Web Programming Step by Step, 2nd Edition

Chapter 5

Slides courtesy: Stepp, Miller & Kirst

5.1: Server-Side Basics

- **5.1: Server-Side Basics**
- 5.2: PHP Basic Syntax
- 5.3: Embedded PHP
- 5.4: Advanced PHP Syntax

URLs and web servers

`http://server/path/file`

- usually when you type a URL in your browser:
  - your computer looks up the server's IP address using DNS
  - your browser connects to that IP address and requests the given file
  - the web server software (e.g. Apache) grabs that file from the server's local file system, and sends back its contents to you
- some URLs actually specify *programs* that the web server should run, and then send their output back to you as the result:

  https://webster.cs.washington.edu/cse190m/quote.php
  - the above URL tells the server webster.cs.washington.edu to run the program quote.php and send back its output

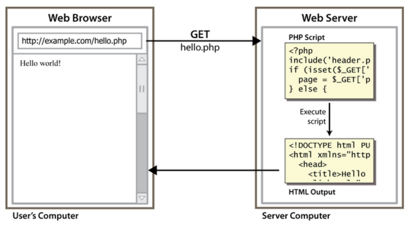
Server-Side web programming

- server-side pages are programs written using one of many web programming languages/frameworks
  - examples: PHP, Java/JSP, Ruby on Rails, ASP.NET, Python, Perl
- the web server contains software that allows it to run those programs and send back their output
- each language/framework has its pros and cons
  - we use PHP for server-side programming in this textbook

What is PHP?

- **PHP** stands for "PHP Hypertext Preprocessor"
- a server-side scripting language
- used to make web pages dynamic:
  - provide different content depending on context
  - interface with other services: database, e-mail, etc
  - authenticate users
  - process form information
- PHP code can be embedded in XHTML code

Lifecycle of a PHP web request



```
<?php
include('header.p
if (isset($_GET['
  page = $_GET['p
} else {
```

```
<!DOCTYPE html PU
<html xmlns="http
  <head>
    <title>Hello
```

- browser requests a .html file (**static content**): server just sends that file
- browser requests a .php file (**dynamic content**): server reads it, runs any script code inside it, then sends result across the network
  - script produces output that becomes the response sent back

Why PHP?

- There are many other options for server-side languages: Ruby on Rails, JSP, ASP.NET, etc. Why choose PHP?
- **free and open source**: anyone can run a PHP-enabled server free of charge
- **compatible**: supported by most popular web servers
- **simple**: lots of built-in functionality; familiar syntax
- **available**: installed on UCY's servers and most commercial web hosts
- **well-documented**: type php.net/functionName in browser Address bar to get docs for any function

Hello, World!

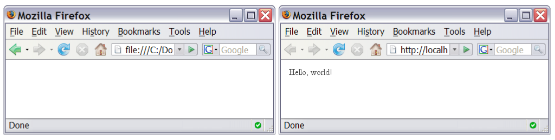
- The following contents could go into a file hello.php:

```php
<?php
print "Hello, world!";
?>
```
PHP

```
Hello, world!
```
output

- a block or file of PHP code begins with `<?php` and ends with `?>`
- PHP statements, function declarations, etc. appear between these endpoints

Viewing PHP output



- you can't view your .php page on your local hard drive; you'll either see nothing or see the PHP source code
- if you upload the file to a PHP-enabled web server, requesting the .php file will run the program and send you back its output

5.2: PHP Basic Syntax

- 5.1: Server-Side Basics
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PHP syntax template

```
HTML content

  <?php
    PHP code
  ?>

HTML content

  <?php
    PHP code
  ?>

HTML content  . . .
```
PHP

- any contents of a .php file between **<?php** and **?>** are executed as PHP code
- all other contents are output as pure HTML
- can switch back and forth between HTML and PHP "modes"

Console output: print

```php
print "text";
```
PHP

```php
print "Hello, World!\n";
print "Escape \"chars\" are the SAME as in Java!\n";

print "You can have
line breaks in a string.";

print 'A string can use "single-quotes".  It\'s cool!';
```
PHP

```
Hello, World! Escape "chars" are the SAME as in Java! You can have line breaks in a string. A string can use "single-quotes". It's cool!
```
output

- some PHP programmers use the equivalent `echo` instead of `print`

Arithmetic operators

- + - * / %
  . ++ --
  = += -= *= /= %= .=
- many operators auto-convert types: 5 + "7" is 12

Variables

```
$name = expression;
```
PHP

```
$user_name = "PinkHeartLuvr78";
$age = 16;
$drinking_age = $age + 5;
$this_class_rocks = TRUE;
```
PHP

- names are case sensitive; separate multiple words with _
- names always begin with **$**, on both declaration and usage
- implicitly declared by assignment (type is not written; a "loosely typed" language)

Types

- basic types: int, float, boolean, string, array, object, NULL
  - test what type a variable is with ***is_type*** functions, e.g. is_string
  - gettype function returns a variable's type as a string (not often needed)
- PHP converts between types automatically in many cases:
  - string → int auto-conversion on + ("1" + 1 == 2)
  - int → float auto-conversion on / (3 / 2 == 1.5)
- type-cast with (*type*):
  - $age = **(int)** "21";

Comments

```
# single-line comment

// single-line comment

/*
multi-line comment
*/
```
PHP

- like Java, but # is also allowed
  - a lot of PHP code uses # comments instead of //
  - we recommend # and will use it in our examples

for loop

```
for (initialization; condition; update) {
  statements;
}
```
PHP

```
for ($i = 0; $i < 10; $i++) {
  print "$i squared is " . $i * $i . ".\n";
}
```
PHP

if/else statement

```
if (condition) {
  statements;
} elseif (condition) {
  statements;
} else {
  statements;
}
```
PHP

- NOTE: although **elseif** keyword is much more common, **else if** is also supported

while loop *(same as Java)*

```
while (condition) {
  statements;
}                                                             PHP
```

```
do {
  statements;
} while (condition);                                          PHP
```

- break and continue keywords also behave as in Java
  - *break* ends execution of the current *for*, *foreach*, *while*, *do-while* or *switch* structure
  - *continue* is used within looping structures to skip the rest of the current loop iteration and continue execution at the condition evaluation and then the beginning of the next iteration.

Math operations

```
$a = 3;
$b = 4;
$c = sqrt(pow($a, 2) + pow($b, 2));                           PHP
```

abs	ceil	cos	floor	log	log10	max
min	pow	rand	round	sin	sqrt	tan

math functions

M_PI	M_E	M_LN2

math constants

- the syntax for method calls, parameters, returns is the same as Java

int and float types

```
$a = 7 / 2;               # float: 3.5
$b = (int) $a;            # int: 3
$c = round($a);           # float: 4.0
$d = "123";               # string: "123"
$e = (int) $d;            # int: 123
```

- **`int`** for integers and **`float`** for reals
- division between two int values can produce a float

String type

```
$favorite_food = "Ethiopian";
print $favorite_food[2];            # h
```

- zero-based indexing using bracket notation
- string concatenation operator is **.** (period), not +
  - 5 + "2 turtle doves" produces 7
  - 5 . "2 turtle doves" produces "52 turtle doves"
- can be specified with `""` or `''`

Interpreted strings

```
$age = 16;
~~print "You are " . $age . " years old.\n";~~
print "You are $age years old.\n";    # You are 16 years old.
```

- strings inside " " are **interpreted**
  - variables that appear inside them will have their values inserted into the string
- strings inside ' ' are ***not*** interpreted:

```
print 'You are $age years old.\n';    # You are $age years old.\n     PHP
```

String functions

Name	Java Equivalent
strlen	length
strpos	indexOf
substr	substring
strtolower, strtoupper	toLowerCase, toUpperCase
trim	trim
explode, implode	split, join
strcmp	compareTo

```
# index  0123456789012345
$name = "Stefanie Hatcher";
$length = strlen($name);                # 16
$cmp = strcmp($name, "Brian Le");       # > 0
$index = strpos($name, "e");            # 2
$first = substr($name, 9, 5);           # "Hatch"
$name = strtoupper($name);              # "STEFANIE HATCHER"          PHP
```

String functions (ctd)

Name
array explode (string, string)
string implode(string, array)
string trim(string, [,string])
rtrim
ltrim

bool (Boolean) type

```
$feels_like_summer = FALSE;
$php_is_rad = TRUE;

$student_count = 217;
$nonzero = (bool) $student_count;     # TRUE
```

PHP

- the following values are considered to be FALSE (all others are TRUE):
  - 0 and 0.0
  - "", "0", and NULL (includes unset variables)
  - arrays with 0 elements
- can cast to boolean using **`(bool)`**
- FALSE prints as an empty string (no output); TRUE prints as a 1

5.3: Embedded PHP

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Printing HTML tags in PHP = bad style

```
<?php
print "<!DOCTYPE html PUBLIC \"-//W3C//DTD XHTML 1.1//EN\"\n";
print " \"http://www.w3.org/TR/xhtml11/DTD/xhtml11.dtd\">\n";
print "<html xmlns=\"http://www.w3.org/1999/xhtml\">\n";
print "  <head>\n";
print "    <title>Geneva's web page</title>\n";
...
for ($i = 1; $i <= 10; $i++) {
  print "<p> I can count to $i! </p>\n";
}
?>
```

- printing HTML tags with print statements is bad style and error-prone:
  - must quote the HTML and escape special characters, e.g. \"
- but without print, how do we insert dynamic content into the page?

Embedding PHP in HTML

```
<!DOCTYPE html>
<html>
<head><title>My web page</title></head>
<body>
<?php
 for ($i = 1; $i <= 100; $i++) {
?>
  <p>Hello world!</p>
  <?php
  }
 ?>
</body>
</html>
```

HTML Mode

Enter PHP Mode

Exit PHP Mode

HTML Mode

Enter PHP Mode

Exit PHP Mode

HTML Mode

PHP expression blocks

```
<?= expression ?>
```

PHP

```
<h2> The answer is <?= 6 * 7 ?> </h2>
```

PHP

The answer is 42

output

- **PHP expression block**: evaluates and embeds an expression's value into HTML
- ***<?= expr ?>*** is equivalent to **<?php print *expr*; ?>**

Expression block example

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.1//EN"
 "http://www.w3.org/TR/xhtml11/DTD/xhtml11.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
  <head><title>CSE 190 M: Embedded PHP</title></head>
  <body>
    <?php for ($i = 99; $i >= 1; $i--) { ?>
      <p> <?= $i ?> bottles of beer on the wall, <br />
          <?= $i ?> bottles of beer. <br />
          Take one down, pass it around, <br />
          <?= $i - 1 ?> bottles of beer on the wall. </p>
    <?php } ?>
  </body>
</html>
```
PHP

Common errors: unclosed braces, missing = sign

```
  <body>
    <p>Watch how high I can count:
      <?php for ($i = 1; $i <= 10; $i++) { ?>
        <? $i ?>
    </p>
  </body>
</html>
```
PHP

- `</body>` and `</html>` above are inside the for loop, which is never closed
- if you forget to close your braces, you'll see an error about `'unexpected $end'`
- if you forget = in `<?=`, the expression does not produce any output

Complex expression blocks

```
  <body>
    <?php for ($i = 1; $i <= 3; $i++) { ?>
      <h<?= $i ?>>This is a level <?= $i ?> heading.</h<?= $i ?>>
    <?php } ?>
  </body>
```
PHP

This is a level 1 heading.
This is a level 2 heading.
This is a level 3 heading.

output

- expression blocks can *even go inside HTML tags and attributes*

5.4: Advanced PHP Syntax

NULL

```
$name = "Victoria";
$name = NULL;
if (isset($name)) {
  print "This line isn't going to be reached.\n";
}
```

- a variable is NULL if
  - it has not been set to any value (undefined variables)
  - it has been assigned the constant NULL
  - it has been deleted using the unset function
- can test if a variable is NULL using the isset function
- NULL prints as an empty string (no output)

Arrays

```
$name = array();                                   # create
$name = array(value0, value1, ..., valueN);

$name[index]                                        # get element value
$name[index] = value;                               # set element value
$name[] = value;                                    # append
```
PHP

```
$a = array();     # empty array (length 0)
$a[0] = 23;       # stores 23 at index 0 (length 1)
$a2 = array("some", "strings", "in", "an", "array");
$a2[] = "Ooh!";   # add string to end (at index 5)
```
PHP

- **`array()`** : creates empty array
- to append, use bracket notation without specifying an index
- element type is not specified; can mix types
- element indexes can be non-consecutive
  - if you assign a value at an index that is past the end of the array, the array creates a new index and element at that index

Array functions

function name(s)	description
count	number of elements in the array
print_r	print array's contents
array_pop, array_push, array_shift, array_unshift	using array as a stack/queue
in_array, array_search, array_reverse, sort, rsort, shuffle	searching and reordering
array_fill, array_merge, array_intersect, array_diff, array_slice, range	creating, filling, filtering
array_sum, array_product, array_unique, array_filter, array_reduce	processing elements

Array function example

```
$tas = array("MD", "BH", "KK", "HM", "JP");
for ($i = 0; $i < count($tas); $i++) {
  $tas[$i] = strtolower($tas[$i]);
}                                  # ("md", "bh", "kk", "hm", "jp")
$morgan = array_shift($tas);       # ("bh", "kk", "hm", "jp")
array_pop($tas);                   # ("bh", "kk", "hm")
array_push($tas, "ms");            # ("bh", "kk", "hm", "ms")
array_reverse($tas);               # ("ms", "hm", "kk", "bh")
sort($tas);                        # ("bh", "hm", "kk", "ms")
$best = array_slice($tas, 1, 2);   # ("hm", "kk")
```
PHP

- the array in PHP replaces many other collections in Java
  - list, stack, queue, set, map, ...

The foreach loop

```
foreach ($array as $variableName) {
  ...
}
```
PHP

```
$stooges = array("Larry", "Moe", "Curly", "Shemp");
~~for ($i = 0; $i < count($stooges); $i++) {~~
~~  print "Moe slaps {$stooges[$i]}\n";~~
~~}~~
foreach ($stooges as $stooge) {
  print "Moe slaps $stooge\n";  # even himself!
}
```
PHP

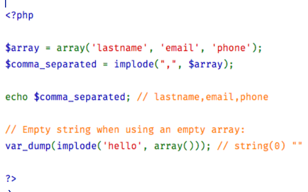
- a convenient way to loop over each element of an array without indexes

Splitting/joining strings

```
$array = explode(delimiter, string);
$string = implode(delimiter, array);
```

```
$s   = "CSE 190 M";
$a   = explode(" ", $s);      # ("CSE", "190", "M")
$s2  = implode("...", $a);    # "CSE...190...M"
```

- **explode** and **implode** convert between strings and arrays
- for more complex string splitting, you can use **regular expressions** (later)



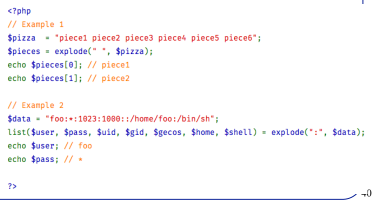
```
<?php

$array = array('lastname', 'email', 'phone');
$comma_separated = implode(",", $array);

echo $comma_separated; // lastname,email,phone

// Empty string when using an empty array:
var_dump(implode('hello', array())); // string(0) ""

?>
```



```
<?php
// Example 1
$pizza  = "piece1 piece2 piece3 piece4 piece5 piece6";
$pieces = explode(" ", $pizza);
echo $pieces[0]; // piece1
echo $pieces[1]; // piece2

// Example 2
$data = "foo:*:1023:1000::/home/foo:/bin/sh";
list($user, $pass, $uid, $gid, $gecos, $home, $shell) = explode(":", $data);
echo $user; // foo
echo $pass; // *

?>
```

Example with explode

contents of input file names.txt

```
Martin D Stepp
Jessica K Miller
Victoria R Kirst
```

```
foreach (file("names.txt") as $name) {
$tokens = explode(" ", $name);
?>
<p> author: <?= $tokens[2] ?>, <?= $tokens[0] ?> </p>
<?php
}
```
PHP

```
author: Stepp, Marty

author: Miller, Jessica

author: Kirst, Victoria
```
output

file: Returns the file in an array.

Each element of the array corresponds to a line in the file, with the newline still attached.

Query strings and parameters

```
URL?name=value&name=value...
```

```
http://www.google.com/search?q=Obama
```

```
http://example.com/student_login.php?username=stepp&id=1234567
```

- **query string**: a set of parameters passed from a browser to a web server
  - often passed by placing name/value pairs at the end of a URL
  - above, parameter **username** has value **stepp**, and **id** has value **1234567**
- PHP code on the server can examine and utilize the value of parameters
- a way for PHP code to produce different output based on values passed by the user

Query parameters: $_REQUEST

```
$user_name = $_REQUEST["username"];
$id_number = (int) $_REQUEST["id"];
$eats_meat = FALSE;
if (isset($_REQUEST["meat"])) {
  $eats_meat = TRUE;
}
```

- `$_REQUEST["parameter name"]` returns a parameter's value as a `string`
- test whether a given parameter was passed with `isset`

Functions

```
function name(parameterName, ..., parameterName) {
  statements;
}
```

```
function bmi($weight, $height) {
  $result = 703 * $weight / $height / $height;
  return $result;
}
```

- parameter types and return types are not written
- a function with no return statements is implicitly "void"
- can be declared in any PHP block, at start/end/middle of code

Calling functions

```
name(expression, ..., expression);
```

```
$w = 163;  # pounds
$h = 70;   # inches
$my_bmi = bmi($w, $h);
```

- parameters are passed "*by value*" (κατ' αξία / με τιμή), meaning that the actual parameter values are copied into the functions
- parameters are also passed "*by reference*" (κατ' αναφορά), which causes the function's parameters to be an alias or link to the original parameter
  - to do this, place a `&` before the `$` in front of its name
- if the wrong number of parameters are passed, it's an error

Variable scope: global and local vars

```
$school = "UW";                   # global
...

function downgrade() {
  global $school;
  $suffix = "(Wisconsin)";        # local

  $school = "$school $suffix";
  print "$school\n";
}
```

- variables declared in a function are `local` to that function; others are `global`
- PHP does not have a narrower scope than function-level
- if a function wants to use a global variable, *it must have a global statement*
  - but don't abuse this; mostly you should use parameters

Default parameter values

```
function name(parameterName = value, ..., parameterName = value) {
  statements;
}
```

```
function print_separated($str, $separator = ", ") {
  if (strlen($str) > 0) {
    print $str[0];
    for ($i = 1; $i < strlen($str); $i++) {
      print $separator . $str[$i];
    }
  }
}
```

```
print_separated("hello");        # h, e, l, l, o
print_separated("hello", "-");   # h-e-l-l-o
```

- if no value is passed, the default will be used (defaults must come last)

```
function make_bigger($num) { $num = $num * 2.2; }
$x = 5;
make_bigger($x);
print $x;
```

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Ποιά τιμή θα εκτυπωθεί;

- 5
- 10
- 11
- 10.1

```
function make_bigger(&$num) { $num = $num * 2.2; }
$x = 5;
make_bigger($x);
print $x;
```

88 : 38

Ποιά τιμή θα εκτυπωθεί;

- 5
- 10
- 11
- 10.1

```
<?php
  $firstname="Victoria";
?>

<?php
  $fullname = "$firstname" . "Kirst";
?>
<p>Your full name is <?= $fullname ?></p>
```

88 : 38

Τι θα εκτυπωθεί κάτα τη μεταφόρτωση του αρχείου;

- **Your full name is VictoriaKirst**
- **Your full name is Victoria Kirst**
- **Your full name is Kirst**
- **Your full name is NULL Kirst**

PHP file I/O functions

function name(s)	category
`file`, `file_get_contents`, `file_put_contents`	reading/writing entire files
`basename`, `file_exists`, `filesize`, `fileperms`, `filemtime`, `is_dir`, `is_readable`, `is_writable`, `disk_free_space`	asking for information
`copy`, `rename`, `unlink`, `chmod`, `chgrp`, `chown`, `mkdir`, `rmdir`	manipulating files and directories
`glob`, `scandir`	reading directories

The file function

- file returns the lines of a file as an array of strings
- each ends with `\n` ;
- to strip it, use an optional second parameter:

```
$lines = file("todolist.txt", FILE_IGNORE_NEW_LINES);
```

- common idiom: foreach or for loop over lines of file

```
# display lines of file as a bulleted list
$lines = file("todolist.txt");
foreach ($lines as $line) {        # for ($i = 0; $i < count($lines); $i++)
  print "<li>$line</li>\n";
}
```

Reading an entire file

- file_get_contents returns entire contents of a file as a string
  - if the file doesn't exist, you will get a warning and an empty return string

```
# reverse a file
$text = file_get_contents("poem.txt");
$text = strrev($text);
file_put_contents("poem.txt", $text);
```

Reading files

contents of foo.txt	file("foo.txt")	file_get_contents("foo.txt")
Hello how r u? I'm fine	array("Hello\n", # 0 "how r u?\n", # 1 "\n", # 2 "I'm fine\n" # 3)	"Hello\n how r u?\n # a single \n # string I'm fine\n"

Unpacking an array: list

```
list($var1, ..., $varN) = array;
```
PHP

```
Marty Stepp
(206) 685-2181
570-86-7326
```
contents of input file `personal.txt`

```
list($name, $phone, $ssn) = file("personal.txt");
...
```
PHP

- the odd list function "unpacks" an array into a set of variables you declare
- when you know a file's exact length/format, use file and list to unpack it

Writing / Appending to a file

- file_put_contents writes a string into a file, *replacing* its old contents
  - if the file doesn't exist, it will be created

```
# add a line to a file
$new_text = "P.S. ILY, GTG TTYL!~";
file_put_contents("poem.txt", $new_text, FILE_APPEND);
```

old contents	new contents

`Roses are red,`
`Violets are blue.`
`All my base,`
`Are belong to you.`
	`Roses are red,`
	`Violets are blue.`
	`All my base,`
	`Are belong to you.`
	`P.S. ILY, GTG TTYL!~`

Reading directories

function	*description*
scandir	*returns an array of all file names in a given directory (returns just the file names, such as "myfile.txt")*
glob	*returns an array of all file names that match a given pattern (returns a file path and name, such as "foo/bar/myfile.txt")*

- `glob` can accept a general path with the `*` wildcard character

glob example

```
# reverse all poems in the poetry directory
$poems = glob("poetry/poem*.dat");
foreach ($poems as $poemfile) {
  $text = file_get_contents($poemfile);
  file_put_contents($poemfile, strrev($text));
  print "<p>I just reversed " . basename($poemfile) . "</p>\n";
}
```

- **`glob`** can match a "wildcard" path with the * character
  - glob("foo/bar/***.doc**") returns all .doc files in the foo/bar subdirectory
  - glob("**food***") returns all files whose names begin with "food"
- the **`basename`** function strips any leading directory from a file path
  - basename("foo/bar/baz.txt") returns "baz.txt"

scandir example

```
<ul>
  <?php
  $folder = "taxes/old";
  foreach (scandir($folder) as $filename) {
    print "<li>$filename</li>\n"
  }
  ?>
</ul>
```
PHP

```
• .
• ..
• 2007_w2.pdf
• 2006_1099.doc
```
output

- **`scandir`** sucks; current directory (".") and parent ("..") are included in the array
- don't need **`basename`** with **`scandir`**; returns file names only without directory

Why use classes and objects?

- PHP is a primarily procedural language
- small programs are easily written without adding any classes or objects
- larger programs, however, become cluttered with so many disorganized functions
- grouping *related data and behavior* into objects helps manage size and complexity

Constructing and using objects

```
# construct an object
$name = new ClassName(parameters);

# access an object's field (if the field is public)
$name->fieldName

# call an object's method
$name->methodName(parameters);
```

```
$zip = new ZipArchive();
$zip->open("moviefiles.zip");
$zip->extractTo("images/");
$zip->close();
```

- the above code unzips a file
- test whether a class is installed with class_exists

Object example: Fetch file from web

```
# create an HTTP request to fetch student.php
$req = new HttpRequest("student.php", HttpRequest::METH_GET);
$params = array("first_name" => $fname, "last_name" => $lname);
$req->addPostFields($params);

# send request and examine result
$req->send();
$http_result_code = $req->getResponseCode();   # 200 means OK
print "$http_result_code\n";
print $req->getResponseBody();
```

- PHP's HttpRequest object can fetch a document from the web

Class declaration syntax

```
class ClassName {
  # fields - data inside each object
  public $name;    # public field
  private $name;   # private field

  # constructor - initializes each object's state
  public function __construct(parameters) {
    statement(s);
  }

  # method - behavior of each object
  public function name(parameters) {
    statements;
  }
}
```

- inside a constructor or method, refer to the current object as $this

Class example

```
<?php
class Point {
  public $x;
  public $y;

  # equivalent of a Java constructor
  public function __construct($x, $y) {
    $this->x = $x;
    $this->y = $y;
  }

  public function distance($p) {
    $dx = $this->x - $p->x;
    $dy = $this->y - $p->y;
    return sqrt($dx * $dx + $dy * $dy);
  }

  # equivalent of Java's toString method
  public function __toString() {
    return "(" . $this->x . ", " . $this->y . ")";
  }
}
?>
```

Class usage example

```
<?php
# this code could go into a file named use_point.php
include("Point.php");

$p1 = new Point(0, 0);
$p2 = new Point(4, 3);
print "Distance between $p1 and $p2 is " . $p1->distance($p2) . "\n\n";

var_dump($p2);   # var_dump prints detailed state of an object
?>
```

```
Distance between (0, 0) and (4, 3) is 5

object(Point)[2]
  public 'x' => int 4
  public 'y' => int 3
```

- $p1 and $p2 are references to Point objects

Basic inheritance

```
class ClassName extends ClassName {
  ...
}
```

```
class Point3D extends Point {
  public $z;

  public function __construct($x, $y, $z) {
    parent::__construct($x, $y);
    $this->z = $z;
  }

  ...
}
```

- the given class will inherit all data and behavior from *ClassName*

Static methods, fields, and constants

```
static $name = value;     # declaring a static field
const $name = value;      # declaring a static constant
```
PHP

```
# declaring a static method
public static function name(parameters) {
  statements;
}
```
PHP

```
ClassName::methodName(parameters);  # calling a static method (outside class)
self::methodName(parameters);        # calling a static method (within class)
```
PHP

- static fields/methods are shared throughout a class rather than replicated in every object

Abstract classes and interfaces

```
interface InterfaceName {
  public function name(parameters);
  public function name(parameters);
  ...
}

class ClassName implements InterfaceName { ...
```
PHP

```
abstract class ClassName {
  abstract public function name(parameters);
  ...
}
```
PHP

- **interfaces** are supertypes that specify method headers without implementations
  - cannot be instantiated; cannot contain function bodies or fields
  - enables polymorphism between subtypes without sharing implementation code
- **abstract classes** are like interfaces, but you can specify fields, constructors, methods
  - also cannot be instantiated; enables polymorphism with sharing of implementation code