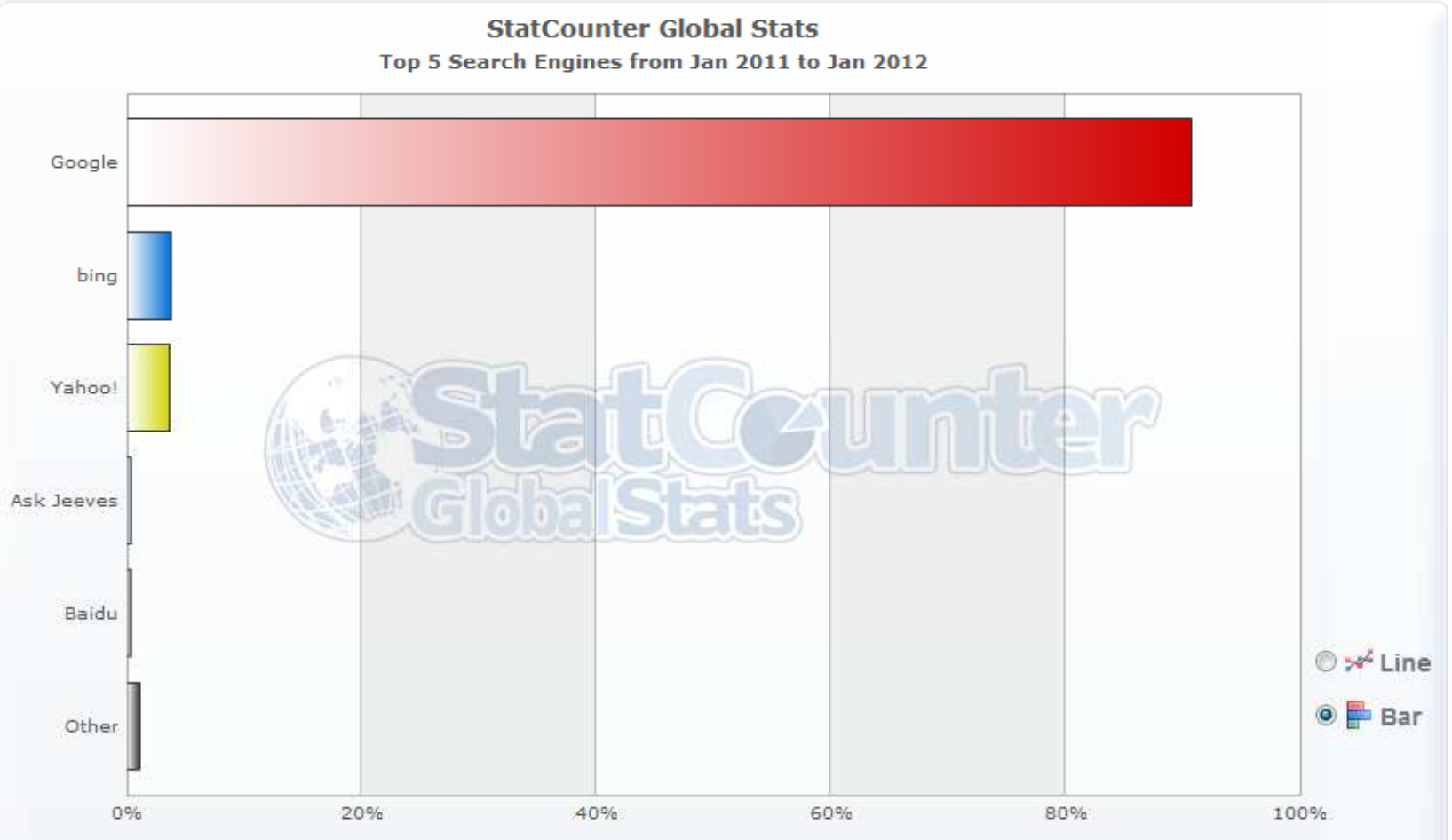
Antonius Rachmat C

Search engine





Search Engine Statistics Jan 2012



Searches per Day

Service	Searches Per Day	As Of/Notes
AltaVista	50 million	9/00 (as reported to me by AltaVista, for its site and queries through partners)
Inktomi	47 million	4/00 (still reflects queries from Yahoo, which will be handled by Google from July 2000).
Google	40 million	8/00 (14 million of these are at Google.com, 15 million are probably generated through Google's partnership with Yahoo, and the remainder come through Google partner sites, such as Netscape Search)
GoTo	5 million	4/00 (as reported by GoTo to a reader, who forwarded the information to me. Includes queries through affiliates and partners).
Ask Jeeves	4 million	3/00
Voila	1.5 million	1/00 (as reported to me by Voila, for its entire network of sites)

SE Statistics

Search Engine Analysis

The following report shows **search engines** for the industry '**All Categories**', ranked by **Volume of Searches** for the **4 weeks** ending **01/14/2012**.

Rank	Search Engine	Searches
1.	www.google.com	62.40%
2.	search.yahoo.com	16.13%
3.	www.bing.com	14.64%
4.	www.ask.com	3.88%
5.	search.aol.com	2.43%

Industry Rankings

The following report shows **websites** for the industry '**Computers and Internet - Search Engines**', ranked by **Visits** for the **week** ending **01/14/2012**.

Rank	Website	Visits Share
1.	Google	66.59%
2.	Bing	10.99%
3.	Yahoo! Search	10.90%
4.	Ask	2.59%
5.	AOL Search	1.63%

Industry Clickstream

The following report shows **downstream websites** for the industry '**Computers and Internet - Search Engines**', ranked by **Clicks** for the **week** ending **01/14/2012**.

Rank	Website	Clicks
1.	Facebook	6.29%
2.	YouTube	3.48%
3.	Gmail	2.36%
4.	Wikipedia	1.46%
5.	Yahoo! Mail	1.08%

Search Engine Search Terms

The following report shows **search terms** for the search engine '**www.google.com**', ranked by **Volume of Searches** for the **4 weeks** ending **01/14/2012**.

Rank	Search Term	Volume
1.	facebook	3.11%
2.	youtube	0.96%
3.	yahoo	0.53%
4.	yahoo mail	0.44%
5.	craigslist	0.41%

Purpose of Search Engines

- Helping people find what they're looking for
  - Starts with an "information need"
  - Convert to a query
  - Gets results
- Materials available in:
  - Web pages
  - Image, Flash, Audio, Video
  - Any other format

Searching example

- pizza AND pepperoni AND ham AND NOT olives AND NOT garlic

- “Carilah link ke semua pages yang meliputi kata *pizza* seperti halnya kata *pepperoni* dan kata *ham*, tetapi *mengabaikan* pages yang mengandung kata *zaitun* atau kata *garlic*.”

tattoos self-esteem teens

Search

Advanced Search
Preferences

Web Results **1** - **1**

Teen Tattoos & Piercings -- All About Parenting and Tweens & **Teens** ...
"It's important for kids to forge a sense of **self**." So tread lightly and choose your battles **...**
Teens, **Tattoos**, and Piercings: More Than Meets the Eye **...**
family.go.com/parentpedia/pre**teen-teen**/behavior/**teen-tattoos**-piercings/ - 107k -
Cached - Similar pages

For **Teens** - Convincing Your Parents to Let You Get a **Tattoo** or ...
Without that acceptance, their **self-esteem** can suffer and they may carry **....** For **Teens** - Convincing Your Parents to Let You Get a **Tattoo** or Piercing **...**
tattoo.about.com/cs/articles/a/convinceparents.htm - 26k - Cached - Similar pages

Teens, **Tattoos** and Body Piercing, **Tattoo** and Body Piercing
Sep 25, 2006 **...** while others take part to enhance their **self-esteem** and peer image. **...**
Teens who are considering a **tattoo** should realize the following: **...**
www.emaxhealth.com/68/7541.html - 19k - Cached - Similar pages

Teen Fashion, Body Piercing and **Tattooing** - **Teen** Behavior Article
Body piercing, dyed hair, shaved heads and **tattoos**. Should **teen** fashion be cause **...** Related Books. Safe **Teen** · 501 Ways to Boost Your Child's **Self-Esteem ...**
www.theparentreport.com/resources/ages/**teen**/behavior/100.html - 41k -
Cached - Similar pages

Tattoos

What's the safest way to get a tattoo? Does it hurt? What can go wrong? **...** Body Image and **Self-Esteem**. **Tattoos**. KidsHealth>**Teens**>Your Body>Skin Stuff>**Tattoos ...**
kidshealth.org/teen/your_body/skin_stuff/safe_tattooing.html - Cached

Behavior and **Self-Esteem** Articles

Articles on the behaviors, issues and trends influencing modern tweens and **teens**. **...** An Expression Of Individuality - A parent's primer on piercings and **tattoos**. **...**
tweensandteensnews.com/archives/2006/main_behavior**selfesteem**.php - Cached

Tattoos are a sign of low **self-esteem** - Health - Wellness - Lifestyle **...**

Tattoos are a sign of low **self-esteem ...** Milkshakes can help anorexic **teens**. More >> More Lifestyle Stories. Infidelity On-Line **...**
timesofindia.indiatimes.com/Lifestyle/.../articleshow/4361981.cms - Cached

Teenage **Self-Esteem** -- All About Parenting and Tweens & **Teens** Behavior **...**

Tattoos & Piercings. Decoding Teen Lingo. Suggest A Topic. From Our Sponsors. What Experts Say **...** 2007 Not Acceptable? **Teens** and **Self-Esteem**. 5 days ago Not **...**
family.go.com/parentpedia/preteen-teen/behavior/teen-**self-esteem** - 109k - Cached

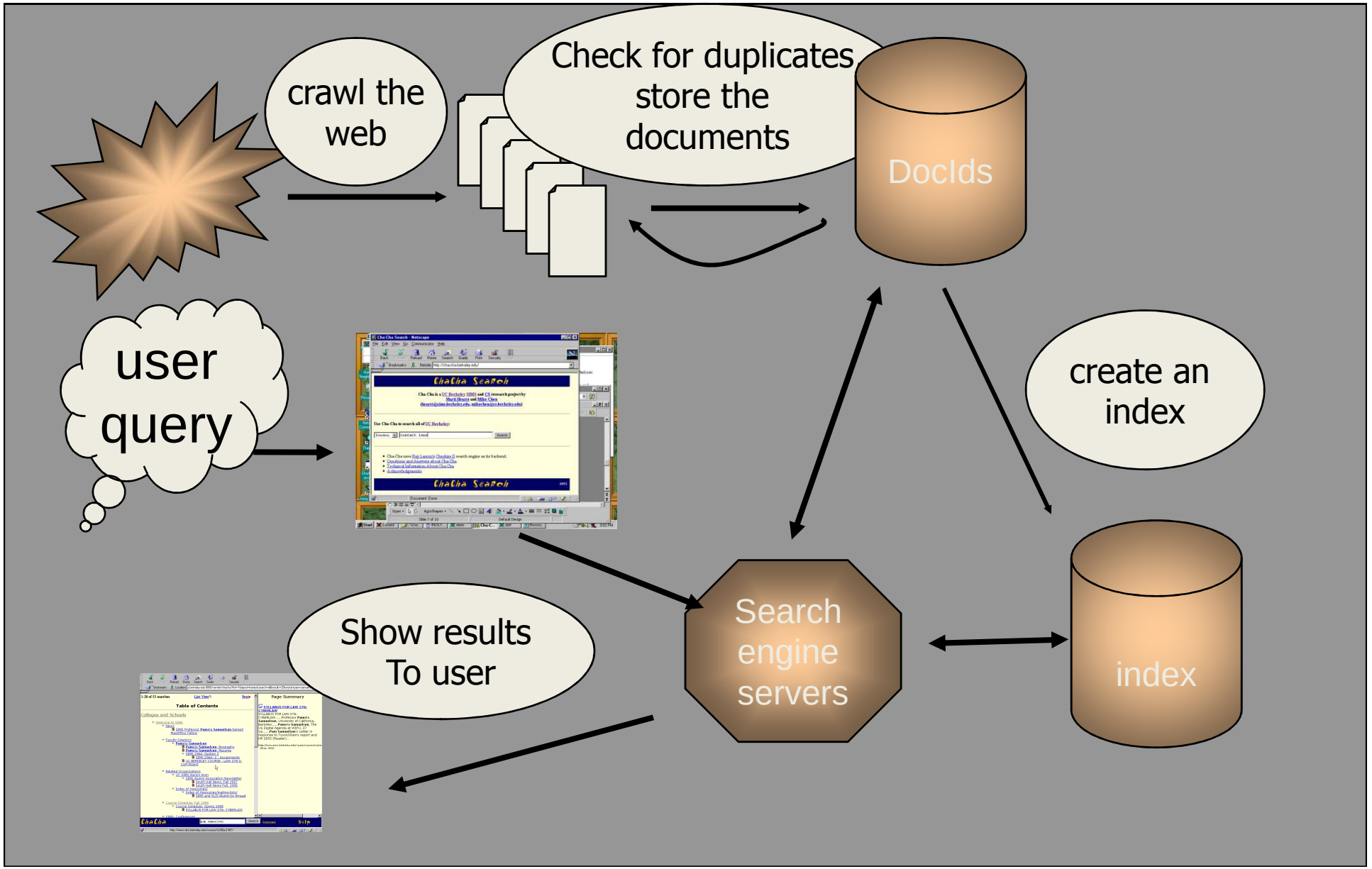
Why Searches Fail

- Empty search
- Nothing on the site on that topic (scope)
- Misspelling or typing mistakes
- Vocabulary differences
- Missed search defaults
- Missed search choices
- System fail

Search engine problem

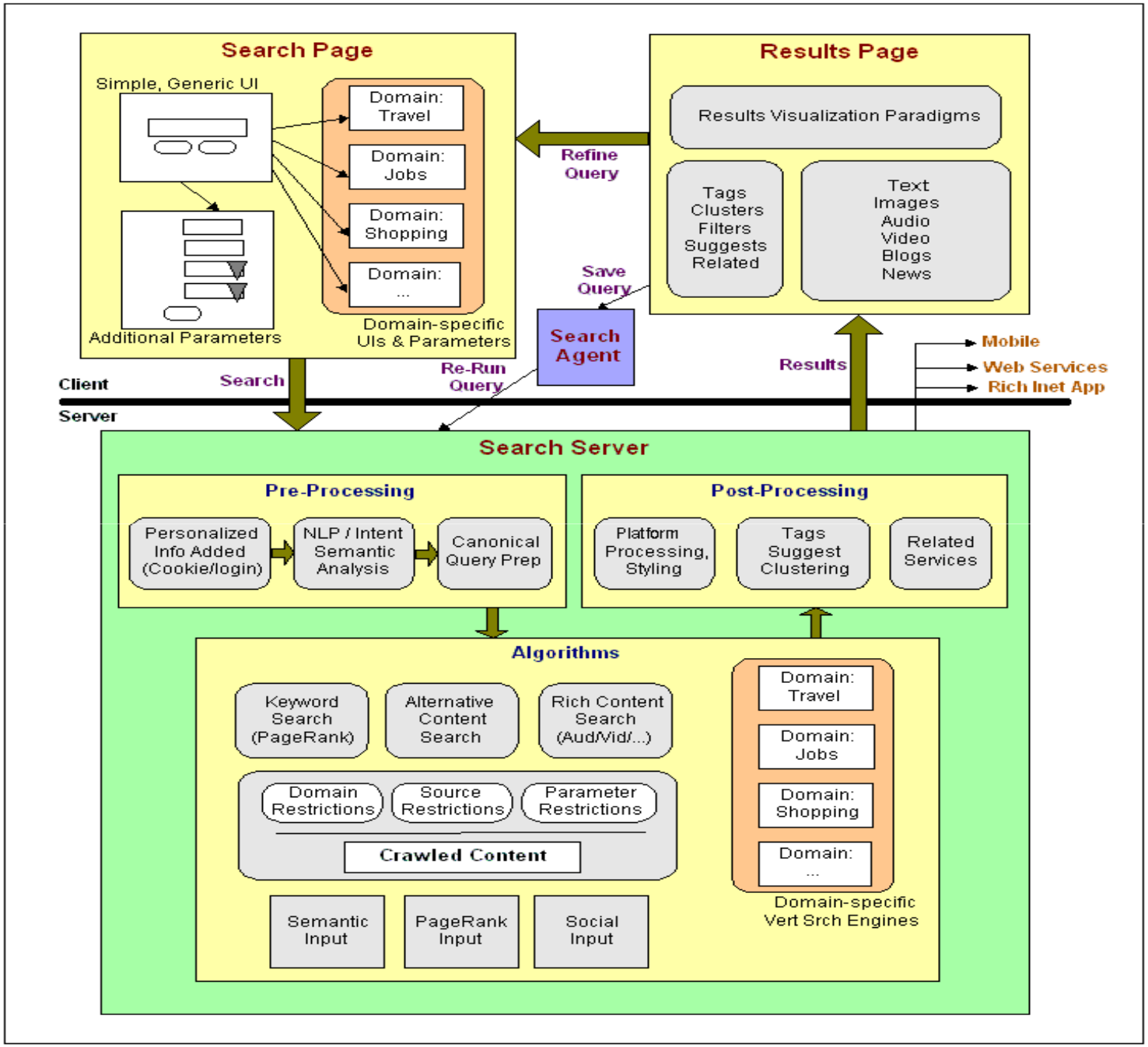
- Human maintenance
  - Subjective
    - Example: Ranking hits based on $$$
- Automated search engines
  - Quality of result
- Searching process
  - High quality results aren't always at the top of the list

Standard Web Search Engine Architecture



How it works?

- Typically, a search engine works by sending out a ***spider*** to fetch as **many documents** as possible.
- Another program, called an ***indexer,*** then reads these documents and creates an **index** based on the **words** contained in each document.
- Each search engine uses a **proprietary algorithm** to create its **indices** such that, ideally, only meaningful results are returned for each *query*.



Search Engine Architecture (2)

Search Engine Characteristics

- Unedited – anyone can not enter content
  - Quality issues; Spam
- Varied information types
  - Audio, video, flash, book, brochures, catalogs, dissertations, news reports, weather, all in one place!
- Different kinds of users
  - Lexis-Nexis: Paying, professional searchers
  - Online catalogs: Scholars searching scholarly literature
  - Web: Every type of person with every type of goal
- Scale
  - Hundreds of millions of searches/day; billions of docs

Web Search Queries

- Web search queries are short:
  - ~2.4 words on average (Aug 2000)
  - Has increased, was 1.7 (~1997)
- User Expectations:
  - Many say "The first item shown should be what I want to see!"
  - This works if the user has the most popular/common word

Search engine Ranking?

- Combining subsets of:
  - IR-style relevance: based on term frequencies, proximities, weightening, position (e.g., in title), font, etc.
  - Popularity information
  - Link analysis information
- Most use a variant of **vector space ranking** to combine these

Relevance: Going Beyond IR

- Page “popularity” (e.g., DirectHit)
  - Frequently visited pages (in general)
  - Frequently visited pages as a result of a query
- Link “co-citation” (e.g., Google)
  - Which sites are linked to by other sites?
  - Draws upon sociology research on bibliographic citations to identify “authoritative sources”
- Using IR
  - Tokenisasi, Stemming, Stopwords, Bobot, Feature Selection, Data mining method, evaluation

How Index files Are Created

- Periodically rebuilt
- Documents are parsed to extract tokens. These are saved with the **Document ID.**

Doc 1

Now is the time for all good men to come to the aid of their country

Doc 2

It was a dark and stormy night in the country manor. The time was past midnight

Term	Doc #
now	1
is	1
the	1
time	1
for	1
all	1
good	1
men	1
to	1
come	1
to	1
the	1
aid	1
of	1
their	1
country	1
it	2
was	2
a	2
dark	2
and	2
stormy	2
night	2
in	2
the	2
country	2
manor	2
the	2
time	2
was	2
past	2
midnight	2

How Index Files are Created

- After all documents have been **parsed** the index file is **sorted** alphabetically.

Term	Doc #
now	1
is	1
the	1
time	1
for	1
all	1
good	1
men	1
to	1
come	1
to	1
the	1
aid	1
of	1
their	1
country	1
it	2
was	2
a	2
dark	2
and	2
stormy	2
night	2
in	2
the	2
country	2
manor	2
the	2
time	2
was	2
past	2
midnight	2

Term	Doc #
a	2
aid	1
all	1
and	2
come	1
country	1
country	2
dark	2
for	1
good	1
in	2
is	1
it	2
manor	2
men	1
midnight	2
night	2
now	1
of	1
past	2
stormy	2
the	1
the	1
the	2
the	2
their	1
time	1
time	2
to	1
to	1
was	2
was	2

How Index Files are Created

- Multiple term entries for a single document are **merged**.
- Within-document term **frequency** information is compiled.

Term	Doc #
a	2
aid	1
all	1
and	2
come	1
country	1
country	2
dark	2
for	1
good	1
in	2
is	1
it	2
manor	2
men	1
midnight	2
night	2
now	1
of	1
past	2
stormy	2
the	1
the	1
the	2
the	2
their	1
time	1
time	2
to	1
to	1
was	2
was	2

Term	Doc #	Freq
a	2	1
aid	1	1
all	1	1
and	2	1
come	1	1
country	1	1
country	2	1
dark	2	1
for	1	1
good	1	1
in	2	1
is	1	1
it	2	1
manor	2	1
men	1	1
midnight	2	1
night	2	1
now	1	1
of	1	1
past	2	1
stormy	2	1
the	1	2
the	2	2
their	1	1
time	1	1
time	2	1
to	1	2
was	2	2

How Index Files are Created

- Finally, the file can be split into
  - A Dictionary or Lexicon file (semua term/token yg unik dan jumlah dokumen yang menghasilkannya)
  - A Postings file (asal term / token per dokumen dan frekuensinya)

How Inverted Files are Created

Term	Doc #	Freq
a	2	1
aid	1	1
all	1	1
and	2	1
come	1	1
country	1	1
country	2	1
dark	2	1
for	1	1
good	1	1
in	2	1
is	1	1
it	2	1
manor	2	1
men	1	1
midnight	2	1
night	2	1
now	1	1
of	1	1
past	2	1
stormy	2	1
the	1	2
the	2	2
their	1	1
time	1	1
time	2	1
to	1	2
was	2	2

Dictionary/Lexicon

Term	N docs	Tot Freq
a	1	1
aid	1	1
all	1	1
and	1	1
come	1	1
country	2	2
dark	1	1
for	1	1
good	1	1
in	1	1
is	1	1
it	1	1
manor	1	1
men	1	1
midnight	1	1
night	1	1
now	1	1
of	1	1
past	1	1
stormy	1	1
the	2	4
their	1	1
time	2	2
to	1	2
was	1	2

Postings

Doc #	Freq
2	1
1	1
1	1
2	1
1	1
1	1
2	1
2	1
1	1
1	1
2	1
1	1
2	1
2	1
1	1
2	1
2	1
1	1
1	1
2	1
2	1
1	2
2	2
1	1
1	1
2	1
1	2
2	2

The indexes

- For each term, the index is consisting of:
  - document ID
  - frequency of term in doc (optional)
  - position of term in doc (optional)
- These lists can be used to solve Boolean queries:
    - country -> d1, d2
    - manor -> d2
    - country AND manor -> d2
- Also used for statistical ranking algorithms

Storage Strategy

- The indexes are still used, even though the web is so **huge**.
- Some systems **partition** the indexes across different machines.
  - Using **distributed** database
  - Each machine handles **different** parts of the data.
  - Other systems **duplicate** the data across many machines; queries are distributed among the machines.
  - Most do a combination of these.

Ranking system: Link Analysis

- Assumptions:
  - If the pages **pointing** to this page are **good**, then this is also a **good** page
  - The **words** on the links pointing to this page are useful indicators of what this page is **about**
- Why does this work?
  - The official Toyota site will be linked to by lots of other official (or high-quality) sites
  - The best Toyota fan-club site probably also has many links pointing to it

Page Rank

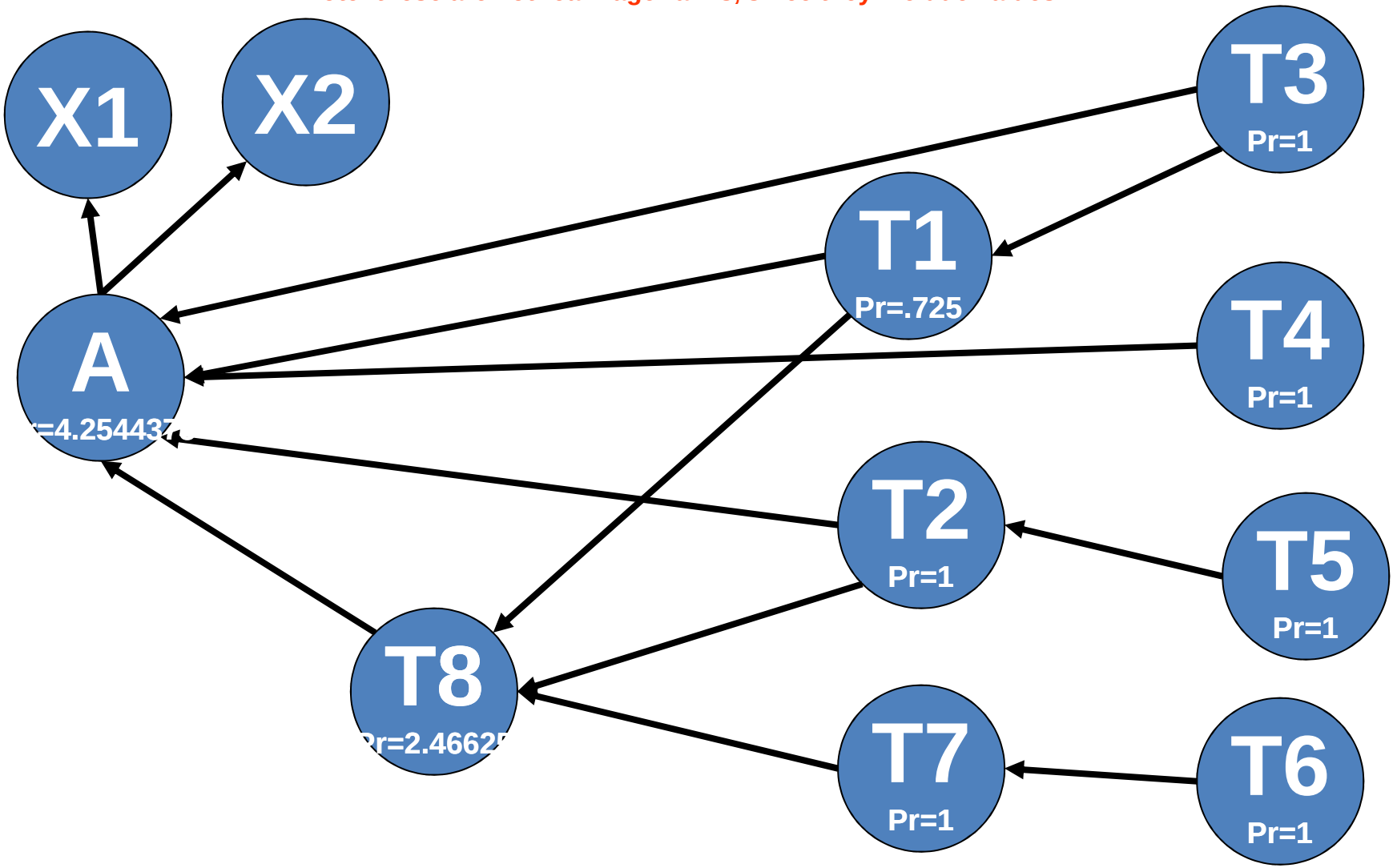
- Sebuah situs akan semakin **populer** jika semakin banyak situs lain yang meletakan **link** yang mengarah ke situsnya, dengan asumsi isi/content situs tersebut lebih berguna dari isi/content situs lain.
- PageRank dihitung dengan skala **1-10.**
- Sebuah halaman juga akan menjadi semakin penting jika halaman lain yang memiliki rangking (**pagerank**) **tinggi** mengacu ke halaman tersebut.
- Jika sebuah situs yang mempunyai Pagerank 9 akan di urutkan lebih **dahulu** dalam list pencarian Google daripada situs yang mempunyai Pagerank 8 dan kemudian seterusnya yang lebih kecil.

Ranking: PageRank

- Google uses the **PageRank**
- We assume page A has pages T1...Tn which point to it (i.e., are citations).
- The parameter d is a damping factor which can be set between 0 and 1. d is usually set to 0.85.
- C(A) is defined as the number of links going out of page A.
- **PR(A) = (1-d) + d (PR(T1)/C(T1) + ... + PR(Tn)/C(Tn))**
- So to be included in Google's top ranked results a page
  - must have lots of votes from outside
  - votes cast by pages that have received many votes of their own.

PageRank

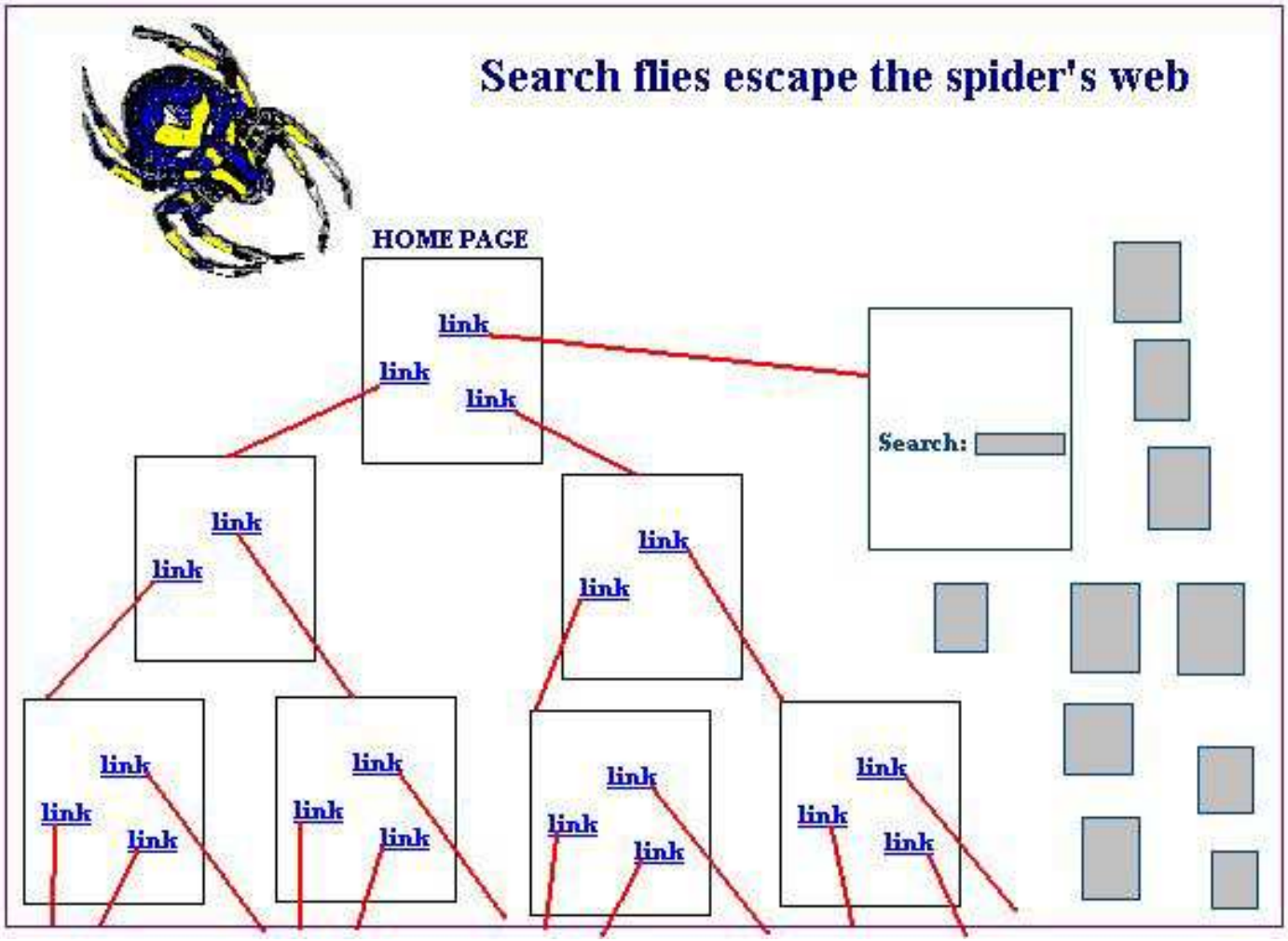
Note: these are not real PageRanks, since they include values >= 1



Web Crawlers

- How do the web search engines get all of the items they index?
- Main idea:
  - Start with **known** sites
  - Record information for **these sites**
  - **Follow the links** from each site
  - Record information found at **new sites**
  - **Repeat**
- 1 doc per minute per crawling server

Crawler Indexing Diagram



What the Index Needs

- Basic information for document or record
  - File name / URL / record ID
  - Title or equivalent
  - Keywords
  - Size, date, MIME type
- Full text of item
- More metadata
  - Product name, picture ID
  - Category, topic, or subject
  - Other attributes, for relevance ranking and display

Web Crawling Issues

- **Keep out signs**
  - A file called norobots.txt / robots.txt
  - Figure out which pages change often, and recrawl these often.
- **Duplicates, virtual hosts, etc.**
  - Convert page contents with a hash function
  - Compare new pages to the hash table
- **Lots of problems**
  - Server unavailable; incorrect html; missing links;

Robots.txt

- Protocol for giving spiders ("robots") **limited** access to a website, originally from 1994
  - www.robotstxt.org/wc/norobots.html
- Website announces its request on what **can(not)** be crawled
  - For a URL, create a file URL/`robots.txt`
  - This file specifies access **restrictions**

Contoh

```
# robots.txt for http://www.example.com/

User-agent: *
Disallow: /cyberworld/map/ # This is an infinite virtual URL space
Disallow: /tmp/ # these will soon disappear
Disallow: /foo.html
```

```
# robots.txt for http://www.example.com/

User-agent: *
Disallow: /cyberworld/map/ # This is an infinite virtual URL space

# Cybermapper knows where to go.
User-agent: cybermapper
Disallow:
```

The Google Search Engine

- Invented by **Larry Page** and **Sergey Brin**
- Online in **1998**
- Mission: to organize the world's information and make it universally accessible and useful
- How google finds data?
  - Using spider **GoogleBot**
  - Using site **submission**

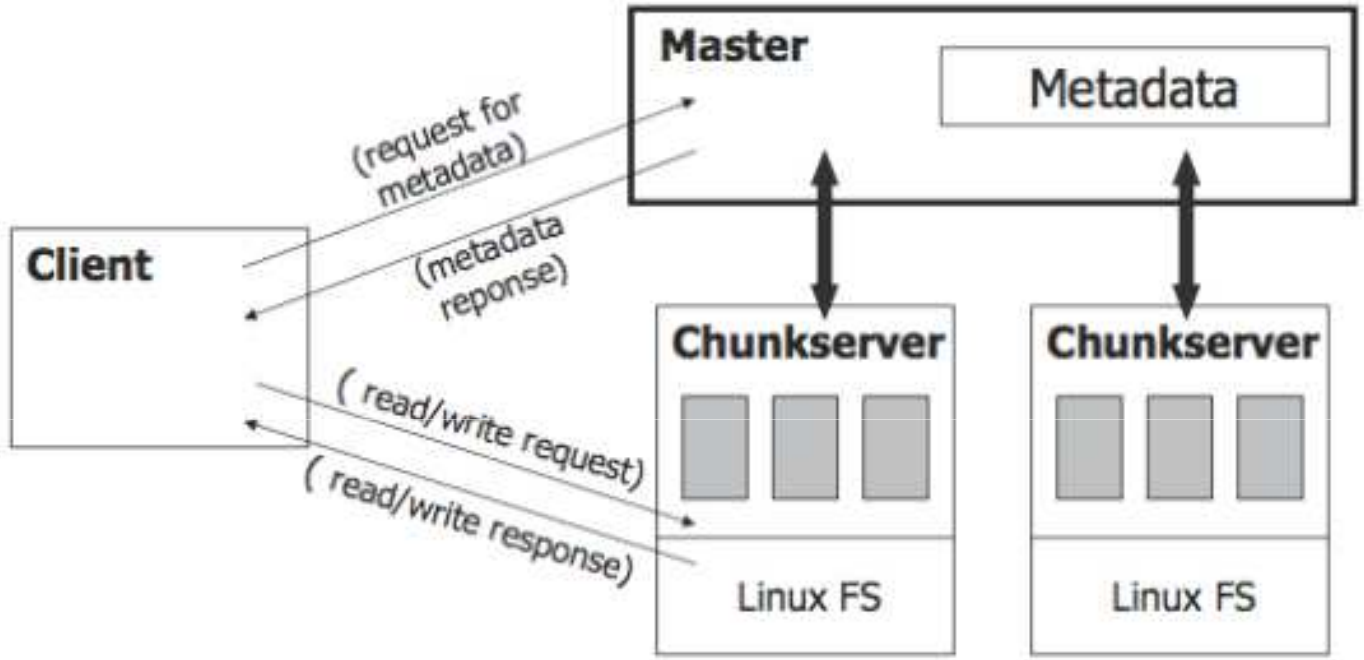
Google Data Components

- Google BigFiles
- Google Repository
  - Use zlib to compress
- Google Lexicon
  - Word base
- Document Indexing
  - Page Rank Algorithm

Google File System (GFS)

- BigFiles
  - A.k.a. Google's Proprietary Filesystem
  - 64-bit addressable
  - Compression zlib
  - GFS: http://labs.google.com/papers/gfs.html

Google File System Architecture



• A master process maintains the metadata
• A lower layer (i.e. a set of chunkservers) stores the data in unit called *chunks*

Google Lexicon

- Lexicon
  - Contains > **14 million words**
  - Implemented as a **hash table** of pointers to words
- Why is it important to have a lexicon?
  - Tokenization
  - Analysis
  - Language Identification
  - SPAM

Next

- Business Process and Information Systems