The World Wide Web

Lecture 7 – COMPSCI111/111G

"On the Internet, nobody knows you're a dog."

Today's lecture

- Recap material on the Internet and World Wide Web (WWW)
- Understand how the WWW works
- Understand how search engines work
- The implications of search engines

Recap

- Previously, we saw:
  - WWW refers to the applications (eg. web pages, email, Skype, Youtube etc) that run on the Internet, which refers to the underlying hardware
  - The Internet includes the hardware and protocols that transport data from sender to receiver
- We've already looked at a few WWW applications (eg. email, blogs, instant messaging)

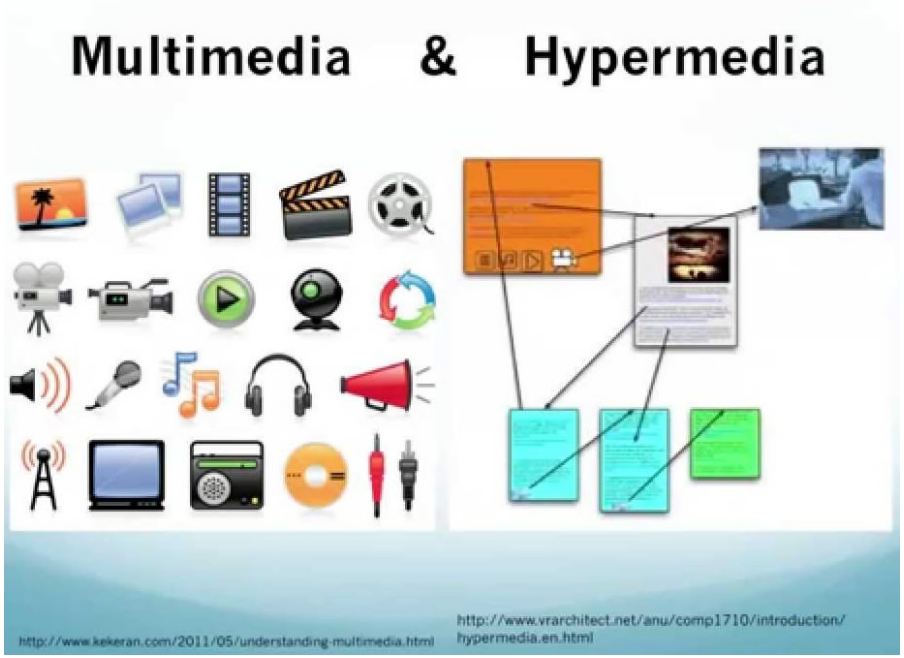
Hypertext

- Hypertext is basically text with links
  - Allows associations to be made between pieces of text
- Vannevar Bush – "*As We May Think*" (1945)
  - Bush described a device called a **memex**, which could store text and links within the text

- Ted Nelson – the Xanadu Project (1960s)
  - First computer-based hypertext implementation
  - Although developed in the 1960s, the first public release was in 1998

Multimedia and hypermedia

- Multimedia: the integration of many forms of media (text, video, sound, images etc)
- Hypermedia: the creation of links between multimedia content



The WWW project

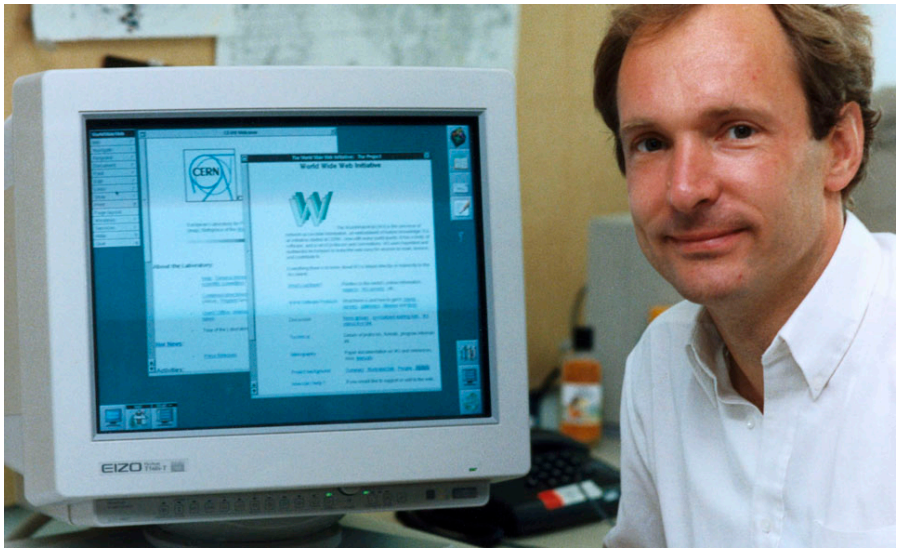
- Tim Berners-Lee worked at CERN in the 1980s
- Physicists performing research at CERN found it difficult to share their research with each other
- Berners-Lee thought he could solve this problem using hypertext and wrote "*Information Management: A Proposal*" outlining his idea in 1989
  - He envisioned a linked information system where pages could be added and accessed by CERN employees
  - Pages would be stored on a server

The WWW project

- After development in CERN, the first public web server was set up in 1991
- In June 1993, Mosaic was released; the first widely used web browser
- By Oct 1993, there were 500 web servers around the world
  - By this point, Berners-Lee realised the WWW had to be freely available so he convinced CERN to make the source code public

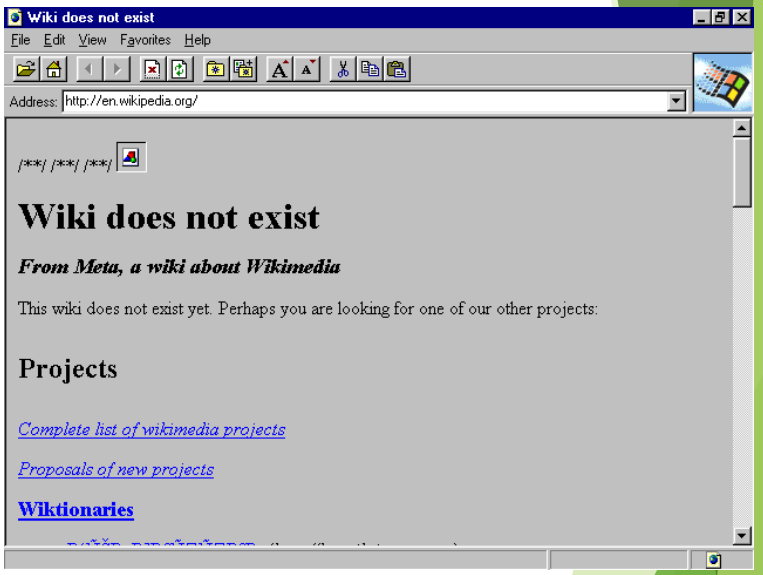
The WWW project

- In 1994, Berners-Lee established the World Wide Web Consortium (W3C), which creates standards for the WWW



Evolution of the Web

- 1994: Netscape Communications and Yahoo! founded
- 1995: first version of Microsoft Internet Explorer released
- 1998: Google founded
- 1997-2001: “Dot-com” boom and bust
- 2004: shift to ‘Web 2.0’ (eg. wikis)



Some terms

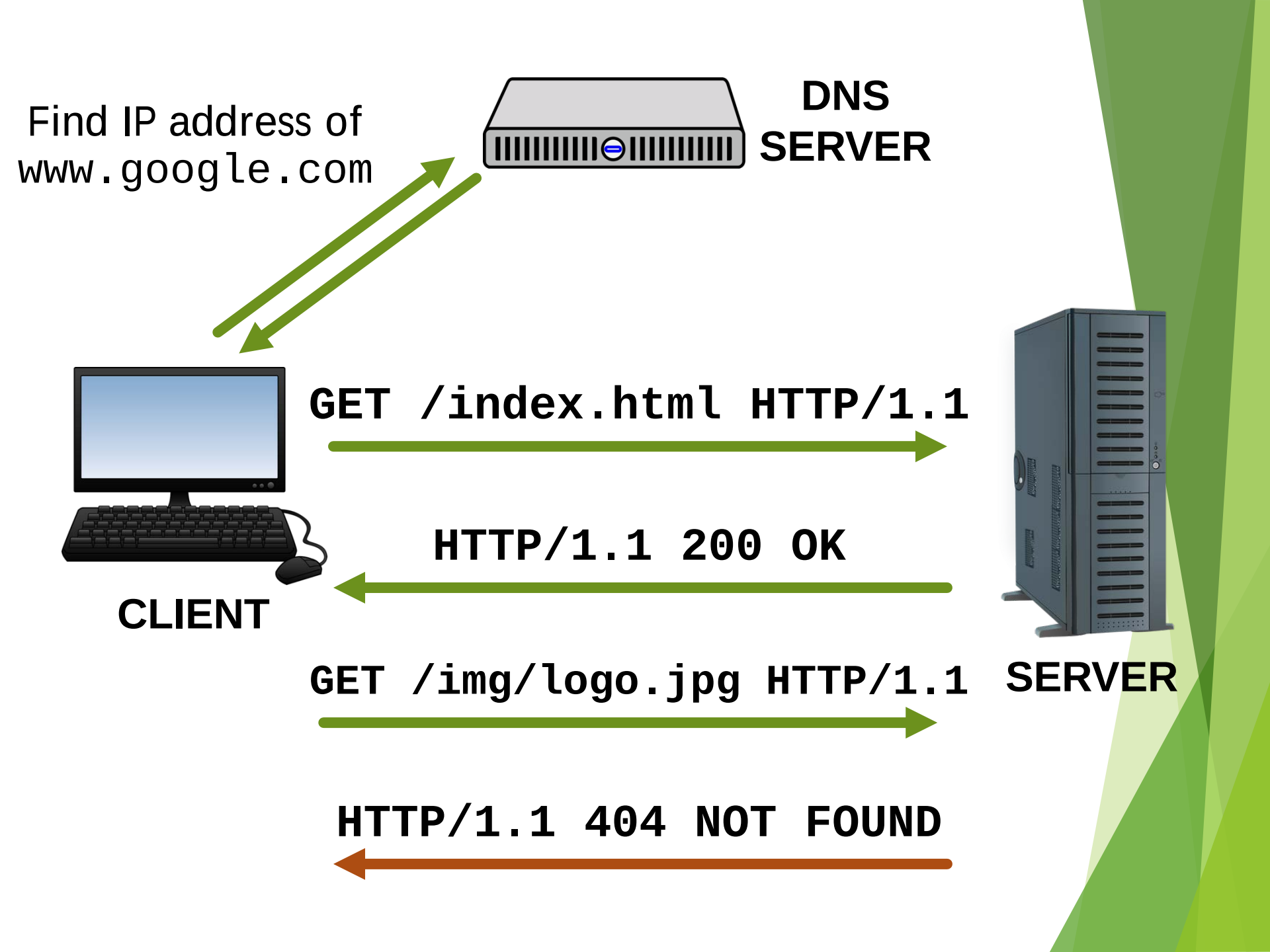
- **Webpage:** a hypermedia document on the WWW that is usually accessed through a web browser
- **Website:** a collection of webpages usually on the same topic or theme
- **Web browser:** application software used to access content on the WWW
- **Web server:** a computer with software that makes files available on the WWW

Uniform Resource Locator (URL)

- **https://www.cs.auckland.ac.nz/~andrew/teaching.html**
- Protocol: https
  - Other common protocols: ftp, http
- Domain: www.cs.auckland.ac.nz
  - Can be a domain name or an IP address
- Path on server: /~andrew/
- Resource: teaching.html

HTTP

- HyperText Transfer Protocol; used by web browsers to request resources (eg. webpages, images, sounds) from a web server
- There's also HTTPS = HyperText Transfer Protocol Secure
  - Encrypts the HTTP connection using TLS (Transport Layer Security)
  - Becoming essential for websites to use HTTPS to keep user information secure

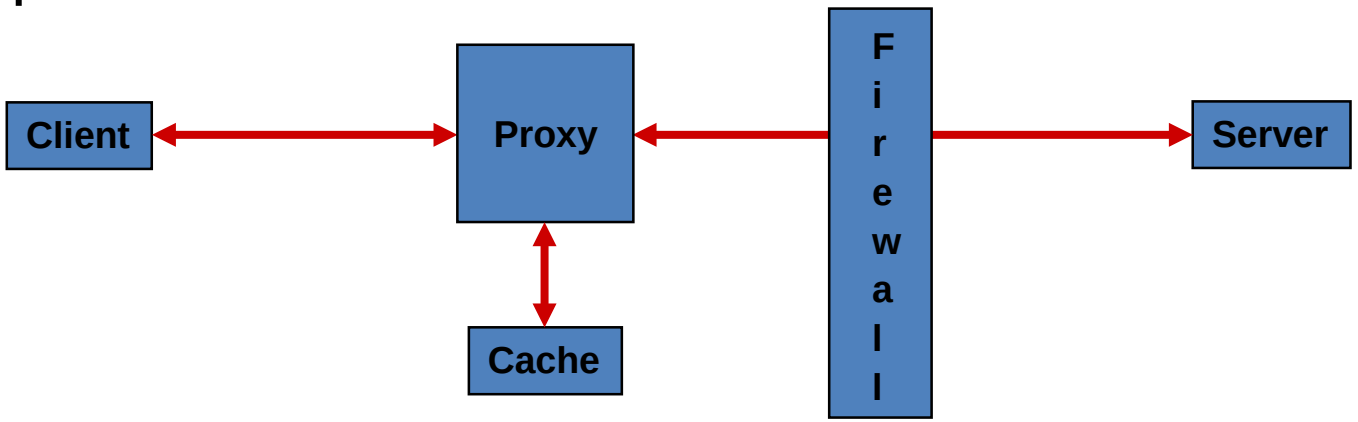

Find IP address of
www.google.com
DNS
SERVER
GET /index.html HTTP/1.1
HTTP/1.1 200 OK
CLIENT
SERVER
GET /img/logo.jpg HTTP/1.1
HTTP/1.1 404 NOT FOUND

Logging browsing history

- A number of computers keep a record of the webpages accessed by a client:
  - Web browser
  - Computer's operating system
  - ISPs
    - They hold varying amounts of information
    - In Australia, ISPs must retain information about their customers' web usage for at least 2 years
  - The web server

Other parts of the WWW

- **Proxy:** sits between client and server so it can intercept and process requests
- **Cache:** stores recently requested resources so they can be accessed quickly
  - A proxy can use a cache to store recent requests, enabling it to process requests faster
- **Firewall:** prevents unauthorised access to a private network



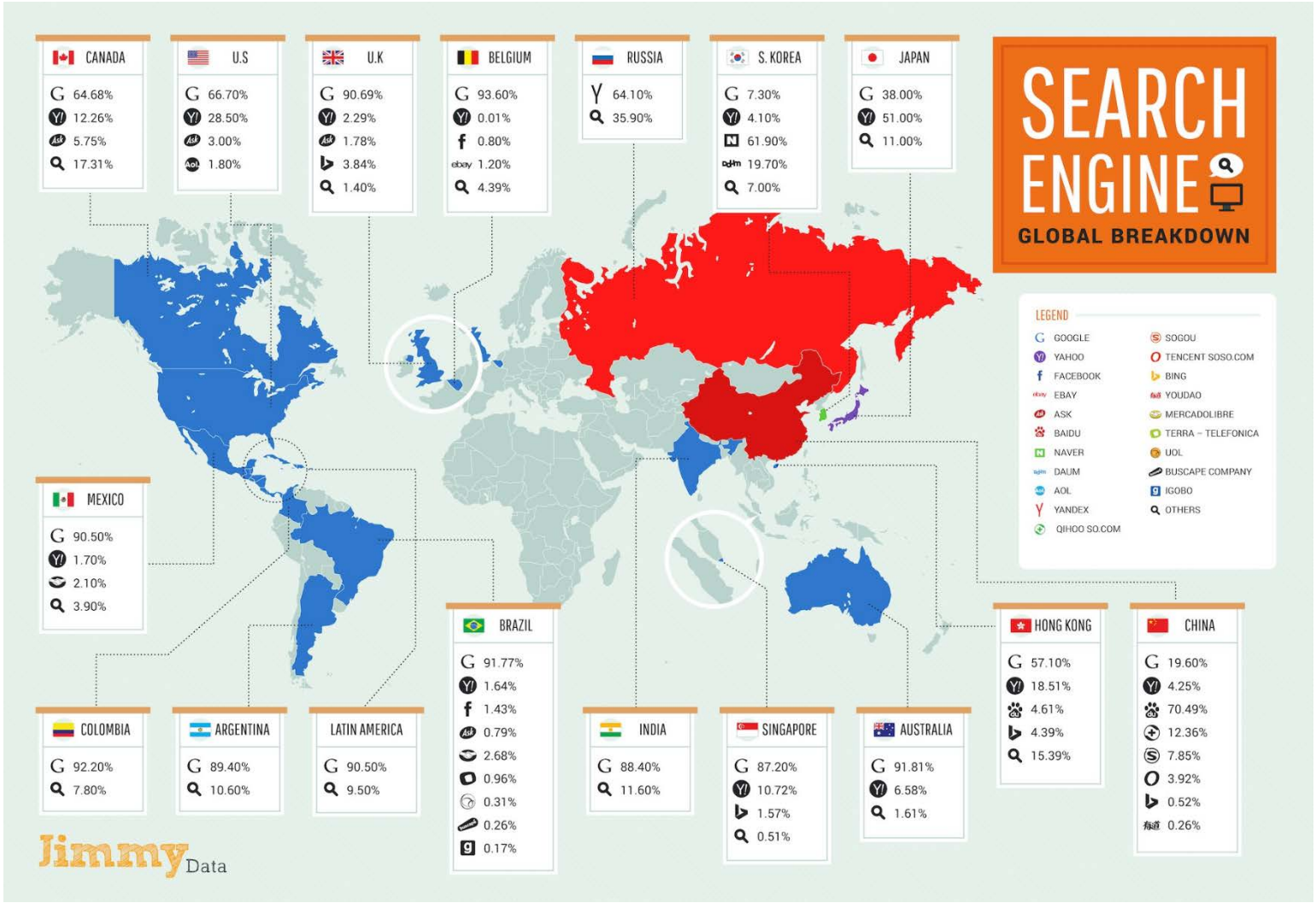
Problems with webpages

- Broken links
  - Usually the result of a webpage being moved or deleted
- No inherent security/tracking/accounting system
  - Difficult to have layers of security and a consistent level of security
  - Websites rely heavily on ad revenues
- No inherent way of indexing information
  - Difficult to find information on the web, although search engines help
  - Dynamically generated webpages and different file formats (eg. PDF, archives) also make indexing difficult

Search engines

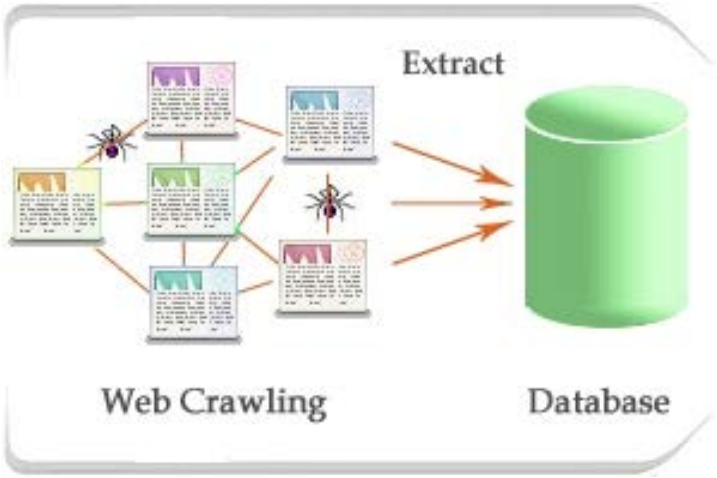
- A website that helps a user to search for information on the WWW
- Software indexes content on the web. This index is used to build a list of results based on the search terms entered by the users
  - **Indexing:** organising data so that it is easier to search
- Popular search engines include:
  - Google
  - Bing
  - Yahoo search
  - DuckDuckGo

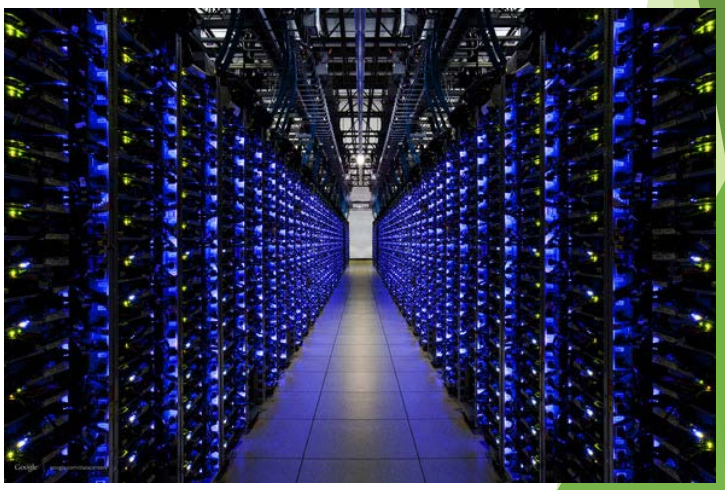
Search engines



How do search engines work?

- Spiders crawl across the WWW to scan webpages
  - Spiders are programs that follow links and gather information from webpages
- The search engine's index is updated with information gathered by the spiders





How do search engines work?

- User enters a search term
- The search engine uses algorithms to find the most relevant results in its index
  - These algorithms are secret and highly complex
  - They use a number of criteria, such as keywords and popularity, to determine a page's relevance to the user
- Search engine gives the user a list of results
  - This list is complied from billions of webpages in a couple of seconds!

Can we trust search engines?

- Bias in the results?
  - Since search algorithms are secret, we have to trust that they operating fairly
  - Effect of filtering on search results (eg. DMCA, images of child abuse)
- Advertising plays a big role in how search engines operate
  - Search engines make money from advertising
  - Companies misuse search engines to get a competitive edge: NakedBus using ‘inter city’ on Google Adwords (a good summary can be found here)

Can we trust search engines?

- The right to be forgotten (R2BF)
  - In 2014, European Court of Justice decided R2BF meant Google has to remove out-of-date search results when requested by individuals
    - A good summary can be found here
  - In Europe, the General Data Protection Regulation 2016 contains a more limited 'right to erasure'
- R2BF helps an individual to preserve their privacy
- However, the R2BF distorts search results and could be abused (eg. a businessman wanting news articles removed from search results)

Filter bubble

- Occurs when a search algorithm offers personalised results, which limits the diversity of information presented to the user
  - Examples include Facebook's News Feed and Google's personalised search results
- Personalised search results can help people to find relevant information
- However, it also risks isolating people within their own bubble of information

Privacy

- Search engines are gathering vast amounts of information about our searches and ourselves
  - This information is generally used for advertising purposes
- Can we trust private companies to treat our information with care? To keep it secure? To not sell it to others without consent?
- While you can search anonymously, search history can be used to identify individuals
  - A reporter used a person's anonymised search history to track them down – article here

Questions

- What problem did Tim Berners-Lee want to solve using the Web?
- What is the difference between a firewall and proxy?
- Name two ways that bias could be introduced into search results

Answers

- What problem did Tim Berners-Lee think he could solve using the Web?
  - Sharing information between researchers at CERN
- What is the difference between a firewall and proxy?
  - Firewall: prevents unauthorised access to a network
  - Proxy: intercepts and processes requests from clients and servers
- Name two ways that bias could be introduced into search results
  - Any of: DMCA requests, filtering illegal content, filter bubbles, right to be forgotten

Summary

- The WWW was designed to be a system to share information
  - It has become a system for creating and sharing a variety of content
  - Key protocol on the WWW is HTTP
- Search engines use an index of the WWW to provide results based on search terms
- Issues around search engines
  - Bias
  - Protecting privacy (eg. R2BF)
  - Use of personal information for advertising
  - Filter bubbles

Given the URL:
https://www.cs.auckland.ac.nz/~andrew/teaching.html
which of the following statements is FALSE?

- teaching.html is the resource
- ~andrew is the path on the server
- www.cs.auckland.ac.nz is the domain
- URL stands for Uniform Resource Locator
- https stands for hypertext transfer protocol standard

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