Lecture 17: (World Wide) Web

- **a way to connect computers that provide information (servers) with computers that ask for it (clients like you and me)**
  - uses the Internet, but it's not the same as the Internet

- **URL (uniform resource locator, e.g., http://www.amazon.com)**
  - a way to specify what information to find, and where
- **HTTP (hypertext transfer protocol)**
  - a way to request specific information from a server and get it back
- **HTML (hypertext markup language)**
  - a language for describing information for display
- **browser (Firefox, Safari, Chrome, Edge, …)**
  - a program for making requests, and displaying results

- **embellishments**
  - pictures, sounds, movies, ...
  - loadable software
- **the set of everything this provides**

Web history

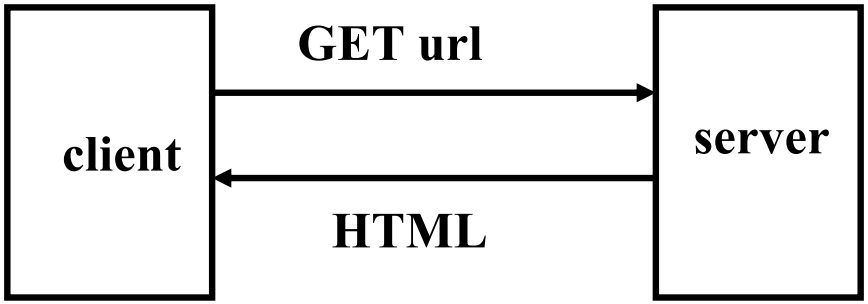
- **1989: Tim Berners-Lee at CERN**
  - a way to make physics literature and research results accessible on the Internet
- **1991: first software distributions**
- **Feb 1993: Mosaic browser**
  - Marc Andreessen at NCSA (Univ of Illinois)
- **Mar 1994: Netscape**
  - first commercial browser
- **technical evolution managed by World Wide Web Consortium**
  - non-profit organization at MIT, Berners-Lee is director
  - official definition of HTML and other web specifications
  - see **`www.w3.org`**

HTTP: Hypertext transfer protocol

- **What happens when you click on a URL?**
- **client opens TCP/IP connection to host, sends request**

  `GET /filename HTTP/1.0`

- **server returns**
  - **header info**
  - **HTML**



- **server returns text, which can be dynamically created as needed**
  - can contain encoded material for images, music, video (MIME format)
- **URL format**

  `service://hostname/filename?other_stuff`

- ***`filename?other_stuff`* part can encode**
  - data values from client (forms)
  - request to run a program on server (cgi-bin)
  - anything else

Embellishments

- **original design of HTTP just returns text to be displayed**
- **MIME format for pictures, sound, video, ...**
  - helpers or plug-ins display non-text content
- **forms filled in by user**
  - needs a program on the server to interpret the information (cgi-bin)
- **cookies to remember information on client**
  - HTTP is stateless: server doesn't save anything from one request to next
  - cookies are a way to remember information at the client
- **Javascript: download code to run on the client**

Forms and CGI programs

- **"common gateway interface"**
  - standard way to request the server to run a program
  - using information provided by the client via a form

- **if the target file on the server is an executable program**
- **and if it has the right properties and permissions**
  - e.g., in /cgi-bin directory and executable
- **then run it on the server to produce HTML to send back to the client**
  - using the contents of the form as input
  - output depends on client request: created on the fly, not just a file

- **CGI programs can be written in any programming language**
  - e.g., Python, Java, …

Cookies

- **HTTP is stateless: it doesn't remember from one request to the next**
- **cookies are intended to deal with stateless nature of HTTP**
  - remember preferences, manage "shopping cart", etc.
- **cookie: one chunk of text sent by server to be stored on the client**
  - stored in browser while it is running (transient)
  - stored in client file system when browser terminates (persistent)
- **when the client reconnects to same domain,**

  browser sends the cookie back to the server
  - sent back verbatim; nothing added
  - sent back only to the same domain that sent it originally
  - contains no information that didn't originate with the server

- **in principle, pretty benign**
- **but pervasively used to monitor browsing, for commercial purposes**

Cookie crumbs

- **fetch a page from, e.g., xyz.com**
  - it contains, e.g., <img src=http://doubleclick.com/advt.gif>
  - this causes a page to be fetched from DoubleClick.com (part of Google)
  - which now knows your IP address and what page you were looking at

- **DoubleClick sends back (or arranges for) a suitable advertisement**
  - with a cookie that identifies "you" at DoubleClick

- **next time you fetch <u>any</u> page that contains a DoubleClick.com image**
  - the most recent DoubleClick cookie is sent back to DoubleClick
  - DoubleClick now knows even more about you
  - the set of sites and images that you are viewing is used to
    - update the record of where you have been and what you have looked at
    - send further targeted advertising
    - allow more cookies from advertisers

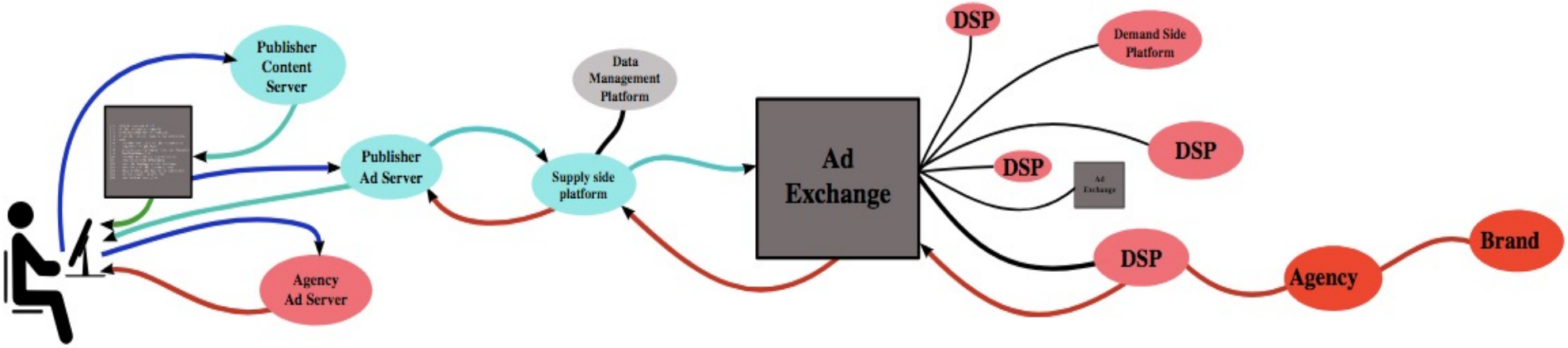
Advertising marketplace

- **When you use a browser to view a web page...**

- **the web page "publisher" notifies advertising exchanges that advertising space on that page is available**
  - publishers are often social media or entertainment or news sites
  - exchanges include Google Ad Manager, Microsoft Xandr, Yahoo, ...
- **the publisher provides information about you to the ad exchange**
  - past online activity, viewing and shopping habits, geographic location, demographics
  - (probably) not your actual identity
- **advertising exchanges tell potential advertisers about you**
- **advertisers bid on the ad space**
  - amount depends on your attributes and location, advertiser's budget, etc.
- **winners' advertisements are inserted into the page that you see**
- **elapsed time: 10-100 milliseconds**

Who's involved?

- publisher: integrates advertisements into its online content
- advertiser: provides the advertisements to be displayed on the publisher's content
- advertising agencies: generate and place the ad copy
- ad exchange: connects buyers and sellers, auctions ad space on pages
- data supplier: provide information about the viewer
- ad server: delivers the adverts and tracks statistics



Cookies are not the only tracking mechanism

- **3th party cookies are decreasing in value**
  as more browsers block them by default

- **Alternatives:**

- **JavaScript**
  - potentially continuous monitoring and reporting of activity on a page

- **web bugs, web beacons, single-pixel gifs**
  - tiny images that report the use of a particular page
  - these can be used in mail messages, not just browsers

- **HTML canvas fingerprinting**
  - uses subtle differences in browser behavior to distinguish users

Javascript

- **programming language loosely in the C family (surface syntax similar)**
  - (no relationship to Java)
  - compiled into instructions for a virtual machine

    like the Toy machine on steroids
  - instructions are interpreted by a virtual machine in browser

- **most common use is embedded in web pages, running in browser**
  - can also run standalone

    `<script> ... </script>`
- **can interact with browser to see what is displayed,**

  change what is displayed
  - can watch events like clicks, mouse motion, ...
  - can send and receive data from network (with restrictions)
  - can load more Javascript from network (with restrictions)

What does Facebook know about you?

- https://www.cnbc.com/2018/03/27/facebook-knows-a-lot-about-me.html

- It can recognize my face
- It knows every ad topic I've ever clicked
- It has a list of every company that has my contact information from the ads I've clicked
- It has a list of every contact in my phone book
- It knows every social event I was invited to and/or attended through Facebook
- It has a log of every friend I have on Facebook and when we became friends
- It knows every time I logged in
- It has a copy of my timeline going back to the time I joined
- It knows my major life events
- It knows every video I've watched on Facebook
- It knows exactly where I was
- It has old messages
- It has a copy of every photo I've ever uploaded