Web programming

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Web programming

- Web services vs. "classical" web programming
- Client vs. server programming
  - client: JavaScript, Java
  - HTML-centric vs. program-centric
  - HTML-centric: PHP, ASP
  - cgi, fast-cgi
  - (Java) servlet
- data model: Java servlet, database

Web services vs. web programming

- web services = remote procedure call
  - we saw SOAP
  - structured data (XML)
  - methods and responses
  - generally, for machine consumption
- web programming → generate HTML pages
  - for humans
  - often, database-driven
  - replacement for IBM 3270 terminals ...

Client vs. server programming

- Execute code on client:
  - download Java applet → self-contained programming environment
  - JavaScript (aka ECMAscript):
    - modify and get values from HTML ("document object model" – DOM)
- Execute code on server → generate document
  - state maintenance (HTTP stateless)
    - login, shopping cart, preferences

Taxonomy

	embedded in HTML	separate
server	SSI, ASP, PHP, JSP, CFM	server API (NSAPI), cgi, servlets
client	JavaScript	Java applets, plug-in

Example: JavaScript – cookies

```
var expires = new Date()
var today   = new Date()
function setCookie(name, value, hours) {
  var expire = new Date();
  expire.setTime (expire.getTime() + (1000 * 60 * 60 *
   hours));
  document.cookie = name + "=" + escape(value)
  + ((expire == null) ? "" : ("; expires=" +
   expire.toGMTString()))
}
function unsetCookie(name) {
  var exp = new Date();
  exp.setTime(today.getTime() - 10);
  document.cookie = name + "=" + "; expires=" +
   exp.toGMTString()
}
expires.setTime(today.getTime() + 86400*365)
```

JavaScript – DOM

```
function tz (f,v) {
  var t = -1;
  switch (f[v].value) {
    case "US": t=128; break;
    case "CI": t=0; break;
    case "GH": t=1; break;
  ..
 }
  if (t != -1) {
    f.form.timezone.options[t].selected = true
  }
}
```


Web as RPC

- request = HTTP GET, PUT
- response (result): headers + body
- object identifier ~ URL
- typed data (XML) vs. HTML
- from constant → mostly constant → completely on-demand

Server-side include

- `.shtml` documents (or configured by default for all .html documents)
- include in HMTL/XML comments

```
<!-- #element attribute=value
attribute=value ... -- >
```

- limited scripting: if/else, include, exec, variables
- primarily for conditional inclusion, boilerplate
- security issues: `exec`

SSI example

- Columbia CS home page

```
<html>
  <head><TITLE>Computer Science: Welcome </TITLE>
    <script language=javascript>
      var section = "home";
      var subsection = "home";
      var subsectionID = "-1";
    </script>
  </head>
    <!--#set var="SECTION" value="HOME" -->
    <!--#include file="top.inc" -->
    <!--#include file="home.txt" -->
    </tr> </table>
    <!--#include file="bottom.txt" -->
</html>
```


SSI Example

```
<body>
<h1>SSI Test</h1>
The document was last modified on
<!-- #flastmod file="$DOCUMENT_NAME" →
  and has <!-- #fsize
  file="$DOCUMENT_NAME" -- > bytes.
<h2>Environment</h2>
<!-- #printenv →
</pre>
```


Common gateway interface (cgi)

- Earliest attempt at dynamic web content
- language-independent
- passes HTTP request information via
  - command line (ISINDEX) – rarely used
  - environment variables: system info + query string (GET)
  - request body (POST) → standard input
- return HTML or XML via standard output
- non-parsed headers (NPH) return complete response

cgi arguments

- application/x-www-form-urlencoded format
  - space characters → "+"
  - escape (%xx) reserved characters
  - name=value pairs separated by &
- GET:

```
foo.cgi?name=John+Doe&gender=male&family=5&city=kent
&city=miami&other=abc%0D%0Adef&nickname=J%26D
```

- POST: include in body of message

cgi forms

- single form per submission

```
<form action=scripturi method=GET|POST>
form fields:
  <input type="text" name="text1" size=10
  maxlength=15 value="Initial text">
  <input type="hidden" name="state"
  value="secret">
  <input type=radio name=radio value=WNYC
  checked>
  <input type=radio name=radio value=KQED>
<input type=submit value="Submit">
```


Web state

- State:
  - stateless
  - state completely stored on client
  - state referenced by client, stored on server (most common)
- Mechanisms:
  - hidden form fields
  - URL parameters
  - cookies (HTTP headers)

cgi mechanics

- either called .cgi in HTML directory or stored in cgi-bin
  - in CS, both /home/alice/html/foo.cgi or /home/alice/secure_html/foo.cgi work
- executable (script file)
- runs as nobody or as owning user (~user/mycgi.cgi)
- store secret data off the document tree!

SQL interface

- Most common web model:
  - cgi script (or Java servlet) accesses database
  - database via TCP connection (ODBC, JDBC, script)
- n-tier model:
  - delegate "business logic" to RPC-based server
- XML-based model:
  - generate XML, render via XSLT

Tcl cgi example

```
set env(LD_LIBRARY_PATH) /home/hgs/sun5/lib
load $env(LD_LIBRARY_PATH)/libfbsql.so

lappend auto_path /home/hgs/html/edas3
lappend auto_path /home/hgs/lib
package require cgi
cgi_debug -on
cgi_eval {
   sql connect dbhost.columbia.edu dbuser secret
  cgi_body {
       ...
  }
   sql disconnect
}
```

Tcl cgi

```
cgi_body {
  h1 "Database view"
  set conflist [sql "SELECT
   conference,name,url,logo
   FROM conference WHERE conference=$c"]
  table {
   foreach conf $conflist {
    maplist $conf c name url logo
    table_row {
      td "$name"
      td "$url"
    }
   }
  }
}
```


Python for cgi

- Handles processing cgi variables
- need to generate HTML by print
- but separate object-oriented routines

```
#!/usr/local/bin/python
#!/opt/CUCSpython/bin/python2.2

import os, string, sys
from types import ListType

print "Content-Type: text/html"  # HTML is following
print                            # blank line, EOH
```


cgi python

```
print "<title>Python cgi script</title>"
print "<body>"
print "<h1>Python script</h1>"
print "Before script"
print sys.path
try:
  import cgi
except:
  print "error", sys.exc_info()[0]

# only for Python 2.2!
import cgitb; cgitb.enable()
```


cgi python

```
form = cgi.FieldStorage()
if not (form.has_key("name")):
  print "<form action=pcgi.cgi method=get>"
  print "<input type=text name=name size=10>"
  print "<input type=submit value=Submit>"
  print "</form>"
else:
  print "<p>name:", form["name"].value

print "</body>"
```


SQL interface

- SQL = more-or-less standard retrieval language for databases
- Examples:
  - Oracle
  - Sybase
  - IBM DB/2
  - Microsoft SQL Server
  - mySQL
  - PostgreSQL

SQL architecture

- library interface
  - proprietary
  - JDBC, ODBC
- driver that connects (via TCP) to database
  - same or different host
- issue queries, get results
- modify content
- transactions

SQL basics

- relational database: tables with labeled columns, combined into database
- columns are atomic types:

```
create table person (
  person integer unsigned auto_increment
   primary key,
  name varchar(40),
  state enum ('', 'AK', 'AL', ...),
  biography text,
  verified date,
  index(name)
)
```


SQL basics

- Integer: `tinyint, smallint, mediumint, int(eger), bigint`
- Floating point: `float, double, real`
- Decimal: `decimal(m,d)` (for $)
- Date: `date, datetime, timestamp, time, year`
- String: `char(N), varchar(N), tinyblob, tinytext, blob, text, enum, set`

SQL basics

- Retrieval: `SELECT field1, field2 FROM table WHERE condition ORDER BY expression`
- Insertion: `INSERT table SET field1=value1,field2=value2, ...`
- Update: `UPDATE table SET field1=value1, field2=value2 WHERE expression`
- Delete row: `DELETE FROM table WHERE expression`

SQL basics: joins

- Join two tables that have a common value ("product")
- e.g., `SELECT lastname,city.name FROM person,city WHERE city.zip=person.zip AND lastname='Jones'`

SQL

- Get description of table:

```
$ mysql -h grandcentral -u cs3995 -p
mysql> use grades
mysql> describe students;
+-----------+---------+------+-----+---------+-------+
| Field     | Type    | Null | Key | Default | Extra |
+-----------+---------+------+-----+---------+-------+
| firstname | text    | YES  |     | NULL    |       |
| lastname  | text    | YES  |     | NULL    |       |
| points    | int(11) | YES  |     | NULL    |       |
+-----------+---------+------+-----+---------+-------+
3 rows in set (0.00 sec)
```


SQL Python interface

```
import MySQLdb
import MySQLdb.cursors

try:
  db = connect(host='grandcentral',
      user='cs3995', passwd='cs3995',
      db='grades')
except MySQLdb.Error, e:
  print "Error %d: %s" % (e.args[0], e.args[1])
  sys.exit(1)
c = db.cursor()
c.execute("SELECT ... FROM ...")
results = c.fetchall() # list of tuples
c.close()
```

SQL Python interface

- Results are just tuples, with fields in order of table definition
- can also fetch one row at a time:

```
c.execute("SELECT firstname,lastname FROM
  students ORDER BY lastname")
print "<ul>"
while (1):
  student = c.fetchone()
  if student == None: break
  print "<li>", student, student[0]
print "</ul>"
```


Python SQL – dictionary cursor

- Map rows to dictionary elements instead of list elements:

```
c.close()
c = db.cursor(MySQLdb.cursors.DictCursor)
c.execute("SELECT firstname,lastname FROM
  students")
results = c.fetchall()
for row in results:
  print "%s, %s" % (row["firstname"],
   row["lastname"])
print "%d rows were returned" % c.rowcount
```


Servlet life cycle

- server application loads `ServletClass`
- creates instance via no-args constructor
- servers call servlet's `init()` method
- server calls `service(req, res)` method for each request (often, with class name as URL), possibly concurrently
- servers calls `destroy()` on shutdown

HTTP requests as servlets

- HTTP method GET, PUT, POST, ... → `doGet, doPut, doPost`
- subclass of `HttpServlet` overrides default implementation

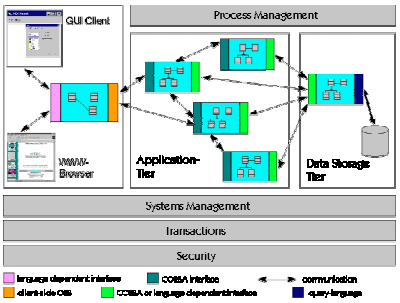
Servlet example

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;
public class HelloClientServlet extends HttpServlet
{
 protected void doGet(HttpServletRequest req, HttpServletResponse res)
    throws ServletException, IOException
    {
        res.setContentType("text/html");
        PrintWriter out = res.getWriter();
        out.println("<HTML><HEAD><TITLE>Hello Client!</TITLE>" +
                "<HEAD><BODY>Hello Client!</BODY><HTML>");
        out.close();
    }
    public String getServletInfo() {
        return "HelloClientServlet 1.0 by Stefan Zeiger";
    }
}
```


2-tier architecture

- "client-server", "fat client"
- e.g., ODBC on client (PC), accessing SQL database
- business logic on PC
- (-) transport data across network
- (-) need applications for each platform
- (-) need to update applications on many desktops

n-tier architecture



n-tier architecture

- client tier:
  - receives user events (keyboard, mouse)
  - presentation of data
  - user interface
  - e.g., Java applets, web browser, thin client application
- application-server tier:
  - "business logic" → actual data processing, algorithms
  - can be component-based (Java Beans)

n-tier architecture

- Data-server tier
  - data storage
  - relational and legacy databases
- all tiers could run on same machine, but usually separated
  - HTTP (or SOAP) from client to server
  - Corba or SOAP or remote-SQL between server tiers
- Advantages:
  - independent of storage model
  - simpler authentication to database