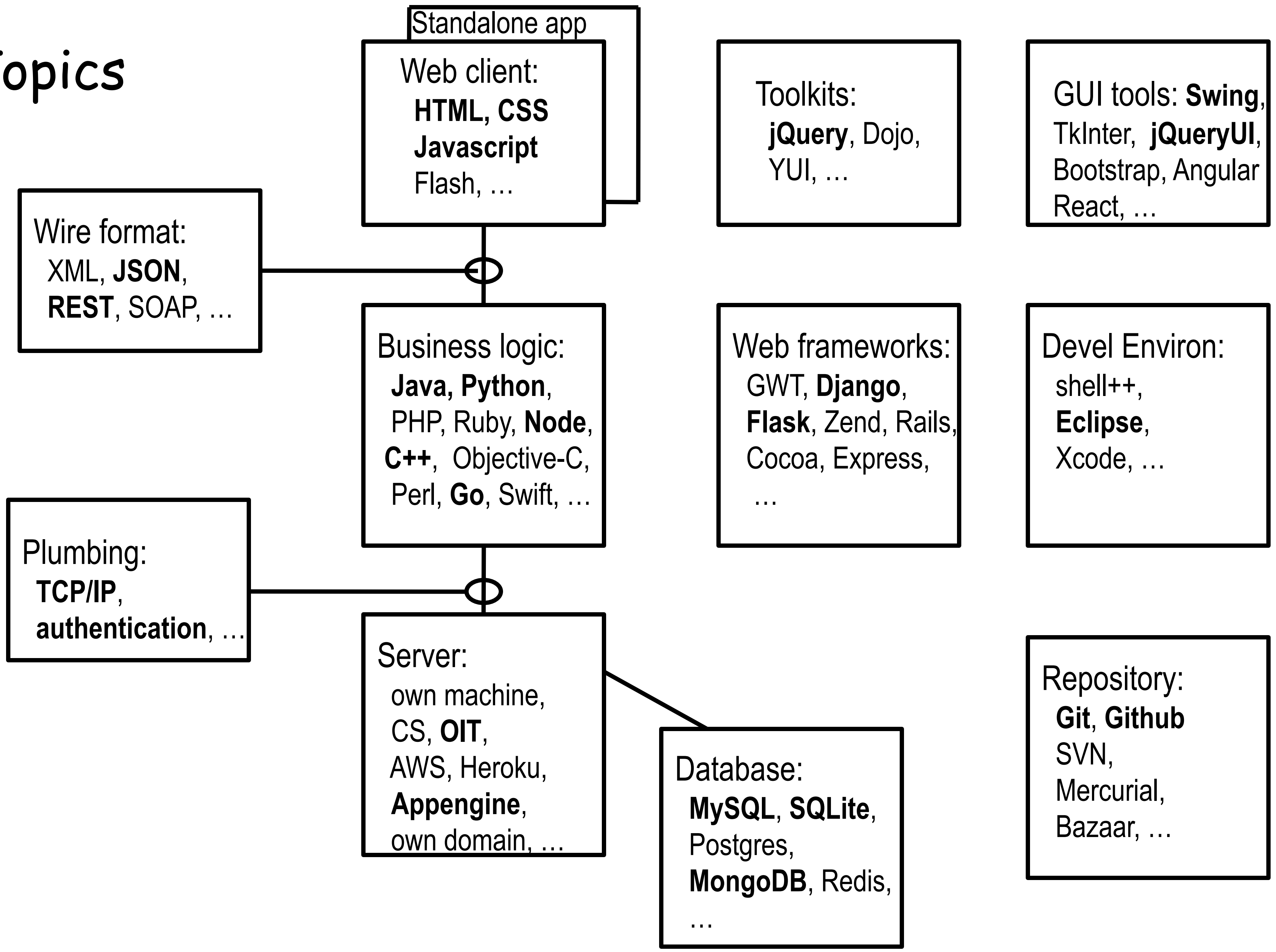
Web technologies

- **client-server architecture**
- **browser**
  - sends requests to server, displays results
  - DOM (document object model): structure of page contents
- **forms / CGI (common gateway interface)**
  - client side uses HTML/CSS, Javascript, XML, JSON, ...
  - server side code in Perl, PHP, Python, Ruby, Javascript, C, C++, Java, ...
    extracts info from a form, creates a response, sends it back
- **client-side interpreters**
  - Javascript, Java, Flash, Silverlight, HTML5 (animation, audio/video, …)
- **Ajax (asynchronous Javascript and XML)**
  - update page content asynchronously **(e.g., Google Maps, Suggest, Instant, …)**
- **libraries, APIs, GUI tools**
  - client-side Javascript for layout, interfaces, effects, easier DOM access, ...
    JQuery, Bootstrap, Backbone, Underscore, Angular, React, ...
- **frameworks**
  - integrated server-side systems for creating web applications
    Rails (Ruby), Django (Python), Google Web Toolkit (Java), Express (Javascript), ...
- **databases**
- **networks**
- **hosting: Platform/Infrastructure as a service (PaaS, IaaS)** **[foaas]**

Topics


Standalone app
Web client: **HTML, CSS** **Javascript** Flash, …
Toolkits: **jQuery**, Dojo, YUI, …
GUI tools: **Swing**, TkInter, **jQueryUI**, Bootstrap, Angular React, …
Wire format: XML, **JSON**, **REST**, SOAP, …
Business logic: **Java, Python**, PHP, Ruby, **Node**, **C++**, Objective-C, Perl, **Go**, Swift, …
Web frameworks: GWT, **Django**, **Flask**, Zend, Rails, Cocoa, Express, …
Devel Environ: shell++, **Eclipse**, Xcode, …
Plumbing: **TCP/IP**, **authentication**, …
Server: own machine, CS, **OIT**, AWS, Heroku, **Appengine**, own domain, …
Database: **MySQL**, **SQLite**, Postgres, **MongoDB**, Redis, …
Repository: **Git**, **Github** SVN, Mercurial, Bazaar, …

World Wide Web

- **basic components**
  - URL (uniform resource locator)
  - HTTP (hypertext transfer protocol)
  - HTML (hypertext markup language)
  - browser

- **embellishments in browser**
  - helpers or plug-ins to display non-text content
    pictures (e.g., GIF, JPEG), sound, movies, …
  - forms filled in by user
    client encodes form information in URL or on stdout
    server retrieves it from environment or stdin
    usually with cgi-bin program
    can be written in anything: Perl, PHP, shell, Java, ...
  - active content: download <u>code</u> to run on client
    Javascript
      add-ons and extensions
    Java applets
    plug-ins (Flash, Quicktime, Silverlight, ...)
    ActiveX

URL: Uniform Resource Locator

- **URL format**

  `protocol://hostname:port/filename`

- ***`hostname`*** **is domain name or IP address**

- ***`protocol`*** **or service**
  - http, https, file, ftp, mailto, …
  -

- ***`port`*** **is optional; defaults to 80 for HTTP**

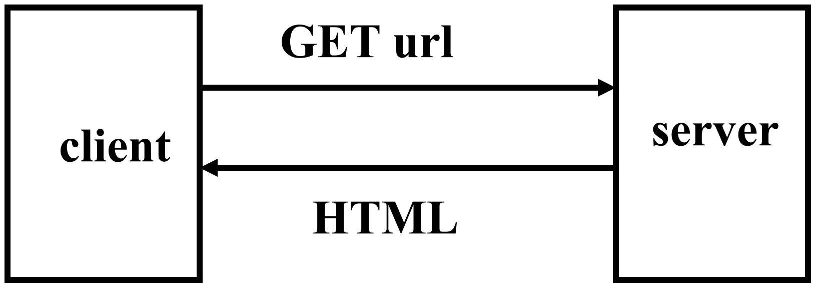
- ***`filename`*** **is an arbitrary string, can encode many things**
  - data values from client (forms)
  - request to run a program on server (cgi-bin)

- **encoded in very restricted character set**
  - special characters as %hh (hex), space as +

HTTP: Hypertext transfer protocol

- **what happens when you click on a URL?**
- **client sends request:**

```
GET  url  HTTP/1.0
[other header info]
     (blank line)
```



- **server returns**

```
header info
 (blank line)
HTML
```

  - server returns text that can be created as needed
  - can contain encoded material of many different types
    uses MIME (Multipurpose Internet Mail Extensions)

HTML: hypertext markup language

- **plain text description of content and markup for a page**
- **markup describes structure and appearance**
- **interpreted by a browser**
  - browsers differ significantly in how they interpret HTML
- **tags bracket content**

```
<html><title>...</title><body>...</body></html>
<h1>...</h1> <p> <b>bold</b> <ul><li>...<li>...</ul>
<a href="http://www.google.com">link to Google</a>
<form … > ... </form>
<table … > .. .</table>
<script> alert("hello"); </script>
```

- **and many, many more**
- **tags can have attributes**

```
<font size=-1 color="red"> ... </font>
```

Forms and CGI-bin programs

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

- **if target file on server is executable program,**
  - e.g., in /cgi-bin directory
  - and if it has right permissions, etc.,
- **server runs it to produce HTML to send to client**
  - using the contents of the form as input
  - server code can be written in any language
  - most languages have a library for parsing the input

- **CS department runs a cgi server**
  - restrictions on what scripts can access and what they can do
- **OIT offers "Personal cPanel"**
  - http://helpdesk.princeton.edu/kb/display.plx?ID=1123

HTML form hello1.html

```
<FORM
 ACTION="http://bwk.mycpanel.princeton.edu/cgi-bin/hello1.cgi"
 METHOD=GET>
<INPUT TYPE="submit" value="hello1: shell script, plain text">
</FORM>


<FORM
 ACTION="http://bwk.mycpanel.princeton.edu/cgi-bin/hello2.cgi"
 METHOD=POST>
<INPUT TYPE="submit" value="hello2: shell script, html">
</FORM>
```

[and a bunch of others]

Simple echo scripts hello[12].cgi

- **plain text… (hello1.cgi)**

```
#!/bin/sh
echo "Content-type: Text/plain"
echo
echo Hello, world.
```

- **HTML … (hello2.cgi)**

```
#!/bin/sh
echo 'Content-Type: text/html

<html>
<title> Hello2 </title>
<body bgcolor=cyan>
<h1> Hello, world </h1>'

echo "<h2> It's `date` </h2>"
```

- **no user input or parameters but content can change (as in hello2)**

HTML forms: data from users (surv0.html)

```
<html>
<title> COS 333 Survey </title>
<body>
<h2> COS 333 Survey </h2>
<form METHOD=GET ACTION=
   "http://bwk.mycpanel.princeton.edu/cgi-bin/surv2.py">
Name: <input type=text name=Name size=40> <p>
Password: <input type=password name=password> <p>
Class: <input type=radio name=Class value=17> '17
       <input type=radio name=Class value=16> '16
<p> CS courses:
<input type=checkbox name=c126> 126
<input type=checkbox name=c217> 217
<p> Experience?
<textarea name=Exp rows=3 cols=40 wrap></textarea>
<p>
<input type=submit> <input type=reset>
</form>
</body></html>
```

Retrieving info from forms (surv2.py)

- **HTTP server passes info to cgi program in environment variables**
- **form data available in environment variable QUERY_STRING (GET) or on stdin (POST)**

```
#!/usr/bin/python

import os
import cgi
form = cgi.FieldStorage()

print "Content-Type: text/html"
print ""
print "<html>"
print "<title> COS 333 Survey </title>"
print "<body>"
print "<h1> COS 333 Survey </h1>"
for i in form.keys():
        print "%s = %s <br>" % (i, form[i].value)
print "<p>"
for i in os.environ.keys():
        print "%s = %s <br>" % (i, os.environ[i])
```

URL encoding of form data

- **how form data gets from client to server**
  - http://hostname/restofpotentially/very/very/longline
  - everything after hostname is interpreted by server
  - usually /program?encoded_arguments
- **if form uses GET, encoded in URL format in QUERY_STRING environment variable**
  - limited length
  - visible in browser, logs, ...; can be bookmarked
  - usually used if no change of state at server
- **if form uses POST, encoded in URL format on stdin (CONTENT_LENGTH bytes)**
  - sent as part of message, not in URL itself
  - read from stdin by server, no limit on length
  - usually used if causes change of state on server
- **URL format:**
  - keywords in keyword lists separated by +
  - parameters sent as **`name=value&name=value`**
  - funny characters encoded as %NN (hex)
  - someone has to parse the string
    most scripting languages have URL decoders in libraries

CSS: Cascading Style Sheets

- **a language for describing appearance of HTML documents**
- **separates structure (HTML) from presentation (CSS)**
- **style properties can be set by declarations**
  - for individual elements, or all elements of a type, or with a particular name
- **can control color, alignment, border, margins, padding, …**

```
<style type="text/css" media="all">
    body { background: #fff; color: #000; }
    pre { font-weight: bold; background-color: #ffffcc; }
    a:hover { color: #00f; font-weight: bold;
              background-color: yellow; }
</style>
```

- **can dramatically change appearance without changing structure or content**

- **style properties can be queried and set by Javascript**

CSS syntax

- **optional-selector { property : value; property : value; … }**
- **selectors:**

  HTML tags like h1, p, div, …

  .classname (all elements with that classname)

  #idname (all elements with that idname)

  :pseudo-class (all elements of that pseudo-class, like hover)

```
h1 { text-align: center; font-weight: bold; color: #00f }
h2, h3 { margin:0 0 14px; padding-bottom:5px; color:#666; }
.big { font-size: 200%; }
```

- **styles can be defined inline or in a file:**

```
<link rel="stylesheet" href="mystyle.css">
```

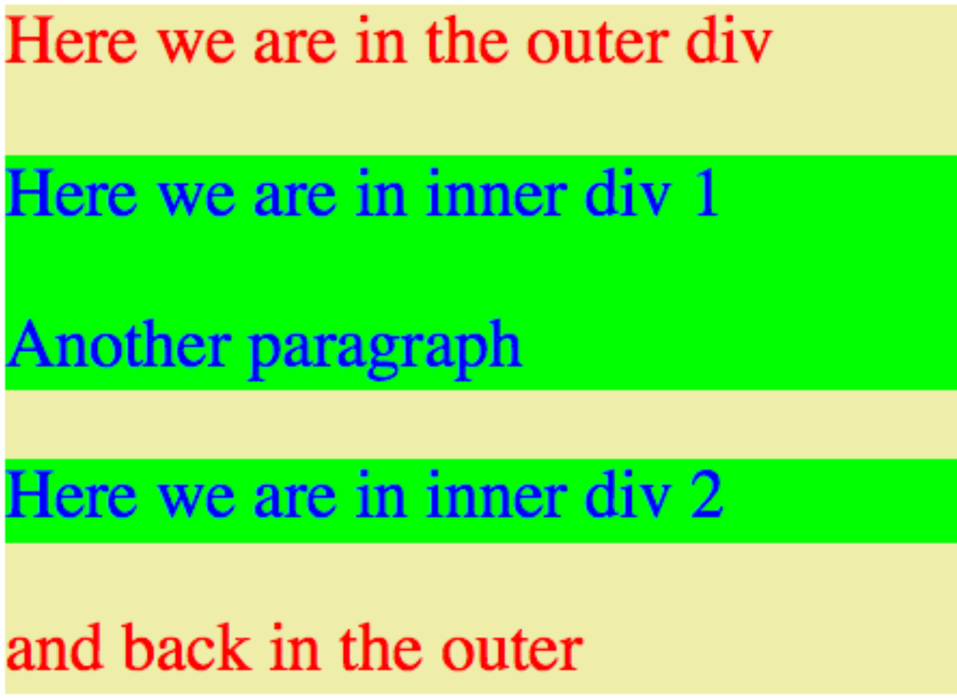
- **can be defined in `<style> ... </style>` tag**
- **can be set in a `style="..."` attribute in an element tag**

```
<p class=big style="color:red">
```

Page layout with HTML and CSS

- **use HTML <div> tag for layout (not tables)**

```
<html>
<body style="font-size: 24pt">
<div id="outer" style="color: #ff0000; background-color: #eeeeaa">
  <P> Here we are in the outer div
  <div id="inner1" style="color: #0000ff; background-color: #00ff00">
    <p> Here we are in inner div 1
    <p> Another paragraph
  </div> <!-- inner1 -->
  <div id="inner2"
      style="color: #0000ff;
      background-color: #00ff00">
    <p> Here we are in inner div 2
  </div> <!-- inner2 -->
  <p> and back in the outer
</div> <!-- outer -->
</body>
</html>
```



Here we are in the outer div

Here we are in inner div 1

Another paragraph

Here we are in inner div 2

and back in the outer

Cookies

- **HTTP is <u>stateless</u>: doesn't remember from one request to next**
- **cookies intended to deal with stateless nature of HTTP**
  - remember preferences, manage "shopping cart", etc.
- **cookie: one line of text sent by server to be stored on client**
  - stored in browser while it is running (transient)
  - stored in client file system when browser terminates (persistent)
- **when 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 heavily used to monitor browsing habits, for commercial purposes**

Cookie crumbs

- **get a page from xyz.com**
  - it contains <img src=http://doubleclick.com/advt.gif>
  - this causes a page to be fetched from DoubleClick.com
  - which now knows your IP address and what page you were looking at
- **DoubleClick sends back a suitable advertisement**
  - with a cookie that identifies "you" at DoubleClick
- **next time you get <u>any</u> page that contains a doubleclick.com image**
  - the last DoubleClick cookie is sent back to DoubleClick
  - 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 back targeted advertising (and a new cookie)
- **this does not necessarily identify you personally so far**
- **but if you ever provide personal identification, it can be (and will be) attached**
- **defenses:**
  - turn off all cookies; turn off "third-party" cookies
  - don't reveal information
  - clean up cookies regularly

PHP (www.php.com)

- **another scripting language for generating web pages**
  - Rasmus Lerdorf (1997), Andi Gutmans, Zeev Suraski
  - originally Personal Home Pages, then PHP Hypertext Processor
- **sort of like Perl turned inside-out**
  - text sent by server after PHP code within it has been executed

```
<html>
<title> PHP hello </title>
<body>
<h2> Hello from PHP </h2>
<?php
echo $_SERVER["SCRIPT_FILENAME"] . "<br>";
echo $_SERVER["HTTP_USER_AGENT"] . "<br>";
echo $_SERVER["REMOTE_ADDR"] . "<br>";
echo $_SERVER["REMOTE_HOST"] . "<br>";
phpinfo();
?>
</body>
</html>
```

Formatter in PHP

```
<?
$line = ''; $space = '';
$rh = STDIN;
while (!feof($rh)) {
   $d = rtrim(fgets($rh));
   if (strlen($d) == 0) {
      printline();
      print "\n";
   } else {
      #$words = split("/[\s]+/", $d); # doesn't work
      $words = explode(" ", $d);
      $c = count($words);
      for ($i = 0; $i < $c; $i++)
         if (strlen($words[$i]) > 0)
            addword($words[$i]);
   }
}
fclose($rh);
printline();

function addword($w) {
   global $line, $space;
   if (strlen($line) + strlen($w) > 60)
      printline();
   $line .= $space . $w;
   $space = ' ';
}
function printline() {
   global $line, $space;
   if (strlen($line) > 0)
      print "$line\n";
   $line = ''; $space = '';
}
# the \n after the next line shows up in the output!!  even if it's removed!!
?>
```

Formatter in Ruby

```
$space = ''
$line = ''

def addword(wd)
   println() if $line.length()+wd.length()>60
   $line = "#{$line}#{$space}#{wd}"
   $space = ' '
end

def printline()
   print "#{$line}\n" if ($line.length() > 0)
   $line = $space = ''
end

while line = gets()
   line.chop       # get rid of newline
   if (line =~ /^$/)
      printline()
      print "\n"
   else
      line.split().each {|wd| addword(wd) }
   end
end
printline()
```