Class 30: Vocational Skills
*How (and Why) to Build a Dynamic Web Application*

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**Trick-or-Treat**

- Trick or Treat?
- Challenge: $N$
- $R = H(\text{secret}, N)$
- Valid!

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**Ghost-in-the-Middle Attack**

- Trick or Treat?
- “Go”
- Challenge: $N$
- $R = H(\text{secret}, N)$

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**Who Invented the Internet?**

- Internetwork
  A collection of multiple networks connected together, so messages can be transmitted between nodes on different networks.

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**The First internet**

- 1800: Sweden and Denmark worried about Britain invading
- Edelcrantz proposes link across strait separating Sweden and Denmark to connect their (signaling) telegraph networks
- 1801: British attack Copenhagen, network transmit message to Sweden, but they don’t help.
- Denmark signs treaty with Britain, and stops communications with Sweden
First Use of Internet

- October 1969: First packets on the ARPAnet from UCLA to Stanford. Starts to send "LOGIN", but it crashes on the G.
- 20 July 1969: Live video (b/w) and audio transmitted from moon to Earth, and to millions of televisions worldwide.

The Modern Internet

- Packet Switching: Leonard Kleinrock (UCLA) thinks he did, Donald Davies and Paul Baran, Edelcrantz’s signalling network (1809) sort of did it
- Internet Protocol: Vint Cerf, Bob Kahn
- Vision, Funding: J.C.R. Licklider, Bob Taylor
- Government: Al Gore (first politician to promote Internet, 1986; act to connect government networks to form “Interagency Network”)

Kahn and Cerf’s Answer

Al Gore was the first political leader to recognize the importance of the Internet and to promote and support its development.

No one person or even small group of persons exclusively “invented” the Internet. It is the result of many years of ongoing collaboration among people in government and the university community. But as the two people who designed the basic architecture and the core protocols that make the Internet work, we would like to acknowledge VP Gore’s contributions as a Congressman, Senator and as Vice President. No other elected official, to our knowledge, has made a greater contribution over a longer period of time.

http://www.firstmonday.org/issues/issue5_10/wiggins/

Government and Networking

Chappe wanted a commercial network

The use of novel methods that modify established habits, often hurts the interests of those who profit the most from the older methods. Few people, with the exception of the inventors, are truly interested in helping projects succeed while their ultimate impact is still uncertain. . . Those in power will normally make no effort to support a new invention, unless it can help them to augment their power; and even when they do support it, their efforts are usually insufficient to allow the new ideas to be fully exploited. (Claude Chappe, 1824)

Anyone performing unauthorized transmissions of signals from one place to another, with the aid of telegraphic machines or by any other means, will be punished with an imprisonment of one month to one year, and a fine of 1,000 to 10,000 Francs.

French Law passed in 1837 made private networking illegal

The World Wide Web

The “Desk Wide Web”

Memex Machine.
Vannevar Bush, As We May Think, LIFE, 1945
Licklider and Taylor’s Vision
Available within the network will be functions and services to which you subscribe on a regular basis and others that you call for when you need them. In the former group will be investment guidance, tax counseling, selective dissemination of information in your field of specialization, announcement of cultural, sport, and entertainment events that fit your interests, etc. In the latter group will be dictionaries, encyclopedias, indexes, catalogues, editing programs, teaching programs, testing programs, programming systems, data bases, and – most important – communication, display, and modeling programs. All these will be – at some late date in the history of networking - systematized and coherent; you will be able to get along in one basic language up to the point at which you choose a specialized language for its power or terseness.

J. C. R. Licklider and Robert W. Taylor, The Computer as a Communication Device, April 1968

The World Wide Web
- Tim Berners-Lee, CERN (Switzerland)
- First web server and client, 1990
- Established a common language for sharing information on computers
- Lots of previous attempts (Gopher, WAIS, Archie, Xanadu, etc.)

World Wide Web Success
- World Wide Web succeeded because it was simple!
  - Didn’t attempt to maintain links, just a common way to name things
  - Uniform Resource Locators (URL)

HyperText Transfer Protocol
Client (Browser)
GET /cs150/index.html HTTP/1.0
<html>
<head>
  ...
</head>

Contents of file
HTML
HyperText Markup Language

Popular Web Site: Strategy 1
Static, Authored Web Site
Web Programmer, Content Producer
http://www.twinkiesproject.com/

Drawbacks:
- Have to do all the work yourself
- The world may already have enough twinkie-experiment websites

Popular Web Site: Strategy 2
Dynamic Web Applications
Web Programmer, Content Producer
eBay in 1997

Attracts pages
Produce more content
Popular Web Site: Strategy 2
Dynamic Web Applications

Seed content and function

Advantages:
• Users do most of the work
• If you’re lucky, they might even pay you for the privilege!

Disadvantages:
• Lose control over the content (you might get sued for things your users do)
• Have to know how to program a web application

eBay in 2005

Vocational Skills
Job listings at monster.com
(2 Nov 2005, within 100 miles of Charlottesville)

SQL
“more than 1000
within 100 miles” $80-$400K

Python
20 within 100 miles $40-$150K

HTML
427 $30-50K

Scheme
5 $400K

Loan Officers / Mortgage Brokers All Experience Levels Needed
“A performance based incentive scheme including company car”
Salary $400,000/year
(Note: none for Scheme programming language)

HTML: HyperText Markup Language

• Language for controlling presentation of web pages
• Uses formatting tags
  – Enclosed between < and >
• Not a universal programming language
  Proof: no way to make an infinite loop

Dynamic Web Sites

• Programs that run on the client’s machine
  – Java, JavaScript, Flash, etc.: language must be supported by the client’s browser (so they are usually flaky and don’t work for most visitors)
  – Used mostly to make annoying animations to make advertisements more noticeable
  – Occasionally good reasons for this: need a fancy interface on client side (like Google Maps)
• Programs that run on the web server
  – Can be written in any language, just need a way to connect the web server to the program
  – Program generates regular HTML – works for everyone
  – (Almost) Every useful web site does this

HTML Grammar Excerpt

Document ::= <html> Header Body </html>
Header ::= <head> HeadElements </head>
HeadElements ::= HeadElement HeadElements
HeadElement ::= <title> Element </title>
Body ::= <body> Elements </body>
Elements ::= Element Elements
Element ::= <p> Element </p>
make Element a paragraph.
Element ::= <center> Element </center>
center Element horizontally on the page.
Element ::= <b> Element </b>
display Element in bold.
Element ::= Text

What is an HTML interpreter?
Dynamic Web Site

Client (Web Browser)
“HTML Interpreter”

Dynamic Web Site

File Server

Client
GET .../browse.cgi

Request Processor

Server

Client
GET http://www.people.virginia.edu/~dsu9w/hoorides/browse.cgi

<html>
<head>

Server

Request Processor

#!/uva/bin/python
...

Processing a GET Request

#!/uva/bin/python
...

print "<h1>Ride List</h1>

form = cgi.FieldStorage()

print "<h3>Rides Offered</h3>

rideTable = rides.Rides ()

...

Python Code: Evaluate using Python evaluator, send output to client

Python Evaluator

to

Client

Learning New Languages

• **Syntax:** Where the {, ;, $, etc. all go
  – If you can understand a BNF grammar, this is easy

• **Semantics:** What does it mean
  – Learning the evaluation rules
  – Harder, but most programming languages have very similar evaluation rules

• **Style**
  – What are the idioms and customs of experienced programmers in that language?
    • Takes many years to learn
    • Need it to be a “professional” Python programmer, but not to make a useful program

Python

• A universal programming language
  – Everything you can compute in Scheme you can compute in Python, and vice versa
  – Friday we will explain why more convincingly

• Imperative Language
  – Designed to support a programming where most of the work is done using assignment

• Object-Oriented Language
  – Built in support for classes that package data and procedures

Learning New Languages

Python If

*Instruction ::= if (Expression) :
  Statements*

Evaluate Expression. If it evaluates to true, evaluate the Statements.
It is similar to (if Expression (begin Statements))
Differences:
  Indenting and new lines matter!
  Changing the indentation changes meaning of code
What “true” means:
  Scheme: anything that is not #f
  Python: anything that is not False, None, 0, and empty string or container
#!/uva/bin/python

# Tell web server to run the Python interpreter

import cgi
import util
import cookies
import users
import rides
import ride
import sys

util.printHeader("Ride Details")

user = users.userTable.getCurrentUser()

if not user:
    print "Must be logged in to see ride list!"
    util.printFooter()
    sys.exit(-1)

for ride in all:
    if ride.isoffer:
        print "<tr><td>" + users.userTable.lookupPrintName(ride.user) + "</td>
        print "<td><a href="rideinfo.cgi?ride=" + str(ride.id) + "">Link</a></td>
        print "<td>" + str(ride.leaveDate) + "</td><td>" + str(ride.retDate) + "</td>
        print "<td><pre>" + ride.notes + "</pre></td></tr>

print "</table>

print "</p>

Using a Database

- HTTP is stateless
  - No history of information from previous requests
- To do something useful, we probably need some state that changes as people visit the site
- That's what databases are for -- store, manipulate, and retrieve data

SQL

- Structured Query Language (SQL)
  - (Almost) all databases use it
- Database is tables of fields containing values
- All fields have a type (and may have other attributes like UNIQUE)
- Similar to procedures from PS5

Charge

- Combining Python, SQL and HTML is very powerful
  - Query can be a string generated by your program!
  - Code can be generated based on what is in the database
- PS7 is like PS1:
  - Lots of new tools to learn and code to understand, very little code to write
  - Take advantage of lab hours:
    - Thursday, 7-8:30pm; Friday, 2-3:30pm, Sunday, 4-7pm