Database-enabled web technology
Session management & Security

Instructor: Çağrı Çöltekin
c.coltekin@rug.nl

Information science/Informatiekunde

Fall 2012/13

Previous weeks

W1: Quick introductions to form processing in PHP & git.
W2: Project initiation. No lectures.
W3: An introduction to HTTP / server side programming & Accessing databases from PHP.

Version Control Systems

A version control system (or, *revision control* or *source control* system) is an indispensable tool in software development.

A VCS,

- Records a history of all changes to all files under VC.
- Allows going back in time: you can go back to any past state recorded in VCS.
- Allows inspecting which change happened when.
- Allows maintaining multiple branches of the same software without multiple copies.
- Allows sandboxing: you can try (experimental) changes without disrupting the 'working copy'.
- Facilitates team work.
- It can also be used for other purposes, for example, web pages, documents ...

VCS: why?

Have you ever,

- End up with file names like `index4.php`, `reportNov21.doc`, `document-old2.txt` ?
- Lost one or more files, and the last backup was too old?
- Have source code with half of it commented out, 'just in case' you may want to use it in the feature?
- Modified (a set of files) and wanted to 'undo' in a day/week/month/year or two?
- Wanted to find out which change introduced that annoying bug?
- Wanted to know how much work has been done by whom and when?
- ... and wanted to develop code with others?

Learning VCS

Isn't it too much hassle to learn and use a VCS for my small crappy program or homework?

No.

SQL and programming

- SQL has limited use unless combined with a general purpose programming language.
- SQL has the advantage that it abstracts away the way data is stored from the application.
- However, it cannot do many things that a typical application program would require. Just to list a few:
  - arbitrary computation
  - flexible I/O, user interaction
  - formatted input output
  - graphical presentation of data
- There are a number of ways to combine SQL and general purpose programming
  - On DB side: stored procedures.
  - On application side: embedded SQL, or call-level interfaces
- We will be using call-level interfaces in this course.

Accessing Databases from PHP

There are multiple ways/libraries to access databases from PHP

- use 'native' functions for the database management system, e.g., `mysql_` or `mysqli_`.
- use an library or abstraction layer, such as Pear MDB2/DB or PDO.

In both cases, you will

- connect to the database,
- run SQL statements on the database, retrieve and use the results
- close the connection.

Database access/use some guidelines

- Prefer a portable library if you do not have any strong reasons against it.
- Independent of the DBMS or library in use, you should always validate the user input.
- Check for errors. Do not assume the database connection to be fault free, and do not assume the database state to be exactly how you expect it to be.
- Use `prepare()`/`execute()` style of query processing.

Pear DB: a first example

```php
<?php
    require_once('DB.php');
    require_once('db-config.php');
    $dbh = DB::connect("mysql://$user:$pass@$host/$db");

    $qh = $dbh->query('select * from book');

    echo "<table border=\"1\">";
    echo "<tr><th>ISBN</th><th>title</th></tr>";
    while ($row = $qh->fetchRow(DB_FETCHMODE_ASSOC)) {
        echo "<tr><td>${row['ISBN']}</td>";
        echo "<td>${row['title']}</td></tr>";
    }
    echo "</table>";
    $dbh->disconnect();
?>
```


Same example, using PDO

```php
<?php
    require_once('db-config.php');
    $dbh = new PDO("mysql:dbname=$db;host=$host", $user, $pass);

    $qh = $dbh->prepare('select * from book where title like ?');
    $qh->execute(array('%database%'));

    echo "<table border=\"1\">";
    echo "<tr><th>ISBN</th><th>title</th></tr>";
    while ($row = $qh->fetch(PDO::FETCH_ASSOC)) {
        echo "<tr><td>${row['ISBN']}</td>";
        echo "<td>${row['title']}</td></tr>";
    }
    echo "</table>";
    $dbh = null;
?>
```


Abouth homeworks

- Please do check for PHP errors/warnings. You may want to add

  ```
  error_reporting(-1);
  ini_set("display_errors", 1);
  ```

  to the top of your PHP script.
- Use git, do not be afraid to experiment.

Today...

- Revisiting cookies.
- Session management.
- Some bits of security: ...

HTTP Cookies

- A cookie is a piece of information a HTTP server asks the client to retain until a specific expiry date/time.
- Cookies are passed in the HTTP header field (as opposed to GET data in URL, or POST data in content).

The server sends a cookie (in HTTP headers) to a client using,

```
Set-Cookie: name=val; expires=datetime; domain=d; path=p
```

There may be additional options, e.g., `Secure` or `HttpOnly`.
The client sends the matching cookie back in every request if,

- the domain and path matches
- the cookie is not expired

```
Cookie: name=val; name=val; name=val; ...
```


Cookies: domain

- Server can set the `domain` of the cookie, by default the domain is the full domain name of the server.
- Client sends back a cookie, only if domain matches.
- If the web server runs on `www.let.rug.nl`, then all cookies for `www.let.rug.nl`, `let.rug.nl` and `rug.nl` will be sent by the client to the server.
- A server is allowed to set cookie domain for its higher level domains (except the top-level domains).
- Cookies for top-level domains, e.g., `.nl`, `.edu`, `.net`, are ignored by the browsers.
- Cross-domain cookies are also discarded by the clients. The server with domain name `www.let.rug.nl` cannot set a cookie for `example.com`.

Cookies: path

- Similar to the `domain`, server can also specify a `path` attribute for a cookie.
- A client sends a cookie if the `path` it requests is a sub-path of the cookie's `path` attribute.
- If path is `/myapp/` then client will sent the cookie back only if it requests `/myapp/` or a sub-path, e.g., `/myapp/login.php`.
- If the cookie path attribute is `/`, then it is sent for all paths in the domain.

Cookies: expiry

- The client retains the cookie until the `expiry` date/time specified during its creation.
- If unspecified, or the value is `0`, the cookie is kept until the browser terminates.
- The server cannot delete a cookie, but it can (re)set the cookie with an expiry time in the past. This will cause the client to delete the cookie.
- Note that the clocks of server and client may not be in sync.

Cookies: options

Besides the `name`, `value` and the standard options `expiry`, `path` and `domain`, there are a number of additional options.

- If `Secure` options is specified, the client sends the cookie back only if the connection is secure (HTTPS).
- If `HttpOnly` options is specified, the client does not allow client-side programs (e.g., JavaScript) to access the cookie. Otherwise, the client side programs have access to the cookies in the browser.

Working with cookies in PHP

- You can set cookies with function `setcookie()`. For example `setcookie($name, $val, $exp, $path, $domain, $secure, $httponly)` where, except `$name` all arguments are optional.
- You have to set the cookies before sending any content (remember: they are part of the HTTP headers, not the content).
- Received cookies are stored in the global associative array `$_COOKIE`
- Assuming you have a cookie with name `user`, you can access it using `$_COOKIE['user']`.
- Cookies are also present in the combined associative array `$_REQUEST`

PHP and cookies

```
1  <?php
2      if (!isset($_COOKIE['MyCookie'])) {
3          setcookie('MyCookie',
4                    'some value',
5                    time()+3600*24*7);
6      }
7  ?>
8  <html>
9  <!--- ... some html stuff -->
10
11 <?php
12     if (!isset($_COOKIE['MyCookie'])) {
13         echo "You do not have the cookie yet.";
14     } else {
15         echo "MyCookie = ${_COOKIE['MyCookie']}";
16     }
17 ?>
```


Need for session management

A simple interactive/desktop application

1. process starts
2. displays some output
3. receives some input from the user
4. process ends

A simple web application

1. process starts
2. (possibly) receives some input from the user
3. displays some output
4. process ends

Server-side programming: difficulties

A server-side web application,

- cannot use ordinary (global) variables that spans throughout the application lifetime.
- has to identify and cope with multiple runs of the same application,
- cannot assume that input provided on the next run is provided by the same source that started the application.

Session management provides a way to solve these problems.

What is in a session?

A session consist of two components:

1. A unique session ID passed back-and-forth between client and the server. This makes sure that the server side identifies the client and resumes the session where it was left in the previous step. The session ID can be communicated using:
   - Cookies.
   - 'Hidden' form fields, which passed with GET or POST data.
2. A server side storage for session data, for variables that persist throughout session lifetime. The information is typically stored in local files, but can be changed (e.g., use a database for storing session information).

Why not pass all the information back-and-forth like the session ID?

PHP sessions: introduction

- The session is initiated using he function `session_start()`.
- If using cookies for sessions, `session_start()` should be used before any output.
- PHP sessions can use cookies (preferable for most purposes) or GET/POST methods.
- The session information is available through the super global array `$_SESSION`: values of the members of `$_SESSION` persists throughout the session.
- The data is stored in files by default, but other 'handlers' are available, and new handlers can be created by the user.
- Name of the default session ID (cookie or the name of the html form field) is `PHPSESSID`, but can be customized.

PHP sessions: an example

```
1  <?php session_start(); ?>
2  <html> <body>
3  <?php
4      if (!isset($_SESSION['page_seq'])) {
5          $_SESSION['page_seq'] = 0;
6      } else {
7          $_SESSION['page_seq'] += 1;
8      }
9      echo "You are on page ${_SESSION['page_seq']}.";
10 ?>
11
12 </body></html>
```

PHP: starting a session

- `session_start()` starts a session if it is not already started. It will typically send a cookie with default name `PHPSESSID`.
- The default session name can be changed using PHP configuration for the site, or using `session_name()`.
- Cookie parameters, `lifetime`, `path`, `domain`, `secure`, and `httponly` can also be set using `session_set_cookie_params()`.
- Some other session configuration parameters can be configured through `ini_set()` function. A few parameters of interest are (see PHP session manual for more):
  - `session.use_cookies`
  - `session.use_only_cookies`
- Session related parameters must be set before calling `session_start()`.

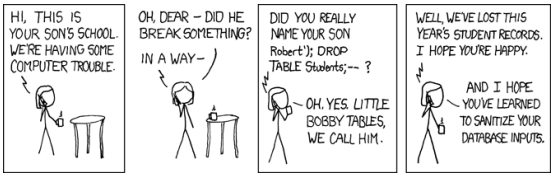
PHP: using session variables

- Session variables are stored in global array `$_SESSION`.
- The members of the `$_SESSION` persists until session is destroyed, by `session_destroy()` or in case the session is expired.
- Session cookie (on the browser side) will by default live until the browser is closed, otherwise it is controlled by `lifetime` of the session cookie.
- `session_name()` (without parameters) returns the name of the session, and `session_id()` returns the session ID.
- Session ID can be changed anytime using `session_regenerate_id()`. It is a good idea to change the session ID at least at every security context change (we will return to this in discussion of security).

Where is my session data?

- PHP keeps your session data, by default, in files in a system-wide directory.
- You can switch to an existing handler, e.g., for sqlite, using PHP configuration variable `session.save_handler`.
- You can write your own handlers, e.g., to keep your session information in MySQL or in memory, using `session_set_save_handler()` You need to specify handlers for: `open`, `close`, `write`, `read`, `destroy`, `garbage collection`.
- This may, for example, allow you to maintain sessions on a load-balanced web server environment.
- Writing your own session handlers may also help you have more control over your sessions.

Web, Databases & Security



http://xkcd.com/327/

Secure coding: why?

An application developed and set up without attention to security, may

- allow unauthorized use of the application,
- provide unauthorized access to a complete system, potentially causing other applications to be compromised,
- leak sensitive information (e.g., passwords, credit card numbers),
- do unintended work for others (typically with malicious intent).

A few guidelines (before we start)

- Always check user input before using (e.g., in an SQL query).
- Do not store and transfer sensitive information unencrypted.
- Do not store or transfer sensitive information if you can avoid it.
- Sanitize your output (e.g., properly escape special characters if you are outputting HTML).
- Try to implement multiple levels/layers of security.

Sessions and Security

Badly implemented session management systems may allow unauthorized access to data/application. Typically,

- An easy to guess session ID may be found by brute-force trial & error.
- An attacker may obtain the session ID by sniffing the network traffic.
- An attacker may steal the session ID/key physically.
- An attacker may trick someone to use a URL (e.g., sent via email), causing a particular session ID to be used (session fixation).

Some guidelines for session security

- Change your session ID frequently, particularly after every authorization level change (e.g., successful login). `session_regenerate_id()` is your friend.
- Avoid using GET, for passing session ID, use cookies when available.
- Use HTTPS, secure cookies if available.
- Timeout your sessions.
- In some cases, you may also consider checking the client IP, or the referrer string.

Summary & Next week

This week:

- Cookies & sessions.
- Security, particularly related to sessions.

Next week:

- More on security.