ĐẠI HỌC BÁCH KHOA HÀ NỘI
VIỆN CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG

Chapter 6.2.
MySQL & PHP Advanced

Content

1. SQL Injection
2. PEAR DB Basics
3. Advanced Database Techniques

Database queries with PHP

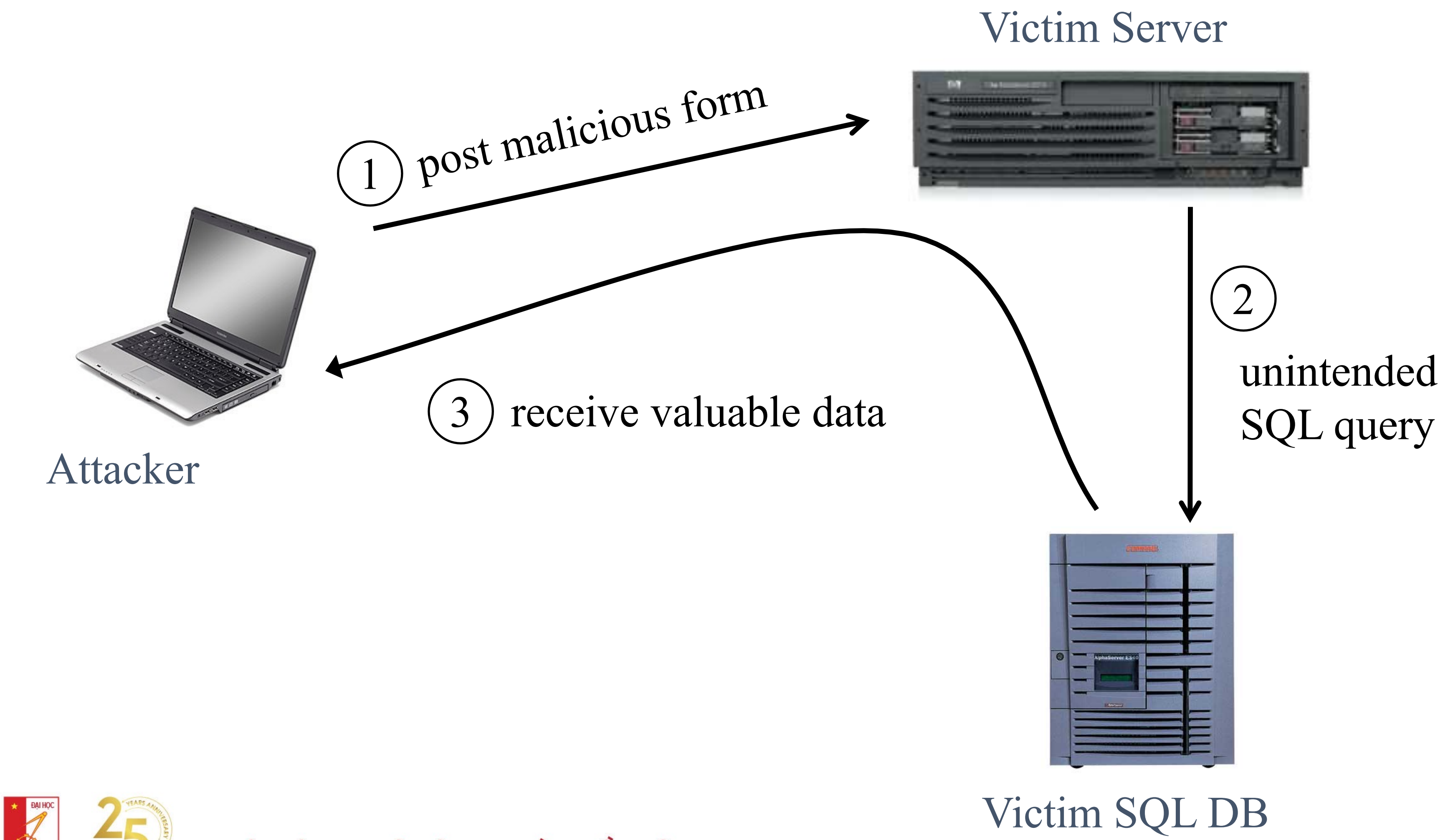
(the wrong way)

- Sample PHP

```
$recipient = $_POST[‘recipient’];
$sql = "SELECT PersonID  FROM People WHERE
            Username='$recipient' ";
$rs = $db->executeQuery($sql);
```

- Problem:
  - Untrusted user input ‘recipient’ is embedded directly into SQL command

Basic picture: SQL Injection

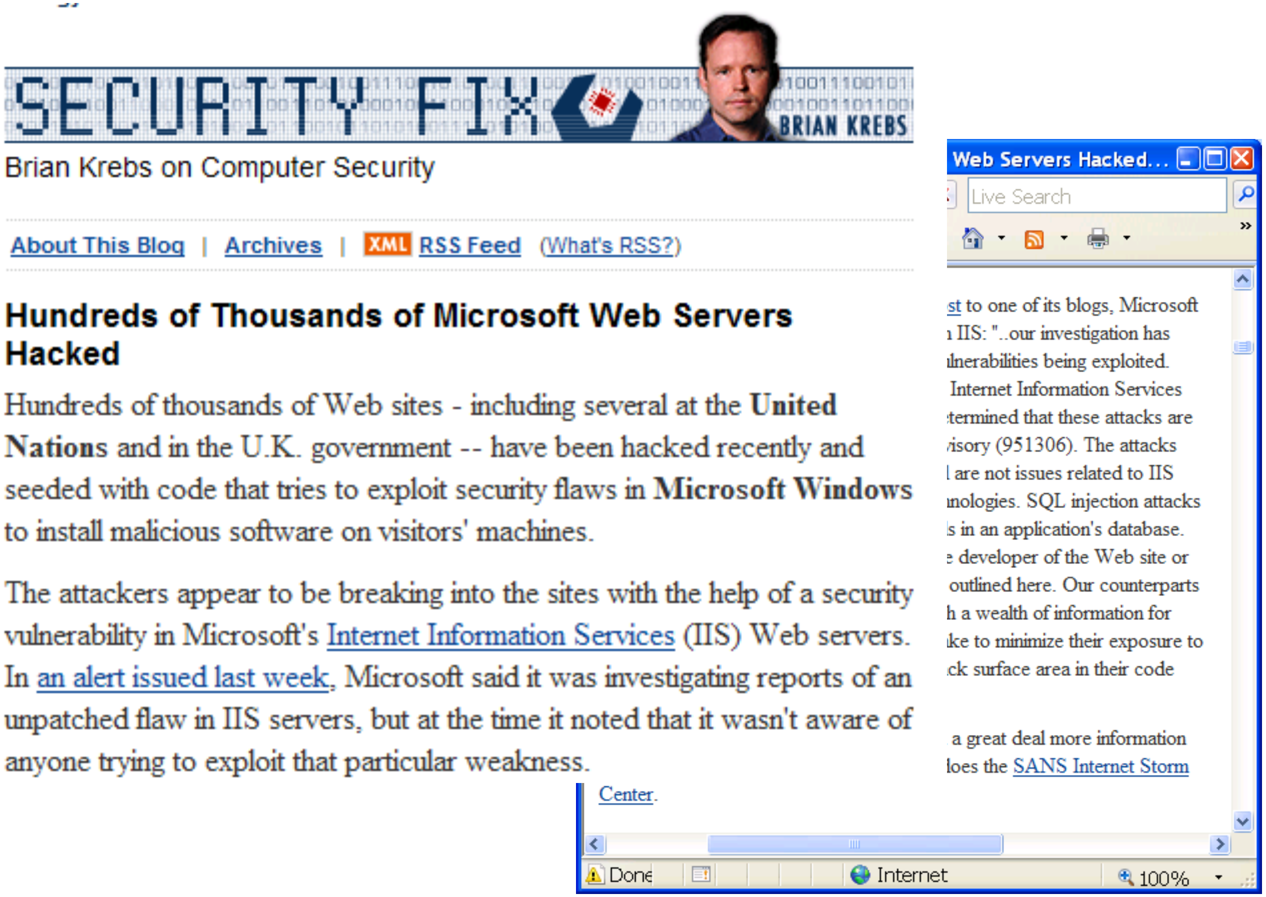


CardSystems Attack

- CardSystems
  - credit card payment processing company
  - SQL injection attack in June 2005
  - put out of business

- The Attack
  - 263,000 credit card #s stolen from database
  - credit card #s stored unencrypted
  - 43 million credit card #s exposed

April 2008 SQL Vulnerabilities



SECURITY FIX

BRIAN KREBS

Brian Krebs on Computer Security

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Hundreds of Thousands of Microsoft Web Servers Hacked

Hundreds of thousands of Web sites - including several at the **United Nations** and in the U.K. government -- have been hacked recently and seeded with code that tries to exploit security flaws in **Microsoft Windows** to install malicious software on visitors' machines.

The attackers appear to be breaking into the sites with the help of a security vulnerability in Microsoft's Internet Information Services (IIS) Web servers. In an alert issued last week, Microsoft said it was investigating reports of an unpatched flaw in IIS servers, but at the time it noted that it wasn't aware of anyone trying to exploit that particular weakness.

st to one of its blogs, Microsoft
ı IIS: "..our investigation has
ılnerabilities being exploited.
Internet Information Services
termined that these attacks are
isory (951306). The attacks
l are not issues related to IIS
ınologies. SQL injection attacks
s in an application's database.
e developer of the Web site or
outlined here. Our counterparts
h a wealth of information for
ıke to minimize their exposure to
ck surface area in their code

a great deal more information
loes the SANS Internet Storm
Center.

Main steps in this attack

- Use Google to find sites using a particular ASP style vulnerable to SQL injection
- Use SQL injection on these sites to modify the page to include a link to a Chinese site nihaor1.com

  (Don't visit that site yourself!)

- The site (nihaorr1.com) serves Javascript that exploits vulnerabilities in IE, RealPlayer, QQ Instant Messenger

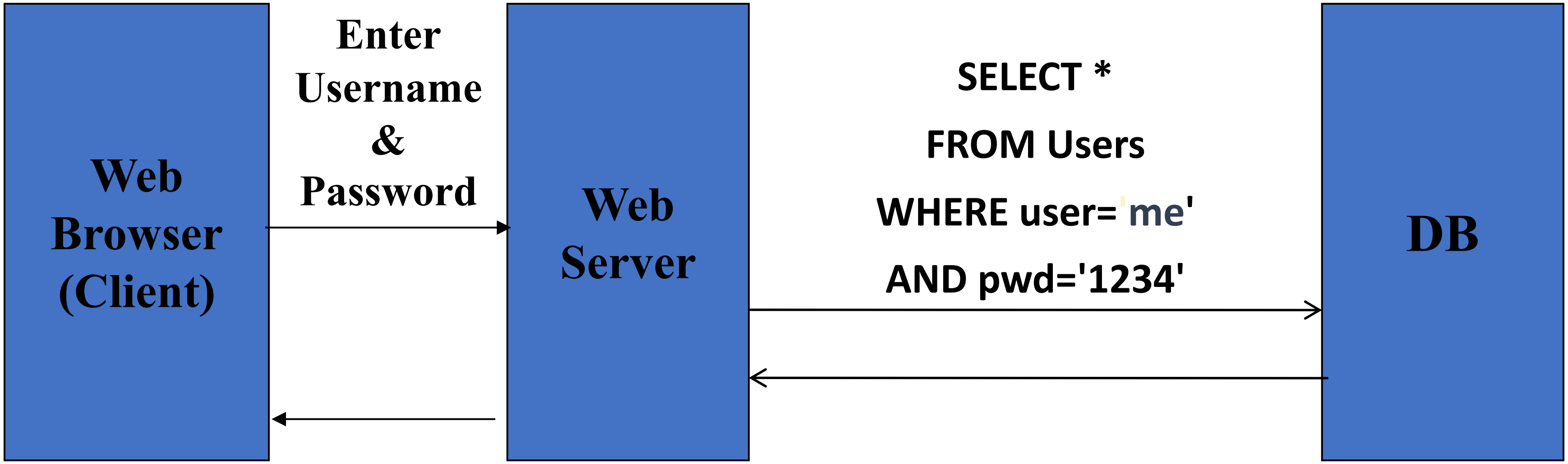
Steps (1) and (2) are automated in a tool that can be configured to inject whatever you like into vulnerable sites

Example: buggy login page (ASP)

```
set ok = execute( "SELECT * FROM Users
     WHERE user=' "  &  form(“user”)  & "
  '
     AND   pwd=' " & form(“pwd”) & “ '” );

if not ok.EOF
      login success
else  fail;
```

Is this exploitable?

Normal Query



Bad input

- Suppose user = “ `'or 1=1 --` ” (URL encoded)

- Then scripts does:

```
ok = execute( SELECT …
          WHERE user= ' ' or 1=1  -- … )
```

  - The “`--`” causes rest of line to be ignored.
  - Now ok.EOF is always false and login succeeds.

- The bad news: easy login to many sites this way.

Even worse

- Suppose user =

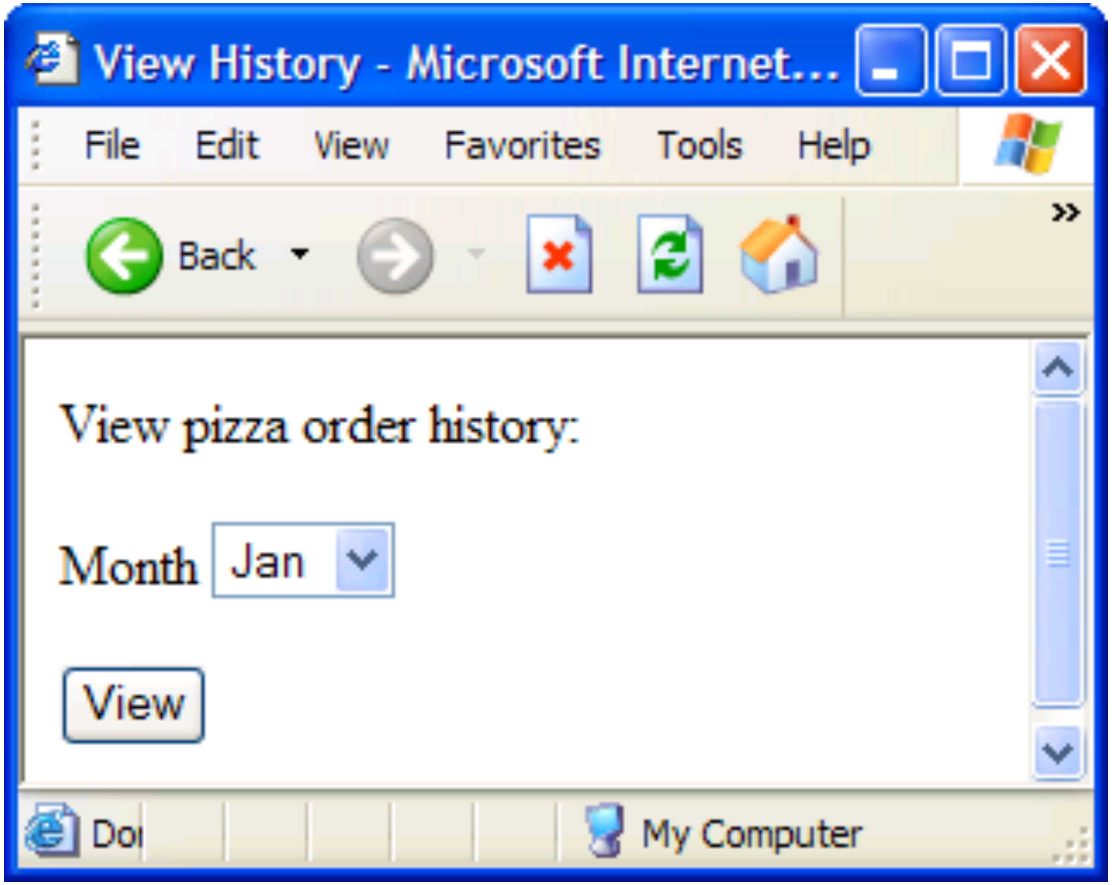
  “ **' ; DROP TABLE Users --** ”

- Then script does:

```
ok = execute( SELECT …
    WHERE user= ' ' ; DROP TABLE Users   …
  )
```

- Deletes user table
  - Similarly: attacker can add users, reset pwds, etc.

Getting private info



View History - Microsoft Internet...
File Edit View Favorites Tools Help
Back
Do
My Computer

View pizza order history:

Month Jan

View

Getting private info

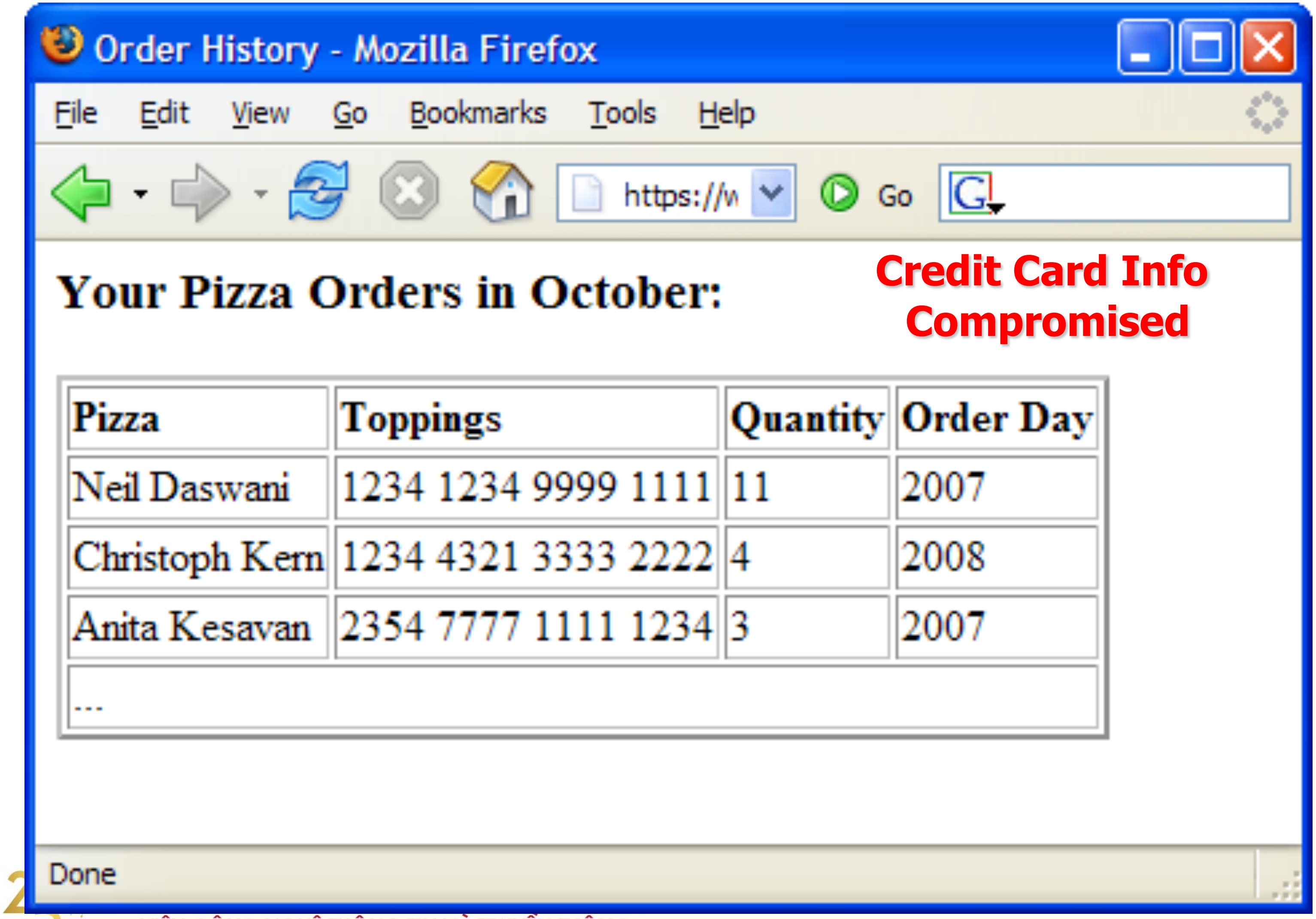
SQL Query

```
"SELECT pizza, toppings, quantity, date
  FROM orders
  WHERE userid=" . $userid .
"AND order_month="  . _GET['month']
```

What if:

```
month = "
      0 AND 1=0
      UNION SELECT   name,  CC_num,  exp_mon,  exp_year
      FROM  creditcards   "
```

Results


Order History - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
https://w
Go
Done

Your Pizza Orders in October:

Pizza	Toppings	Quantity	Order Day
Neil Daswani	1234 1234 9999 1111	11	2007
Christoph Kern	1234 4321 3333 2222	4	2008
Anita Kesavan	2354 7777 1111 1234	3	2007
...			

Credit Card Info Compromised

Preventing SQL Injection

- Never build SQL commands yourself!
  - Using mysql_real_escape_string(): Escapes special characters in a string for use in a SQL statement
  - Use parameterized/prepared SQL
  - Use ORM (Object Relational Mapper) framework.

Parameterized/prepared SQL

- Builds SQL queries by properly escaping args: ′ → \′

- Example: Parameterized SQL: (ASP.NET 1.1)
  - Ensures SQL arguments are properly escaped.

```
SqlCommand cmd = new SqlCommand(
    "SELECT * FROM UserTable WHERE
    username = @User AND
    password = @Pwd", dbConnection);

cmd.Parameters.Add("@User", Request[“user”] );

cmd.Parameters.Add("@Pwd", Request[“pwd”] );

cmd.ExecuteReader();
```

Parameterized/prepared SQL in PHP – using **mysqli**

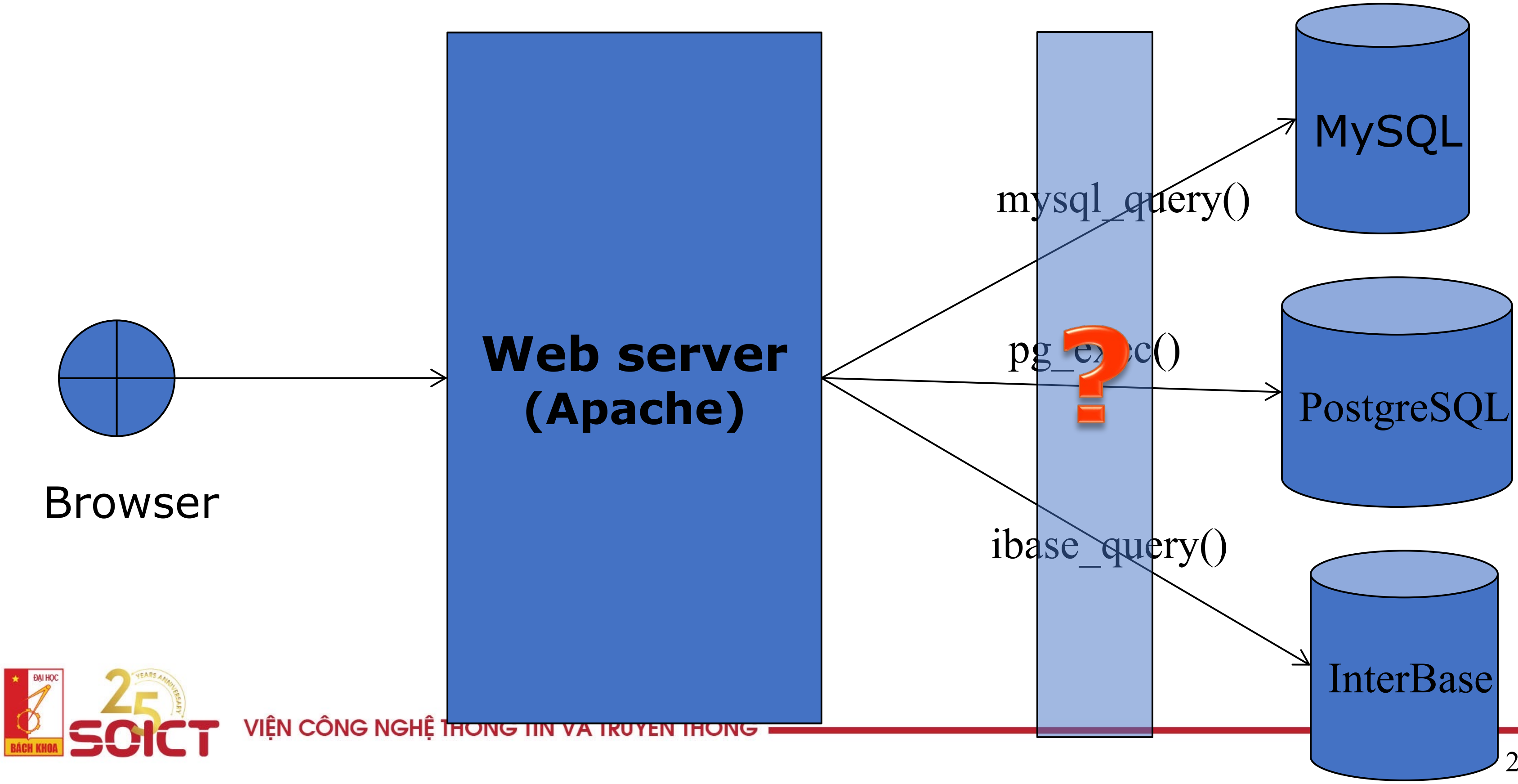
```
  <?php

 $mysqli = new mysqli("localhost", "me", “mypass", "wor
 ld");
  if (mysqli_connect_errno()) {
     printf("Connect failed: %s\n", mysqli_connect_erro
 r());

      exit();
  }

  $city = "Amersfoort";
  $stmt =  $mysqli->stmt_init();
  if ($stmt-
 >prepare("SELECT District FROM City WHERE Name=?")){
     $stmt->bind_param("s", $city);
     $stmt->execute();
     $stmt->bind_result($district);
     $stmt->fetch();
     printf("%s is in district %s\n", $city, $district)
 ;
```

Content

1. SQL Injection
2. PEAR DB Basics
3. Advanced Database Techniques

2.1. Different database engines – Issue in PHP

- no general-purpose database access interface
- separate sets of functions for each database system



2.1. Different database engines - Solutions

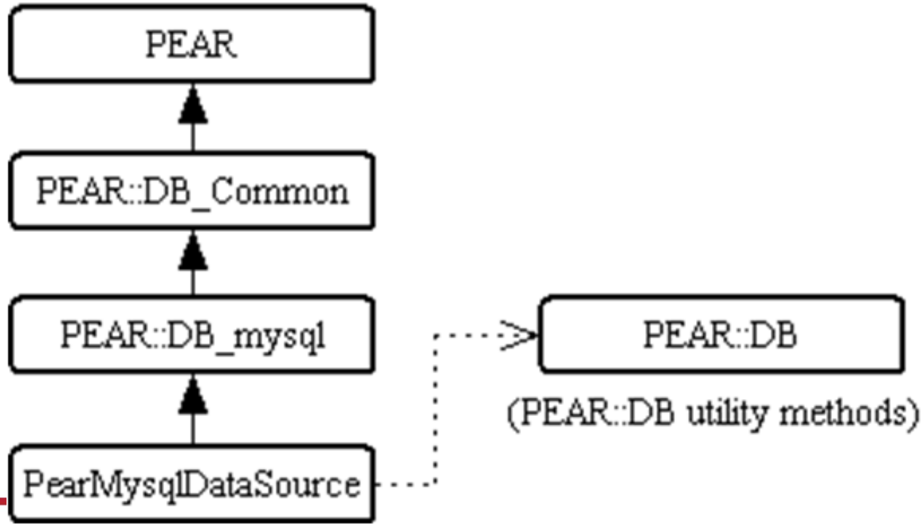
- Provide a DB common mechanism to connect and manipulate to **any** database
- Some popular modules/libraries/extensions/APIs:
    - PDO (PHP Data Object)
        - provides a *data-access* abstraction layer
    - PEAR (the PHP Extension and Add-on Repository)
        - provides an abstract interface that hides database-specific details and thus is the same for all databases supported by PEAR DB
    - PHP Database ODBC
        - an API that allows you to connect to a data source
        - ODBC connection must be available

2.2. PEAR DB Overview

(From PHP4 and up)

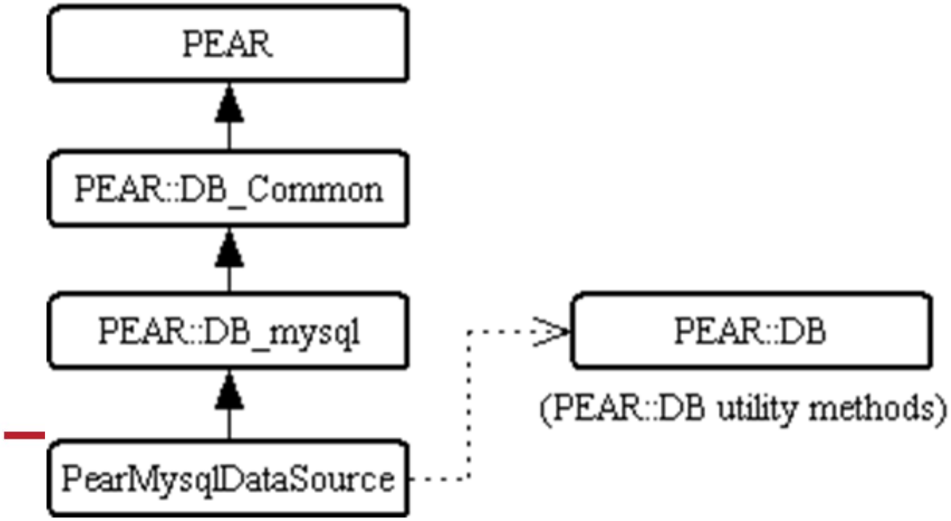
- Two-level architecture:
  - **The top level:** provides **an abstract interface** that hides database-specific details and thus is the same for all databases supported by PEAR DB.
  - **The lower level:** consists of **individual drivers**, each driver supports a particular database engine and translates between the abstract interface seen by script writers and the database-specific interface required by the engine.

Pear::DB Integration Overview



2.2. PEAR DB Overview

- 2 files used for all database engines
  - *DB.php*: Implements the DB class that creates database connection objects, and also contains some utility routines.
  - *DB/common.php* implements the DB_common class that forms the basis for database access.
- 1 file chosen on an engine-specific basis:
  - *DB/driver.php (E.g. DB/mysql.php):* Contains the driver for the database you're using. It implements DB_*driver* class that inherits DB_common class



2.3. Writing PEAR DB Scripts - Steps

- Reference the *DB.php* file to gain access to the PEAR DB module.
- Connect to the MySQL server by calling connect() to obtain a connection object.
- Use the connection object to issue SQL statements and obtain result objects
- Use the result objects to retrieve information returned by the statements.
- Disconnect from the server when the connection object is no longer needed.

2.3.1. Referencing the PEAR DB Source

- Before using any PEAR DB calls, your script must pull in the *DB.php* file

```
    require_once "DB.php";
```

2.3.2. Connecting to the MySQL Server

- DSN (Data Source Name)
  - Contains connection parameters
  - URL-style includes the database driver, hostname, user name and password for your MySQL account, and the database name.
  - Typical syntax:

```
mysqli://user_name:password@host_name/db_name
```

  - E.g.:

```
$dsn =
  "mysqli://testuser:testpass@localhost/test";
$conn = DB::connect ($dsn);
if (DB::isError ($conn))
   die ("Cannot connect: ".$conn-
  >getMessage()."\n");
```

Specifying connections parameters in a separate file

- Create a file *testdb_params.php*

```
<?php
   # parameters for connecting to the "test" database
   $driver = "mysqli";
   $user = "testuser"; $password = "testpass";
   $host = "localhost"; $db = "test";
   # DSN constructed from parameters
   $dsn = "$driver://$user:$password@$host/$db";
?>
```

- Include the file into your main script and use the $dsn variable

```
require_once "testdb_params.php";
$conn = DB::connect ($dsn);
if (DB::isError ($conn)) …
```

2.3.3. Issuing statements

- **`$stmt = "`*`some SQL statement`*`";`**
- **`$result = $conn->query ($stmt);`**
  - If an error occurs, **`DB::isError($result)`** will be true.
  - If the statement is INSERT or UPDATE, **`$result`** will be **`DB_OK`** for success.
  - If the statement is SELECT, **`$result`** is a result set object.

2.3.4. Retrieving result information

- Statements That Return **No** Result Set
  - Using **`$conn->affectedRows()`** to get no of rows the statement changed.
- Statements That Return **a** Result Set
  - Using **`$result->fetchRow()`** to get a row from result set. Result is an array including all cells in that row.
  - Using index to retrieve an element (cell) of the array of a specific row.
  - Using **`$result->free()`** to dispose **`$result`**
  - Using **`$result->tableInfo()`** to get detailed information on the type and flags of fields
    - **`$info = $result->tableInfo();`**

Issuing Statements That Return No Result Set

-
  ```
  CREATE TABLE animal (
             name CHAR(40),
             category CHAR(40))
  ```

-
  ```
  $result = $conn->query(
             "INSERT INTO animal (name, category)
                   VALUES ('snake', 'reptile'),
                           ('frog', 'amphibian'),
                           ('tuna', 'fish'),
                           ('racoon', 'mammal')");
   if (DB::isError ($result))
       die ("INSERT failed: ".$result->getMessage());
   printf("\nNumber of rows inserted: %d\n",
                         $conn->affectedRows());
  ```

Issuing Statements That Return a Result Set

```
$result = $conn->query (
      "SELECT name, category FROM animal");
if (DB::isError ($result))
  die("SELECT failed: ".$result->getMessage());


printf ("Result set contains %d rows and %d
  columns\n",
          $result->numRows(), $result->numCols());
while ($row = $result->fetchRow())
  printf ("%s, %s\n", $row[0], $row[1]);
$result->free();
```

Issuing Statements That Return a Result Set – Other ways

- Optional argument for **`fetchRow()`** indicating what type of value to return
  - **`DB_FETCHMODE_ORDERED`** : refer to array elements by numeric indices beginning at 0.
  - **`DB_FETCHMODE_ASSOC`**: refer to array elements by column name
  - **`DB_FETCHMODE_OBJECT`**: access column values as object properties
- Setting fetching mode only one time:
  - **`$conn->setFetchMode(DB_FETCHMODE_ASSOC);`**

Example

-
  ```
  while ($row = $result->fetchRow
  (DB_FETCHMODE_ASSOC))
      printf ("%s,
  %s\n",$row["name"],$row["category"]);
  ```

-
  ```
  while ($obj = $result->fetchRow
  (DB_FETCHMODE_OBJECT))
      printf ("%s, %s\n", $obj->name, $obj->category);
  ```

-
  ```
  $conn->setFetchMode (DB_FETCHMODE_ASSOC);
  $result = $conn->query ($stmt1);
  while ($row = $result->fetchRow ()) ...
  ...
  $result = $conn->query ($stmt2);
  while ($row = $result->fetchRow ()) ...
  ...
  ```

2.3.5. Disconnecting from the Server

- Close the connection when you're done using the connection:
  - `$conn->disconnect ();`

Content

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3.1. Placeholders

- PEAR DB can build a query by inserting values into a template
- Syntax:
  - `$result = $conn->query(SQL, values);`
- E.g.

```
...
$books = array(array('Foundation', 1951),
                    array('Second Foundation', 1953),
                    array('Foundation and Empire',
  1952));
foreach ($books as $book) {
      $conn->query('INSERT INTO books
  (title,pub_year)
                      VALUES (?,?)', $book);
} ...
```

3.1. Placeholders (2)

- Three characters as placeholder values
  - ?: A string or number, which will be quoted if necessary (recommended)
  - |: A string or number, which will never be quoted
  - &: Requires an existing filename, the contents of which will be included in the statement (e.g., for storing an image file in a BLOB field)

3.2. Prepare/Execute

- Using the **`prepare()`**, **`execute()`**, and **`executeMultiple()`** methods
  - **`$compiled = $db->prepare(SQL);`**

    (SQL using placeholders)
  - **`$response =`**

    `$db->execute(`*`compiled, value`*`);`
  - **`$responses =`**

    `$db->executeMultiple(`*`compileds, values`*`);`

    (takes a two-dimensional array of values)

Example - Prepare/Execute

-
  ```
  $books = array(array('Foundation', 1951),
              array('Second Foundation', 1953),
              array('Foundation and Empire', 1952));
  $compiled = $db->prepare('INSERT INTO
                 books (title,pub_year) VALUES (?,?)');
  foreach ($books as $book) {
              $db->execute($compiled, $book);
  }
  ```

-
  ```
  $books = array(array('Foundation', 1951),
                 array('Second Foundation', 1953),
                   array('Foundation and Empire', 1952));
  $compiled = $db->prepare('INSERT INTO
                   books (title,pub_year) VALUES (?,?)');
  $db->executeMultiple($compiled, $books);
  ```

3.3. Sequences

- PEAR DB sequences are an alternative to database-specific ID assignment (for instance, MySQL's AUTO_INCREMENT).
- Create/drop a sequence
  - `$res = $db->createSequence(sequence);`
  - `$res = $db->dropSequence(sequence);`
- The nextID( ) method returns the next ID for the given sequence:
  - `$id = $db->nextID(sequence);`

3.3. Sequences (2) - Example

```
$res = $db->createSequence('books');
if (DB::isError ($result))
  die("SELECT failed: ".$result->getMessage());

$books = array(array('Foundation', 1951),
          array('Second Foundation', 1953),
          array('Foundation and Empire', 1952));
foreach ($books as $book) {
  $id = $db->nextID('books');
  array_splice($book, 0, 0, $id);
  $db->query('INSERT INTO
                  books(bookid,title,pub_year)
               VALUES (?,?,?)', $book);
```

3.4. Shortcuts

- PEAR DB provides a number of methods that perform a query and fetch the results in one step, allowing placeholders
  - **`getOne(SQL [,values])`**: fetches the first column of the first row of data
  - **`getRow(SQL [,values]])`**: returns the first row of data
  - **`getCol(SQL [,column[,values]])`**: returns a single column from the data
  - **`getAssoc()`**: returns an associative array of the entire result set then frees the result set.
  - **`getAll(SQL [,values[,fetchmode]])`**: returns an array of all the rows

Example - Shortcuts

-
  ```
  $when = $conn->getOne(
                 "SELECT avg(pub_year) FROM
      books");
    if (DB::isError($when)) {
       die($when->getMessage());
    }
    echo "The average book in the library was
                                  published in $when";
  ```
-
  ```
  list($title, $author) = $db->getRow(
        "SELECT books.title,authors.name
         FROM books, authors
         WHERE books.pub_year=1950
              AND books.authorid=authors.authorid");
   echo "($title, written by $author)";
  ```

3.5. Metadata

- Using **`getListOf(something)`** to get information on available databases, users, views, and functions
  - something can be "**`databases`**", "**`users`**", "**`views`**", "**`functions`**".
  - E.g. $data = $conn ->getListOf("*databases*");
    - list of available databases

3.6. Transactions

- Using **`$conn->autoCommit(false)`** to set autocommit
  - Autocommit default is true
- Using **`$conn->commit()`** to commit the current transaction.
- Using **`$conn->rollback()`** to rollback the current transaction.

Example - Transactions

```
$conn->autoCommit(false);

$conn->query('CREATE TABLE blah (a integer)');

$conn->query('CREATE TABLE blue (b integer)');

$conn->commit();

$conn->query('INSERT INTO blah (a) VALUES (11)');

$conn->query('INSERT INTO blah (a) VALUES (12)');

$res = $db->query('SELECT b FROM blue');

if (DB::isError($res)) {
     echo $res->getMessage()."\n";

}

while ($res->fetchInto($row, DB_FETCHMODE_ORDERED)) {
     if ($row[0] == 12) {
          $conn->rollback();
     }

}

$res->free()

$conn->query('DROP TABLE blah');

$conn->query('DROP TABLE blue');

$conn->commit();
```

Question?