Exercise 10.1
What is a social network?

Exercise 10.2
Briefly explain Seeley’s model of prestige in social networks.

Exercise 10.3
What is a co-citation graph?
What is an Erdős number?

Exercise 10.4
What is a Bacon number?
What is Paul Erdős’ Bacon number?
http://oracleofbacon.org

Exercise 10.5
Briefly explain the random surfer model.
Is it a reasonable model of how people surf the Web?
Exercise 10.6
What do you need the Topic-Sensitive PageRank for?

Lecture 13: Miscellaneous
1. Spamdexing
2. Hardware for Large Scale Web Search
3. Metasearch
4. Privacy Issues

Spamdexing

• Spamdexing = The practice of modifying the Web to get certain Web resources unjustifiably ranked high on search engine result lists
• Often a synonym of SEO ("search engine optimization")

Content Spam

Idea:
– Exploit TF-IDF

Method:
– Repeatedly place the keywords to be found in the text, title, or URI of your page
– Place the keywords in anchor texts of pages linking to your page
– Weave your content into high-quality content taken from (possibly a lot of) other pages

Countermeasures:
– Train classification algorithms to detect patterns that are "typical" for spam pages
– Most difficult part: Find suitable features to describe pages

Example (Google bombing):
Keywords are placed in anchor texts of pages linking to your page

Very hard to detect if many unrelated people do it...
There is a further way to detect content spam:

- After a spammer has cheated the search engine, the same must be done for real users
- Therefore, spammers try to hide the parts of their page used for spamdexing:
  - Place text behind images
  - Write text in the background color
  - Set the font size to 0
  - Dynamically delete text using scripts
  - Deliver different Web pages to Web crawlers ("cloaking")
  - Immediately redirect to a different page ("doorway pages")
  - …

- Most of these techniques can be detected by search engines
- But: This kind of analysis is quite expensive...

---

**Cloaking:**

- Has this request been sent by a crawler? (check IP address)
- Send a page constructed to cheat search engines
- Send a page constructed to cheat humans
- Yes
- No

---

**Doorway pages:**

- Page designed to be ranked high for query x
- Page designed to be ranked high for query y
- Page designed to be ranked high for query z

- This is the specific technique that recently caused Google to ban ricoh.de and bmw.de!

---

**Idea:**

- Improve your page’s rank by getting in-links from other pages

**Method (comment spamming):**

- Collect a list of high-quality sites that allow other users to post their own comments
  - Comments in blogs
  - Wikis
- Write (a lot of) comments linking to your page
- This can easily be automated since most people use standard software for running their forums, blogs, …

**Countermeasures:**

- Require users to solve CAPTCHAs

---

**CAPTCHAs:**

- CAPTCHA: “Completely Automated Public Turing test to tell Computers and Humans Apart”
- Character recognition is easy for humans, but hard for machines

**Countermeasures (taken by spammers):**

- Build character recognition algorithms that are hand-tailored to the CAPTCHAs generated by standard CAPTCHA software
- Let real humans solve CAPTCHAs (e.g., pay 1 cent per solution)

---

**Method (link farms):**

- Create a large group of pages that link to each other
- Or: Participate in link exchange programs
- Try to create link patterns that look “normal”
- Set out-links to topically related high-quality pages, which gives you high hub scores
  - This can be done e.g., by cloning directories like DMOZ
- This will consequently lead to high authority scores for your other pages
**Method (honeypots):**
- Create a set of pages (called honeypot) that provide some useful resource
  - Examples: Copies of Unix documentation pages or Wikipedia pages
- Insert hidden links to some target pages to be boosted
- This honeypot then attracts people to link to it, boosting indirectly the ranking of the target pages

**Method (buy expired domains):**
- Monitor DNS records for domains that will expire soon, i.e. whose registration has not been extended on time
- Buy such domains when they expire
- Replace their pages by pages with links to your own pages
- Using this technique you can get hold of all external links linking to the expired domain's pages

**Countermeasures:**
- In general, link spam is quite hard to detect
  - Heuristic: Remove pages whose in-links look almost the same (can detect Google bombing and comment spamming)
  - Heuristic: Remove (modified) copies of high-quality content (can detect honeypots)
  - Heuristic: Create a white-list of pages known to be "good" and use the link-distance to these pages as an indicator of trustworthiness

**“Best Practices”**
- As long as you don’t want to sell Viagra or memberships in online casinos:
  - Invest your time into creating good content!
- Usually, the costs of cheating search engines are higher than the benefits
  - Recall Google’s ban on bmw.de
- Therefore:
  - Create high-quality content
  - Follow the rule “link = recommendation” when creating links
  - Build crawler-friendly Web sites
  - Use “white hat” techniques like Google AdWords

**SEO Contests**

**Webmaster Guidelines**
- Google’s webmaster guidelines: [http://www.google.com/support/webmasters/bin/answer.py?answer=35769](http://www.google.com/support/webmasters/bin/answer.py?answer=35769)
Lecture 13: Miscellaneous

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Google Servers

• ...or how to build one of the most powerful data centers out of crappy hardware
  • For a long time, Google has jealously guarded the design of its data centers
  • In 2007 & 2009 some details have been revealed

• The Google Servers
  • Google uses only custom built servers
  • Google is the world 4th largest server producer
    • They don’t even sell servers...
  • In 2007, it was estimated that Google operates over 1,000,000 servers,
    spanning 34 major and many more minor data centers

• Data centers are connected to each other and major internet hubs via massive fiber lines
  • ~7% of all internet traffic is generated by Google
  • ~60% of that traffic connects directly to consumer networks without connecting to a global backbone
• If Google was an ISP, it would be the 3rd largest global carrier

• Some Google datacenter facts and rumors
  • Construction of four new data centers (in 2007): 600 million dollars
  • Annual operation costs in 2007: 2.4 billion dollars
  • Energy consumption per data center: 50 megawatts
    • The largest center in Oregon: over 110 megawatts
    • The whole region of Braunschweig: 225 megawatts

• Each server rack: 40–80 commodity class PC servers with custom Linux
  • Slightly outdated hardware
  • 12V battery to counter unstable power supplies
  • No cases, racks are setup in standard shipping containers and are just wired together
  • More info: http://www.youtube.com/watch?v=Ho1GEyftpJQ

• Google servers are highly unstable but also very cheap
  • High "bang-for-buck" ratio
  • Typical first year for a new cluster (several racks):
    • ~0.5 overheating
    • Power down most machines in less than 5 minutes, ~1–2 days to recover
    • ~1 PDU (power distribution unit) failure
      • ~50–100 machines suddenly disappear, ~6 hours to come back
    • ~1 rack-move
      • ~500–1000 machines powered down with plenty of warning, ~6 hours
    • ~1 network rewiring
      • Rolling ~5% of machines down over 2-day span
Lecture 13: Miscellaneous

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Metasearch (2)

• A metasearch engine can only access the result lists returned by the individual engines.
• It is not able to exploit any engine’s internal information.
• Therefore, we have to solve the following problem:
  – Given: A set of k individual ordered result lists of size n.
  – Task: Aggregate these k rankings into a single ranking.
  – Of course, some constraints should hold here, that define which properties a “good” aggregate should have.
• This is a well-known problem from social choice theory having a lot of different solutions.

What’s a Good Aggregate?

• Pareto efficiency: If every individual engine ranks a certain page higher than another, then so must the aggregate ranking.
• Non-dictatorship: The aggregate ranking is not just always the same as a certain fixed individual engine’s ranking.
• Independence of irrelevant alternatives: If page A is ranked higher than page B in the aggregate ranking, then adding a new page C to each of the input rankings will not change A’s relation to B.
• Maybe some more…

Challenges to the data center software

– Deal with all these hardware failures
– Avoiding any data loss
– Guarantee ~100% global uptime
– Decrease maintenance costs to minimum
– Allow flexible extension of data centers
– Solution:
  – Use cloud technologies
  – GFS (Google File System) and Google Big Table Data System

More details:

Lecture “Distributed databases”

Google Servers

~20 rack failures
– 40–80 machines instantly disappear, 1–6 hours to get back
– 5 racks go wonky
– 40–80 machines see 50% packet loss
– 6 network maintenance operations
– Might cause ~30-minute random connectivity losses
– ~12 router reloads
– Takes one DNS and external VIPs (virtual IPs) for a couple minutes
– ~3 router failures
– Traffic immediately pulled for an hour
– Dozens of minor 30-second DNS blips
– 1000 individual machine failures
– Thousands of hard drive failures
– Countless slow disks, bad memory, misconfigured machines

Metasearch

Idea:
– Given access to several search engines, each with its individual strengths and weaknesses, then combining their results could improve overall result quality.

How it works:

Query

Redirect query and aggregate results

Search engine 1
Search engine 2
Search engine 3

Metasearch engine

...
What's a Good Aggregate? (2)

- These three constraints sound completely reasonable
- Clearly, any “reasonable” aggregation algorithm should adhere to these constraints
- In fact, “should” means “cannot” in this case
- Kenneth Arrow’s impossibility theorem (1951): “If there are more than two different pages to be ranked, then there is no deterministic aggregation algorithm that satisfies Pareto efficiency, non-dictatorship, and independence of irrelevant alternatives”

Majority Rule

- For any pair of pages \((a, b)\), count how many search engines rank \(a\) higher than \(b\)
- If the majority of engines ranks \(a\) higher than \(b\), then place \(a\) before \(b\) in the aggregate ranking
  - Ties also can be handled but let’s assume that the number of search engines is odd
- Construct the aggregate ranking from this comparisons

Example:

<table>
<thead>
<tr>
<th>Engine 1</th>
<th>Engine 2</th>
<th>Engine 3</th>
<th>Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>C</td>
<td>B</td>
</tr>
</tbody>
</table>

The Borda Count

- The Borda count avoids cycles
- Every engine assigns a numerical score to each page:
  - The best page gets a score of \(n\) (if there are \(n\) pages in total)
  - The second-best page gets a score of \(n - 1\), ...
- The final ranking is created by adding all scores

<table>
<thead>
<tr>
<th>Engine 1 Score</th>
<th>Engine 2 Score</th>
<th>Engine 3 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 3</td>
<td>A 3</td>
<td>B 3</td>
</tr>
<tr>
<td>B 2</td>
<td>C 2</td>
<td>A 2</td>
</tr>
<tr>
<td>C 1</td>
<td>B 1</td>
<td>C 1</td>
</tr>
</tbody>
</table>

Aggregated Score

- For each page, add up its individual scores

What’s a Good Aggregate? (3)

- Thus, whatever method we choose to solve our aggregation problem, it will have severe weaknesses
  - Fortunately, in our case, the aggregate ranking will not be used for anything of importance, so violations are not that critical...
- There are many different aggregation methods available, two of which we will discuss briefly:
  - Majority rule
  - The Borda count
- Let’s assume that any page being ranked by at least one individual engine, is ranked by all of them
  - In fact, this usually is not true
  - But it is possible to extend the methods to handle this problem

One important drawback of majority vote are cycles

Example:

<table>
<thead>
<tr>
<th>Engine 1</th>
<th>Engine 2</th>
<th>Engine 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A C</td>
<td>B A C</td>
<td>B A C</td>
</tr>
</tbody>
</table>

2 engines rate \(A > B\) 2 engines rate \(B > C\) 2 engines rate \(C > A\)

There are many methods available to break cycles…

Advantages of the Borda count:
- It is easy to compute
- It can handle page that have not been ranked by all engines
  - E.g. assign the page a score of 0 if it has not been included in the ranking
- It allows for ties in the aggregate ranking
- It is easy to weight the individual engine’s importance
  - Multiply the scores assigned by “good” engines by a factor larger than 1
  - Multiply the scores assigned by “bad” engines by a factor smaller than 1

Disadvantage:
- It assumes a uniform degradation of relevance in each ranking
The Borda Count vs. Majority Rule:

<table>
<thead>
<tr>
<th>Engine 1</th>
<th>Engine 2</th>
<th>Aggregate</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
<td>A</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>B</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>B</td>
<td>C</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
<td>D</td>
<td>4</td>
</tr>
</tbody>
</table>

Borda Count vs. Majority Rule:

- Sometimes it is useful to measure the agreement between two search engines.
  - Search engines that often yield very similar rankings should be considered as dependent.
  - Therefore, they should get a lower influence at aggregation.

- One of the most popular measures is Kendall’s $\tau$:
  - For each pair of pages $(a, b)$ ranked by both engines, determine if both engines agree in their relative ranking or if one engine ranks $a$ higher than $b$ and the other ranks $b$ higher than $a$.
  - Basically, Kendall’s $\tau$ is the ratio of agreeing pairs compared to all pairs ranked by both engines.

Kendall’s $\tau$

- Define:
  - $m$: The number of pages ranked by both engines.
  - $p_+$: The number of agreeing pairs of pages ranked by both engines.
  - $p_-$: The number of disagreeing pairs of pages ranked by both engines.

- Then, Kendall’s $\tau$ is:
  \[
  \tau = \frac{p_+ - p_-}{\binom{m}{2}} = \frac{2 \cdot (p_+ - p_-)}{m \cdot (m - 1)}
  \]

- Example:

Meteasrch

- Today, metasearch is well-suited for answering very special queries with maximum recall.
- Unfortunately, it fails to increase result quality for most other queries...
- Why?
  - Metasearch works best if...
    - The engines used are completely independent
    - The engines used are all of similar (high) quality
- The reality:
  - Most search engines use similar methods, thus being dependent.
  - There are just a few good engines and many bad ones.

Lecture 13: Miscellaneous

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On August 6, 2006, AOL tried to help IR researchers

They released very private data about its users (without their permission)
- 20 million Web queries from 650,000 AOL users
- All searches from those users for a three month period
- Whether they clicked on a result
- Where this result appeared on the result page

Of course, the data has been made anonymous by replacing each AOL username by a random ID number.

Unfortunately, this did not work too well…

Let’s look at some examples

User 311045:
- how to change brake pads on scion xb
- 2005 us open cup florida state champions
- how to get revenge on a ex girlfriend
- how to get revenge on a friend who f---ed you over
- replacement bumper for scion xb
- florida department of law enforcement
- crime stoppers florida

User 11574916:
- cocaine in urine
- asian mail order brides
- states reciprocity with florida
- florida dui laws
- extradition from new york to florida
- mail order brides from largos
- will one be extradited for a dui
- cooking jobs in french quarter new orleans
- will i be extradited from ny to fl on a dui charge

User 3540871:
- i have an interview at comcast and i need help
- cheap rims for a ford focus
- how can i get a job in joliet il with a theft on my background
- i need to trace a cellular location
- i need to know if my spouse is cheating and i need to do a cellular trace for free
- jobs with no background checks
- how can i get a job with a conviction
- motels in joliet il
- motels in gurnee il area for under 40 dollars
- my baby's father physically abuses me

User 17556639:
- how to kill your wife
- wife killer
- how to kill a wife
- dead people
- pictures of dead people
- killed people
- murder photo
- steak and cheese
- decapitated photos
- car crashes
- car crash photo

User 4417749:

**AOL's Query Log**

- This has just been a very small sample...
- AOL removed the data on August 7, 2006, from their Web site, one day after its release
- They apologized: “This was a screw up”

- However, the data is still out there…
  …and probably always will be

---

**The Netflix Data Set**

- Netflix, America’s largest online DVD rental service, had similar problems
- They released data about what DVDs has been rented by each user, along with the users’ movie ratings
- As with the AOL data set, user IDs have been replaced by random numbers
- Unfortunately, researchers have been able to reconstruct the identity of some customers by comparing their movie ratings with reviews written at imdb.com, a public movie database

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**123people.com**

- [http://www.123people.com](http://www.123people.com)

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**Next Semester**

- Distributed Databases and P2P Data Management
- Data Warehousing and Data Mining Techniques
- Spatial Databases and Geographic Information Systems
- Digital Libraries