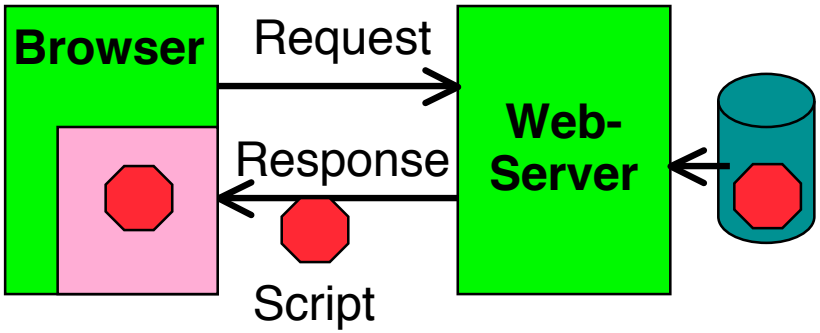
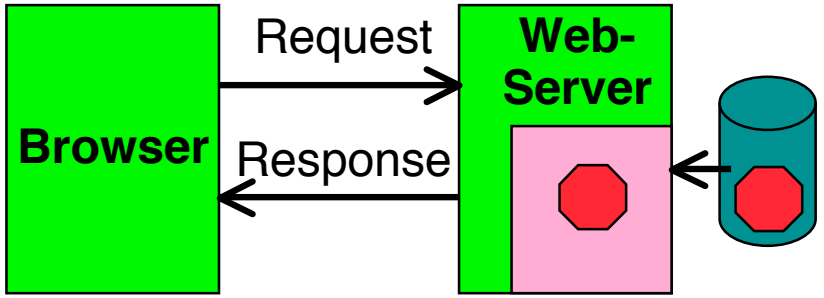
Chapter 3: Interactive Web Applications

Dynamic Web Contents

- Contents shown to user in browser is dependent on some external variables
- Example of external variables:
  - Date and time
  - Contents of an information archive (e.g. recent news)
  - Actions of the user
    - » Pointing to elements
    - » Clicking at a certain position
    - » Filling out forms
- Wide-spread applications:
  - E-Commerce
  - Interpersonal communication media (forums, discussion boards)
  - Mass media (news and other information services)

Server-Side vs. Client-Side Realisation

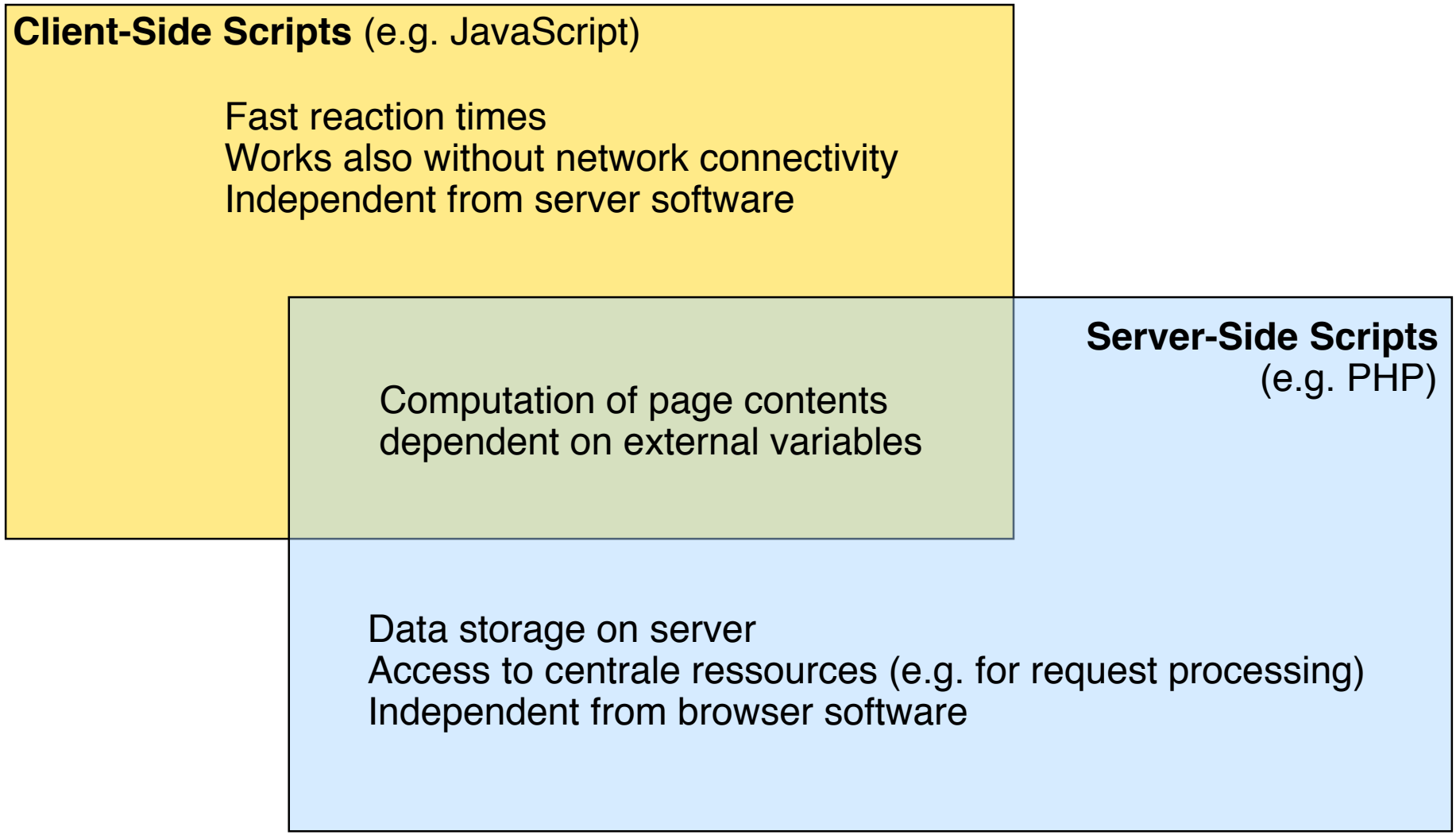




- Client-side realisation:
  - Browser contains execution engine for scripts
  - Web server does not need to execute scripts
  - Script ist sent to client as part of server response
  - Example: JavaScript

- Server-side realisation:
  - Web server contains execution engine for scripts
  - Web server does not need to execute scripts
  - Script is executed on server and computes response to client
  - Example: PHP

Server Scripts vs. Client Scripts



Common Gateway Interface (CGI)

- A request can identify an executable command on the server
  - Command is executed
  - Parameters are passed to it via environment variables (e.g. QUERY_STRING)
- Informal standard, by a developer community in 1993
  - Current standard (1.1) is documented at NCSA (http://hoohoo.ncsa.illinois.edu/cgi/)
  - IETF RFC 3875
- CGI programs can be written in any language that allows it to be executed on the system:
  - Programming languages (e.g. C/C++, Java)
  - Scripting languages (e.g. Unix shells, Perl, TCL)
- Typical locations on server file system:
  - **`/cgi-bin`**
  - **`/cgi-src`**

Principles of Writing CGI Code

- Passing parameters to the CGI program:

  `http://www.example.com/cgi-bin/example.cgi?paraminfo`

  – Program example.cgi is executed

  – String “paraminfo” is made accessible for the program in the environment variable QUERYSTRING

- Passing information to the browser:

  – The CGI program has to write the data in a form displayable by the browser

  – Always the first line is a MIME type specification, e.g.:

```
Content-type: text/html
```

- Example for a very simple CGI program:

```
#!/bin/sh
echo "Content-Type: text/plain"
echo ""
echo "Hello, world."
```

Drawbacks of CGI

- High danger of security problems:
  - Injection of malicious script code (through program errors)
- Calling a CGI command is expensive:
  - Creating a new process (in Unix)
  - Sometimes on demand compilation
  - Generally not suitable to high load situations

- Alternatives to CGI:
  - SCGI (Simple CGI)
  - FastCGI (single persistent process to handle queries)
  - WSGI (Web Server Gateway Interface) for Python
  - Microsoft Internet Server Application Programming Interface (IISAPI)
  - Server modules
    - » E.g. script language modules for Apache

Chapter 3: Interactive Web Applications

Wolfgang Dehnhardt: JavaScript, VBScript, ASP, Perl, PHP, XML: Scriptsprachen für dynamische Webauftritte, Carl Hanser 2001

Server-Side Script Language PHP

(Only an example for a server-side script language!)

- PHP:
  - **P**ersonal **H**ome **P**age Toolkit
    - » 1995, Rasmus Lerdorf
    - » 2003, new by Zeev Suraski, Andi Gutmans
  - **P**HP **H**ypertext **P**reprocessor (recursive acronym, backronym)
- Current version: 5.3 (June 2009), 6 in preparation
- OpenSource project:
  - see www.php.net
  - Can be used and modified freely (PHP license)
- Syntax loosely oriented towards C
  - Variations of possible syntax
- Extensive function library
  - being extended by community

Prerequisites for Using PHP in Practice

- Always (even if using just one computer)
  - Installation of a Web server
    - » OpenSource: *Apache*
    - » Microsoft *Internet Information Server*
  - Invocation of PHP always indirectly by loading pages from server (http://...)
    - » Loading from local computer: http://localhost/...
- Installation of PHP software as plug-in for used Web server
- Very often also installation of a data base system (e.g. MySQL)
- Frequently used acronyms for specific configurations:
  - LAMP: Linux, Apache, MySQL, PHP
  - WIMP: Windows, Internet Information Server, MySQL, PHP
  - MOXAMP: MacOS X, Apache, MySQL, PHP

Activation of PHP Module in Apache

- Example (MacOS 10.5):
  - Apache + PHP module are pre-installed
  - Configuration needs to be updated (remove a comment sign)
- /etc/apache2/httpd.conf:

```
# This is the main Apache HTTP server configuration file.  It contains the
# configuration directives that give the server its instructions.
# See <URL:http://httpd.apache.org/docs/2.2> for detailed information.
...
LoadModule bonjour_module     libexec/apache2/mod_bonjour.so
LoadModule php5_module        libexec/apache2/libphp5.so
#LoadModule fastcgi_module     libexec/apache2/mod_fastcgi.so
```

Hello World in PHP

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01
  Transitional//EN" "http://www.w3.org/TR/html4/loose.dtd">

<html>
<head>
  <title>Hello World with PHP</title>
</head>

<body>
  <h1>
      <?php echo "Hello World!"; ?>
  </h1>
</body>
</html>
```

File hello.php
in Web server directory

Embedding of PHP into HTML

- XML style (used here):
  - Like *Processing Instructions* in XML

```
<?php    PHP Text   ?>
```

- SGML style:
  - Widely used in older scripts
  - Not really recommendable: PHP language not specified

```
<?    PHP Text   ?>
```

- HTML style:
  - Using HTML tag:

```
<script language="php">    PHP Text   </script>
```

A More Useful Example

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
   "http://www.w3.org/TR/html4/loose.dtd">

<html>
<head>
   <title>User Agent Test with PHP</title>
</head>

<body>
   <h1>User agent used:</h1>
   <p>
        <?php echo $_SERVER['HTTP_USER_AGENT']; ?>
   </p>
   <p>
        <?php
               if (strpos($_SERVER['HTTP_USER_AGENT'], 'MSIE') == FALSE) {
                      echo "You are not using Internet Explorer.";
               }
        ?>
   </p>
</body>
</html>
```

PHP Syntax (1)

- Inheritance from shell scripts
  - Variables start with "$"
  - Some UNIX commands part of the language, e.g.:

```
echo "Hello";
```

- Control statements exist in different versions, e.g.:

```
if (bedingung1)
  anw1
elseif (bedingung2)
  anw2
else anw3;

if (bedingung1):          anwfolge1
elseif (bedingung2):      anwfolge2
else:                     anwfolge3
endif;
```

PHP Syntax (2)

- Various comment styles:
  - One-line comment, C style:

```
echo "Hello"; // Hello World
```

  - One-line comment, Perl style / Unix shell style:

```
echo "Hello"; # Hello World
```

  - "One line" ends also at end of PHP block
  - Multi-line comment, C-style:

```
echo "Hello"; /* Comment
  spreads over multiple lines */
```

  - Do not create nested C-style comments!

- Instruction must always be terminated with ";"
  - Exception: end of PHP block contains implicit ";"

PHP Type System

- Scalar types:
  - boolean, integer, float (aka double), string
- Compound types:
  - array, object
- Special types:
  - resource, NULL
  - Resource type: refers to external resource, like a file

- "The type of a variable is not usually set by the programmer; rather, it is decided at runtime by PHP depending on the context in which that variable is used."

  (PHP Reference Manual)

Arrays in PHP (1)

- An array in PHP is actually an ordered map
  - Associates values to keys
  - Keys can be integer or string (even mixed in same array)
  - Multi-dimensional arrays (arrays of arrays) are supported
- Multiple use of the array data structure for array, list, hash table, dictionary, stack, queue, …
- Creating arrays (examples):

```php
<?php
  $arr = array("foo" => "bar", 12 => true);
  echo $arr["foo"]; // bar
  echo $arr[12];    // 1
?>
<?php
  $arr = array("somearray" => array(6 => 5, 13 => 9, "a" => 42));
  echo $arr["somearray"][6];    // 5
  echo $arr["somearray"][13];   // 9
  echo $arr["somearray"]["a"];  // 42
?>
```

Arrays in PHP (2)

- Arrays with strictly numerical keys
  - Implicit position numbers as keys

```
$array = array( 7, 8, 0, 156, -10);
  // this is the same as array(0 => 7, 1 => 8, ...)
```

- Arrays as collections

```
$colors = array('red', 'blue', 'green', 'yellow');
foreach ($colors as $color) {
    echo "Do you like $color?\n";
}
```

- Assignment operations on arrays always mean copying of values!

Object-Orientation in PHP (1)

```php
<?php
  class SimpleClass {

      // property declaration
      public $var = 'a default value';

      // method declaration
      public function displayVar() {
        echo $this->var;
      }
  }
?>
```

Property access with "->" operator

Visibilities:
public, private, protected

```php
$instance = new SimpleClass();
$instance->var = 'property value';
$instance->displayVar();
```

Object-Oriented Concepts in PHP

- Static class properties and methods
  - "static" keyword
- Class Inheritance:
  - "extends" keyword in class definition
- Class Abstraction:
  - "abstract" keyword in class definition
- Scope Resolution operator ("::"):
  - Access to static, constant or overriden properties or methods of a class

```php
<?php
 class MyClass {
     const CONST_VALUE = 'A constant value';
 }
 $classname = 'MyClass';
 echo $classname::CONST_VALUE; // As of PHP 5.3.0
?>
```

  - In combination with "self" and "parent" keywords (denoting classes): Possibility to access overridden version of a method (cf. "super" in Java)

Example: Fibonacci Function in PHP (Version 1)

```
<body> ...
  <h2>
     <?php
          function fib($n){
               if ($n==0)
                    return 0;
               else
                    if ($n==1)
                         return 1;
                    else
                         return fib($n-1)+fib($n-2);
          };
          echo "fib(3) = ", fib(3), "<br>";
          echo "fib(8) = ", fib(8), "<br>";
     ?>
  </h2>
</body>
</html>
```

fibonacci1.html

HTML Reminder: Forms

- User input in HTML:
  `<form>` Element
- Sub-element:
  - **`<input type=`*`ty`* **`name=`*`name`*`>`**
    Allowed types (*ty)* (selection):

`checkbox`	Check box
`radio`	Radio button
`text`	Textzeile
`textarea`	Multi-line text input area
`password`	Text input area not displaying the input
`file`	File selection
`button`	General button
`submit`	Button to send form contents
`reset`	Button to reset form contents

  - **`<select name=`*`name`*`>`** Pop-up menu for selection from options
    List of options: Sub-elements **`<option>`**
    `<option selected>` defines "pre-selected" values

Forms and Server-Side Scripts

- User input into forms
  - Has to be transferred to server
  - Are evaluated in the server script
  - Can be displayed afterwards in a way determined by the script
- HTML: **`action`** attribute for tag **`<form>`**
  - Specifies the server page to process the input
  - Can contain embedded script
- PHP:
  - Well suited for processing input from forms
  - Special syntactic support for form values
    - » (Old versions of PHP: Simply made available as variables)
- Example:
  - **`<form name="formular" action="script.php">`**

Fibonacci Function in PHP (Version 2): Input Form Calling PHP Script

```
<body>
  <h1>
     Fibonacci Function (Input)
  </h1>
  <h2>
     Please enter number:
     <form name="fibform" action="fibonacci2b.php">
          <input type="text" name="fibinput"
            value="0"><br>
          <input type="submit" value="Compute">
     </form>
  </h2>
</body>
</html>
```

fibonacci2a.html

Fibonacci-Funktion mit PHP (Version 2): Ergebnisseite

```
<body>
   <h1>
      Fibonacci Function (Result)
   </h1>
   <h2>
      <?php
           $fibinput = $_REQUEST['fibinput'];
           function fib($n){   as in version 1      };
           echo "fib($fibinput) = ";
           echo fib($fibinput);
           echo "<br>";
      ?>
      <br>
      <a href="fibonacci2a.html">New Computation</a>
   </h2>
</body>
```

fibonacci2b.php

Variables, Parameter Passing and Security

- Global Array $_REQUEST
  - for accessing external values determined at call time (like form input)
  - Obtaining individual variable values by

    ```
    $_REQUEST['var'];
    ```

- Older PHP versions (up zo 4.2.0):
  - Huge security hole by not distinguishing between external values (like form input) and local variables
    - » External values were directly accessible thorugh variables (like "$fibinput")
  - Problem also caused by omitting variable declarations from PHP language
  - Manipulations of URL (GET parameter values) may enable setting og internal variables (e.g. “authorization_successful”...!)
  - Old behaviour can still be enabled by server configuration

Combination of Input and Result Pages

```
<body>
  <h1>
      Fibonacci Function
  </h1>
  <h2>
      <?php
            function fib($n){  wie oben     };
            $eingabe = $_REQUEST['fibinput'];
            echo "fib($fibinput) = ";
            echo fib($fibinput);
            echo "<br>";
      ?>
      <br>
      Please enter number:
      <form name="fibform" action="fibonacci2.php">
            <input type="text" name="fibinput" value="0"><br>
            <input type="submit" value="Compute">
      </form>
  </h2>
</body>
```

fibonacci2.php

Sorry...

- For the rest of this slide set some of the slides are in German language

GET- und POST-Methode in HTTP

- Das Hypertext Transfer Protocol (HTTP) unterstützt zwei Methoden, Parameterwerte an aufgerufene Dokumente zu übergeben
- GET-Methode:
  - Variablenwerte werden als Bestandteil der URL codiert und übergeben:

    `http://host.dom/pfad/fibonacci2.php?eingabe=12`
  - Damit können Parameterangaben auch durch Eintippen der URL gemacht werden (ohne Formular)
  - Geeignet für einfache Abfragen
- POST-Methode:
  - Variablenwerte werden nicht in der URL codiert
  - Webserver wartet auf anschließende Übertragung der Variablenwerte (Einlesen vom Standard-Eingabekanal)
  - (Etwas) schwerer von außen zu "manipulieren“
- HTML: Attribut **`method`** beim Formular-Tag **`<form>`**
  - **`method="get"`** (default!) oder **`method="post"`**

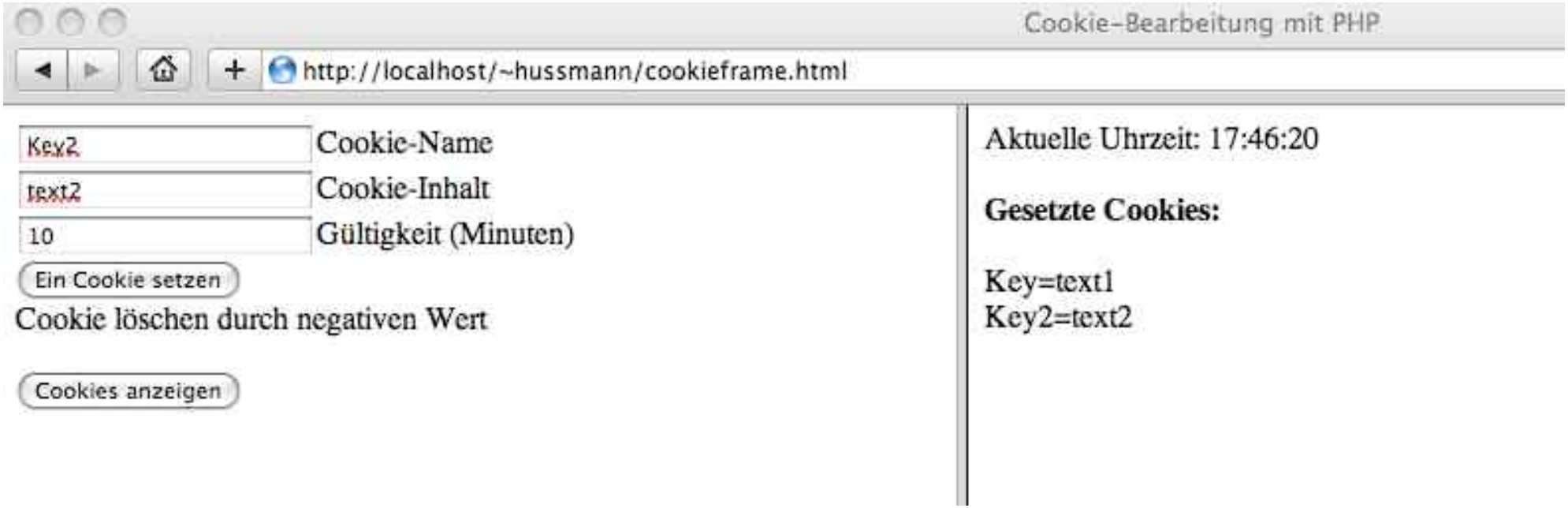
Dauerhafte Speicherung von Information

- Webseiten-Inhalt soll oft von gespeicherter Information abhängen
  - E-Commerce, E-Government, ...
  - Personalisierung von Seiten
  - Diskussionsforen
  - ...
- Serverseitige Speicherung:
  - Grosse Datenmengen (Datenbank)
    - » aber auch einfache Dateien möglich
  - Aktualisierung durch externe Programme
  - Anbindung an komplexe Programmsysteme
- Clientseitige Speicherung:
  - Geringe Datenmengen
  - Starke Einschränkungen aus Sicherheitsgründen
  - Für Identifikation etc.: "Cookies"

Cookies

- Kleine im Browser (bzw. einer vom Browser kontrollierten Datei) gespeicherte Dateneinheiten
- Cookie enthält:
  - Name (String), auch Schlüssel genannt
  - Wert (String)
  - Verfallsdatum
  - optional: Domäne, Pfadname, Sicherheitsinformation
- Übertragung zwischen Client und Server im HTTP-Protokoll
  - Zu jeder Anfrage nach einem Dokument werden alle *zugehörigen* Cookies an den Server gesandt.
- Auf ein Cookie kann nur das Programm/der Server zugreifen, der das Cookie erzeugt hat
- Clientseitige Erzeugung/Zugriff: z.B. mit JavaScript
- Serverseitige Erzeugung/Zugriff: z.B. mit PHP

Screenshot zu Cookie-Experiment



Formular zum Setzen von Cookies

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
   "http://www.w3.org/TR/html4/loose.dtd">

<html>
   <form action="cput.php" target="rechts">
       <input type="text" name="key" value="DEFAULT_KEY">Cookie-
   Name<br>
       <input type="text" name="val" value="text">Cookie-Inhalt<br>
       <input type="text" name="tim" value="10">G&uuml;ltigkeit
    (Minuten)<br>
       <input type="submit" value="Ein Cookie setzen"><br>
       Cookie l&ouml;schen durch negativen Wert
   </form>
   <p>
   <form action="cget.php" target="rechts">
       <input type="submit" value="Cookies anzeigen">
   </form>
</html>
```

cookies.html

Cookies in PHP: Setzen

```
<?php
  $key = $_REQUEST['key'];
  $val = $_REQUEST['val'];
  $tim = $_REQUEST['tim'];
  $zeit = time() + $tim * 60;
  setcookie($key, $val, $zeit);
  echo "<tt>Cookie: ", $key, "=", $val, "<br>";
  echo "g&uuml;ltig bis: ",
     date("d. F Y G:i:s", $zeit);
  echo "</tt><br>";
?>
```

- Benutzergegebene Parameter (rot dargestellt, gesetzt in separater HTML-Datei mit <form>):
  - Verfallszeit (hier in Minuten ab "jetzt")
  - Name
  - Wert

cput.php

Cookies in PHP: Lesen

```
<?php
  echo "<b>Gesetzte Cookies:</b><br>\n";
  while (list($key, $wert) = each($_COOKIE))
     echo $key, "=", $wert, "<br>\n";
?>
```

- Aktuelle Cookies verfügbar über eingebaute Variable
  - codiert in assoziativem Array $_COOKIE
    (Frühere PHP-Versionen: $HTTP_COOKIE_VARS)
- Verwendete Array-Funktionen:
  - **`each()`:** Durchläuft alle Array-Elemente
  - **`list()`:** Weist Array-Werte an Variablen-Tupel zu

cget.php

Ein einfaches Diskussions-forum (1)

- Interaktive Eingabe von Beiträgen
- Aktuelle Anzeige aller Beiträge
- Speicherung des aktuellen Diskussions-Standes in Datei auf Server
- Nur ca. 50 Zeilen HTML+PHP !

Ein einfaches Diskussionsforum (2)

- Beispielinhalt der Datei "forum.txt":
  - Je zwei Zeilen gehören zusammen.
  - Erste Zeile: Name
  - Zweite Zeile: Inhalt

```
Max
Das ist interessant.
Moritz
Das ist eher langweilig.
```

Ein einfaches Diskussionsforum (3)

- Ausgabe der aktuell bekannten Beiträge aus Datei
- Verwendete Dateifunktion:
  - **`file():`** Wandelt Dateiinhalt in String-Array
- Verwendete Arrayfunktion:
  - **`count():`** Länge des Arrays

```
<h2>Bisherige Beitr&auml;ge:</h2>
<?php
  $inhalt = file("forum.txt");
  echo "<h3>", count($inhalt)/2, " Beitr&auml;ge</h3>";
  $i = 0;
  while ($i < count($inhalt)) {
    echo "<h3>Beitrag Nr. ", ($i+2)/2, ":</h3>";
    echo "<b>Name: </b>", $inhalt[$i++], "<br>";
    echo "<b>Beitrag: </b>",$inhalt[$i++], "<br>";
  }
?>
```

forum.php

Ein einfaches Diskussionsforum (4)

- Code zum Erweitern der Datei entweder in separatem Skript oder in gleicher Datei wie Anzeige-Skript (hier gezeigt)
  - Abfrage, ob Eintragen nötig (Variable $eintragen zeigt, ob Einfügen-Schaltfläche gedrückt wurde)
- Verwendete Dateifunktionen:
  - **`fopen(), fclose():`** Datei öffnen ("a"=append), schliessen
  - **`fputs():`** Zeichenreihe schreiben

```
<?php
  $eintragen = $_REQUEST['eintragen']; $name …; $beitrag …;
  if ($eintragen != "" &&
      $name != "" && $beitrag != "") {
    $datei = fopen("forum.txt", "a");
    fputs($datei,$name . "\n");
    fputs($datei,$beitrag . "\n");
    fclose($datei);
  }
?>
```

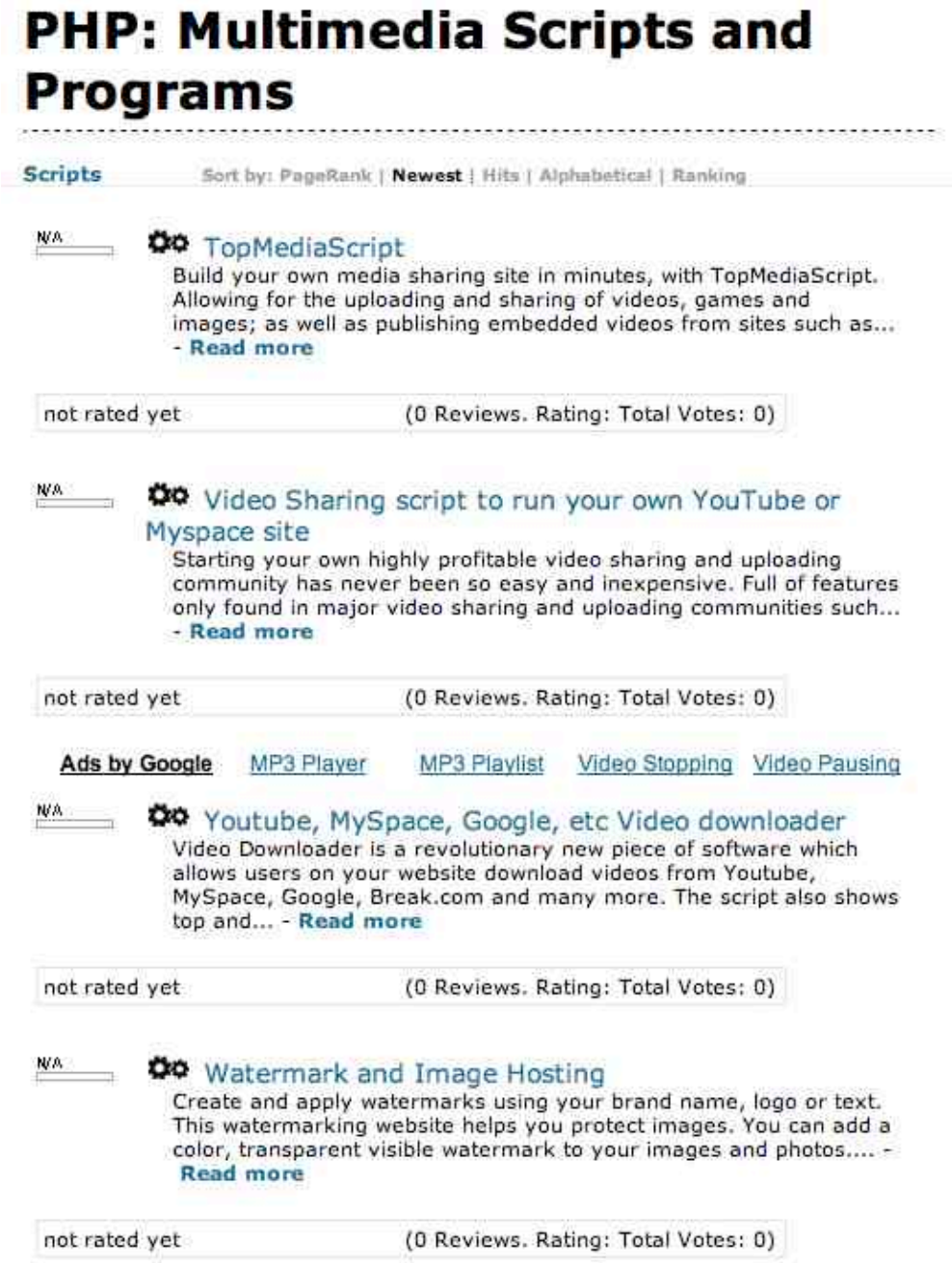
Potential Enabled by Server-Side Scripts

- Receive and store user input
  - In various forms of persistent storage
    - » Plain text files, XML files, data base
- Process input and compute results
  - Depending on various information available on server side
- Create output suitable for being displayed in Web browsers
  - HTML, may include JavaScript
- Make use of advanced features offered by Web browsers
  - Examples: Cookies, user agent identification

Applications to Multimedia

- PHP is not directly multimedia-related, but HTML-oriented
- HTML allows media embedding
- The combination of HTML + PHP + media embedding enables the creation of new digital media
- Examples for interactivity added to media playback, realisable by PHP scripts
  - Selection of media, e.g. search functions
    - » Using forms and backend data base
  - User-specific recommendations
    - » Using cookies
  - Aggregating (explicit and implicit) user input
    - » Frequency of use for individual media (charts)
    - » Correlation of use across media (collective recommendation)
    - » Tagging

Examples for PHP Multimedia Scripts



www.webscriptsdirectory.com

Multimedia Functions in PHP Library (1)

- See e.g. Multimedia chapter of tutorial "Practical PHP Programming" http://www.tuxradar.com/practicalphp/11/0/0
- Example: Creating an image

```
<?php
    $image = imagecreate(400,300);
   // do stuff to the image
   imagejpeg($image, '', 75);
   imagedestroy($image);
?>
```

File: picture1.php

```
<HTML>
   <TITLE>PHP Art</TITLE>
<BODY>
   <IMG SRC="picture1.php" />
</BODY>
</HTML>
```

- Computer graphics functions, like:

```
$white = imagecolorallocate($image, 255, 255, 255);
imagefilledrectangle($image, 10, 10, 390, 290, $white);
```

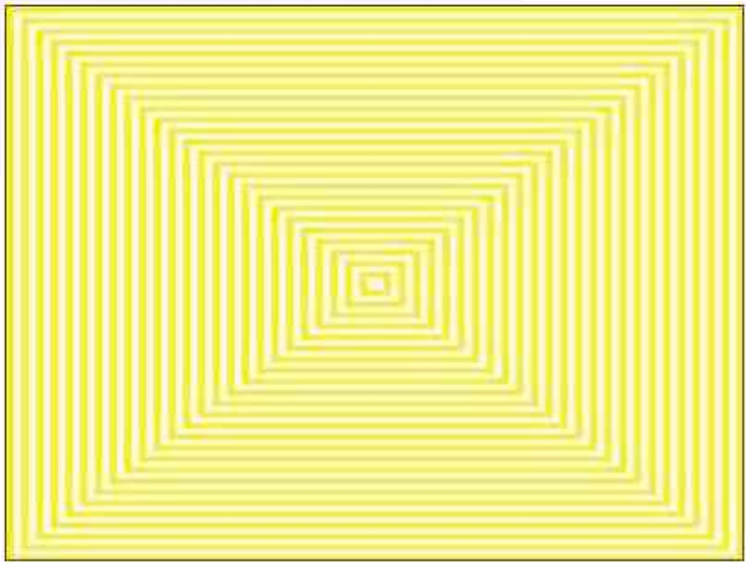
Multimedia Functions in PHP Library (2)

```
<?php
    $image = imagecreate(400,300);
    $gold = imagecolorallocate($image, 255, 240, 00);
    $white = imagecolorallocate($image, 255, 255, 255);
    $colour = $white;

    for ($i = 400, $j = 300; $i > 0; $i -= 4, $j -= 3) {
        if ($colour == $white) {
            $colour = $gold;
        } else {
            $colour = $white;
        }

        imagefilledrectangle($image, 400 - $i, 300 - $j, $i, $j, $colour);
    }

    imagepng($image);
    imagedestroy($image);
?>
```



Creating Flash Movies from PHP (1)

- ***Ming*** is an open-source library for creating SWF (Shockwave for Flash) movies from PHP scripts, using an object-oriented style.

```php
<?php
    $mov = new SWFMovie();
    $mov->setDimension(200,20);

    $shape = new SWFShape();
    $shape->setLeftFill($shape->addFill(0xff, 0, 0));
    $shape->movePenTo(0,0);
    $shape->drawLineTo(199,0);
    $shape->drawLineTo(199,19);
    $shape->drawLineTo(0,19);
    $shape->drawLineTo(0,0);

    $mov->add($shape);
    header('Content-type: application/x-shockwave-flash');
    $mov->output();
?>
```

```
<EMBED src="ming1.php" menu="false" quality="best" bgcolor="#FFFFFF" swLiveConnect="FALSE" WIDTH="200" HEIGHT="200"
TYPE="application/x-shockwave-flash" PLUGINSPAGE="http://www.macromedia.com/shockwave/download/index.cgi?
P1_Prod_Version=ShockwaveFlash">
```

Creating Flash Movies from PHP (2)

- Creating an animation (here animated text):

```php
<?php
    $font = new SWFFont("Impact.fdb");
    $text = new SWFText();
    $text->setFont($font);
    $text->moveTo(300, 500);
    $text->setColor(0, 0xff, 0);
    $text->setHeight(200);
    $text->addString("Text is surprisingly easy");

    $movie = new SWFMovie();
    $movie->setDimension(6400, 4800);

    $displayitem = $movie->add($text);

    for($i = 0; $i < 100; ++$i) {
        $displayitem->rotate(-1);
        $displayitem->scale(1.01, 1.01);
        $movie->nextFrame();
    }

    header('Content-type: application/x-shockwave-flash');
    $movie->output();
?>
```