OO and… Ahh!

An Introduction to Object Oriented Programming With PHP

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About John Valance

- **30+ years IBM midrange experience (S/38 thru IBM i)**
- **17+ years of web development experience**
- **Software Developer**
  - RPG / Java / PHP / JavaScript / SQL
- **Independent consultant - 2000 to 2018**
- **Founder and CTO of Division 1 Systems (www.div1sys.com)**
  - Web / Mobile applications for IBM i

Division 1 Systems

- **Community Involvement**
  - COMMON Board of Directors
  - Presenter at IBM i groups nationwide

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Profound Logic

- **Profound Logic Employee- as of Nov 2018 (www.profoundlogic.com)**
  - Senior Consultant / Modernization and Digital Transformation Strategist

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Goals and Topics of This Presentation

- **Goals:**
  - Introduce Object Oriented programming concepts
    - Use PHP syntax, but concepts apply to all OO languages
  - Focus on basics – avoid advanced OO concepts

- **Topics:**
  - Review of functions – and why objects
  - Basic concepts, keywords and syntax
    - Defining classes and instantiating objects
  - Examples
    - Person class
    - HTML form input class

Assumptions

- **You:**
  - Understand basic PHP syntax
  - Understand PHP functions
  - Understand basics of web programming in PHP
  - Some experience with HTML forms and PHP
  - Interested in Object-Oriented PHP
  - May have no prior experience with OO
    - maybe you've tried it, but got lost or overwhelmed

Functions – Building Blocks of Structured Code

- **Functions have several important properties that set them apart from RPG subroutines**
  - Parameters = input
  - Return value = output
  - Local variables i.e., scope of data

These features allow for re-use across applications

```
2  function formatDate( $dateString, $format = 'M d, Y' )
3  {
4      $dateVar = strtotime($dateString);
5      $fmtDate = date($format, $dateVar);
6      return $fmtDate;
7  }
8  // Mainline
9  echo formatDate('2011-09-27'); // "Sep 27, 2011"
10 echo formatDate('2011-09-27', 'm/d/y'); // "09/27/11"
```

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Why Functions?

- **Function = Black-Box**
  - Pre-tested component
  - Well-defined programming interface (API)
  - Can be relied upon as building blocks for larger programs

- **Can create function libraries and include them in multiple scripts**
  - A group of loosely related functions (customer, item, utility, etc.)
  - Use: require_once('func_lib.php');

Why Objects?

Why not just use functions, and organize them into libraries?

- **Objects take the concepts of functions a BIG step further.**
  - Objects allow you to organize your functions into groups that share a common set of data elements

More accurately:

- **An "Object" is a Data Structure**
  - A collection of related data elements (i.e. variables)
  - With a collection functions for accessing and manipulating the data within the structure.
- **In OO, it's all about the DATA, not the functions**
  - The *functions* are all about the **data**, and the valid operations upon that data
  - Better for organizing and modeling system entities

Encapsulation:

- **Data and Related Functions are tied together**

Creating Classes

What is a Class?

- **A Class is a template for creating objects**
- **A Class defines:**
  - a set of related **data** elements
  - a set of **functions** that perform actions on this data
- **Data elements are called Properties**
  - these are PHP **variables**
- **Actions are called Methods**
  - these are PHP **functions**

Person class

```php
<?php
class Person {
    // Data Elements (i.e.: properties)
    public $firstName;
    public $lastName;

    // Functions (i.e.: methods)
    public function __construct( $first, $last ) {
        $this->firstName = $first;
        $this->lastName = $last;
    }

    public function getFullName() {
        $fullName = $this->firstName . ' ' . $this->lastName;
        return $fullName;
    }

    public function sayHello() {
        echo "Hello, my name is " . $this->getFullName();
    }
}
```

Defining a Class

- **Use `class` keyword, followed by name of the class**
- **Body of class:**
  - curly braces { } enclose entire class definition
  - Properties (variables)
  - Methods (functions)

```
class ClassName {
      // properties…

      // methods…
}
```

- **Properties usually coded at top, before methods**

Class Names

- **Class name should be a noun**
  - represents an object of some sort that we are attempting to model
- **Standard is to start with capital letter**
  - use mixed case or underscores to separate multiple words in class name.
- **Some examples of classes you might create:**
  - Customer, Order, Product, HTML_InputForm, DB2_Connection, ErrorLog, etc.

Basic OO Design

- **Anything that can be boiled down to**
  - a set of properties (variables)
  - and actions (functions) that can be performed on the properties

  can be modeled as an object class.

- **Typically code each class in a separate PHP file**
  - Use same name as class for file name: Person.php
  - Related classes are often in same file (e.g. *Inherited* classes)

- **Include class definition into applications**
  - use **`require_once()`** function

Using Classes in Applications

Instantiating Objects

- **Class definitions are just template**
  - by themselves won't accomplish anything or run any code.
- **Need to create an object *instance* to use them**
- **Use the "new" keyword, followed by Class name**
- **Assign this to an object variable**

```
$bob = new Person;
$tom = new Person;
```

- **Each object has its own set of properties**
  - $bob has a $firstName and $lastName
  - $tom has a $firstName and $lastName
  - These are separate and distinct data structures

Person class again

```php
<?php
class Person {
    // Data Elements (i.e.: properties)
    public $firstName;
    public $lastName;

    // Functions (i.e.: methods)
    public function __construct( $first, $last ) {
        $this->firstName = $first;
        $this->lastName = $last;
    }

    public function getFullName() {
        $fullName = $this->firstName . ' ' . $this->lastName;
        return $fullName;
    }

    public function sayHello() {
        echo "Hello, my name is " . $this->getFullName();
    }
}
```

Application using Person class

personApp.php

```php
<?php
require_once 'Person.php';

$bob = new Person('Bob', 'Smith');
$tom = new Person('Tom', 'Jones');

$bobsName = $bob->getFullName();
echo "Bob's full name is $bobsName <br />";

$tom->sayHello();
```

If your run this script in a browser, it will produce the following output:

Bob's full name is Bob Smith
Hello, my name is Tom Jones

Class vs. Object

- **Similar to the relationship between a File Description and a specific Record in the file**
  - Class is like a DB File Layout – defines a bunch of variables
    - Except a Class also defines functions that can act upon the data.
  - Object is like a record in the file
    - A single “instance” of the data
- **DB anology ends there!**
  - no database is involved
  - objects are in memory only while script executes
- **Each object has its own set of variables**
- **Each object is an “instance” of the class**
  - Instantiation is done with the “new” keyword

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Constructors

- **When object instantiated, special method called `__construct()` is called automatically**
  - *(**Note**:* 2 underscores before `'construct'` in the name)
- **In OO languages, this is called a *constructor* method.**
- **Performs object initialization tasks**
  - like RPG's *INZSR subroutine
- **Optional - don't have to code `__construct()`**

Constructor Example

```
public function __construct( $first, $last ) {
    $this->firstName = $first;
    $this->lastName = $last;
}
```

- **Constructor can be coded with parameters**
  - e.g., to set property values

```
$bob = new Person('Bob', 'Smith');
$tom = new Person('Tom', 'Jones');
```

Accessing Class Members

Object Member Access: ->

- **Properties and Methods are "Members" of the class**
- **Access to object members done with "->"**
  - object member access operator
  - aka, arrow operator

```
echo 'First name: ' . $bob->firstName;
$tom->sayHello();
```

- **The arrow operator is valid in a class definition, as well as in an application that uses (instantiates) objects of that class**
  - ***Note:*** from outside the class definition, can only access ***public*** members. More on this coming…

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Using `$this` within a class

- **From OO application, we instantiate an object, then use arrow operator to access members of that object**
  - e.g.: `$bob->firstName;` `$tom->sayHello();`
  - But, within a class definition, what object do we refer to?

- **From within class definition, accessing properties and methods *of the same class* is done using `$this`**
  - **`$this`** is a special object name
  - can only be used inside class methods (not from application code)
  - refers the current instance of the class, based on context in which method was called

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Example of $this - In Context

- Application context ($tom object):

```
$tomsName = $tom->getFullName();
```

- Class context ($this object):

```
public function getFullName() {
    $fullName = $this->firstName.' '.$this->lastName;
    return $fullName;
}
```

- When `getFullName()` called on $tom object, $this refers to $tom's data

Visibility

Member Visibility: public vs. private

- **Every class member (property/method) should specify the "visibility"**
- **public visibility:**
  - member can be directly accessed from any context, inside or outside the class definition
- **private visibility:**
  - member can only be directly accessed from the methods within the same class
- **Default (implicit) visibility is public**
  - but you should explicitly specify visibility for each member

Person class - one more time

```php
<?php
class Person {
    // Data Elements (i.e.: properties)
    public $firstName;
    public $lastName;

    // Functions (i.e.: methods)
    public function __construct( $first, $last ) {
        $this->firstName = $first;
        $this->lastName = $last;
    }

    public function getFullName() {
        $fullName = $this->firstName . ' ' . $this->lastName;
        return $fullName;
    }

    public function sayHello() {
        echo "Hello, my name is " . $this->getFullName();
    }
}
```

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Getters and Setters

- **Public properties (data) are considered bad form**
  - If public, you can retrieve and modify values
  - Public ties you to a specific implementation
- **Best practice:**
  - make all properties private
  - declare public ***getter*** and ***setter*** methods to access properties
- **Aka – "accessor" methods**
  - controls access to object data

Benefits of Accessor Methods

- **Setters: Add filtering and error checking on values before allowing data elements to be set.**
  - `setFirstName()` method could check for a maximum length
  - throw an error if the value supplied for `firstName` will not fit into a database field.
- **Getters: Format data value for consumption by a variety of applications before being retrieved.**
  - `getFirstNameForWeb()` could filter value using PHP's `htmlentities()` function, preventing XSS attacks.
- **Can simulate read-only properties**
  - Property has public getter, but no public setter
- **Abstracts the Interface from Implementation**
  - Changes to the implementation do not affect applications

Person Class – Private Properties

```php
class Person {
    private $firstName;
    private $lastName;

    public function __construct($first, $last) {
        $this->setFirstName($first);
        $this->setLastName($last);
    }
    public function setFirstName($first) {
        if ($this->checkFirstName($first)) {
            $this->firstName = $first;
            return true;
        }
    }
    public function getFirstName() {
        return htmlentities($this->firstName);
    }
    private function checkFirstName($first) {
        if (strlen ( $first ) > 40) {
            throw new Exception('firstName exceeds 40 characters' );
        } else {
            return true;
        }
    }
```

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Exception Handling

Error Handling in OO Code

```
private function checkFirstName($first) {
    if (strlen ( $first ) > 40) {
        throw new Exception('firstName exceeds 40 characters' );
    } else {
        return true;
    }
}
```

- We don't know in which context an object will be used
- In the class, if error occurs, throw an Exception
- It will bubble up through call stack until caught
- Allows application code to handle error appropriately
- Uncaught exceptions will cause fatal error, and produce ugly stack trace on web page.

Try / Catch Blocks

```
try {
    /* try block: i.e., code accessing
       objects which may throw exception */
} catch (Exception $e) {
    /* catch block: i.e., code to execute
       if exception thrown in try block */
}
```

personApp.php, revised:

```
try {
    $tom->setFirstName('Thomas');
} catch (Exception $e) {
    echo "An error occurred as follows: " . $e->getMessage();
    echo "<br>Stack Trace: <br>" . $e->getTraceAsString();
}
```

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Exception Class
http://www.php.net/manual/en/class.exception.php

- Exception is a PHP built-in class

```
throw new Exception('firstName exceeds 40 characters' );
```

- This instantiates an unreferenced object of type Exception

```
catch (Exception $e)
```

- This receives the thrown Exception object, and assigns it to a variable named $e
- We can now access the public members of the Exception object via the variable $e

```
echo "Error occurred: " . $e->getMessage();
```

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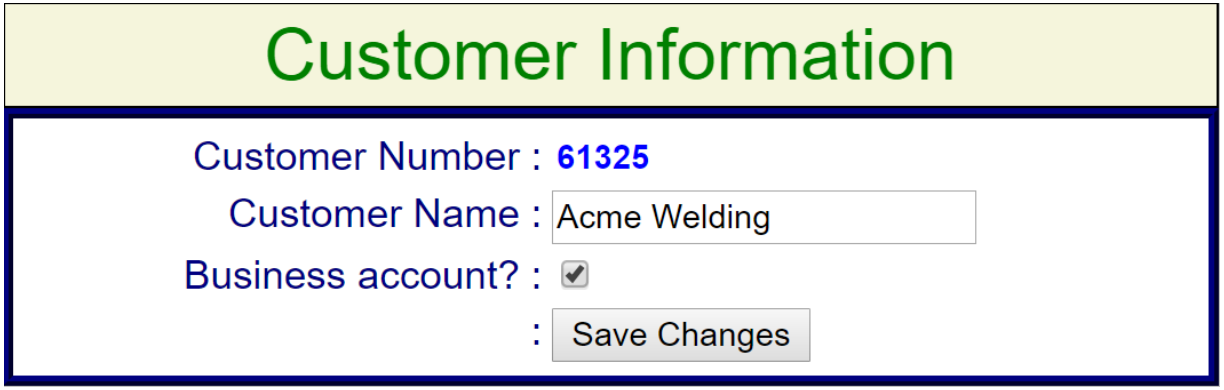
Example:
HTML Form Input Class

Design of `Form_Input` class

- **Design a Class to:**
  - store the properties of an HTML form input field
  - render the HTML for the <input> tag, in a variety of formats



- **Customer Number:** `<input type='text' name='CUNUM' value='61325' disabled="disabled" class="output-only" />`
- **Customer Name:** `<input type='text' name='CUNAME' value='Acme Welding' />`
- **Business account?:** `<input type='checkbox' name='CUBUSINESS' value='1' />`
- **:** `<input type='submit' name='saveButton' value='Save Changes' />`

Properties of `Form_Input` class

- **Properties:**
  - name (attribute of <input> tag)
  - type (attribute of <input> tag)
  - value (attribute of <input> tag)
  - text label (to display next to the input field)
  - output only? (boolean: true = protect input)

```
Customer Number: <input type='text' name='CUNUM' value='61325'
disabled="disabled" class="output-only" />

Customer Name: <input type='text' name='CUNAME' value='Acme Welding' />

Business account?: <input type='checkbox' name='CUBUSINESS' value='1' />

: <input type='submit' name='saveButton' value='Save Changes' />
```

Methods of `Form_Input` class

- **Methods:**
  - constructor (parms: name - req'd.; type - optional, default='text')
  - setters/getters for private properties
  - render (returns HTML <input> tag with all attributes)
  - renderTableRow (returns an HTML <tr> with columns for label and <input>)

```
<tr>
  <td class='label'>Customer Name</td>
  <td class='input'>
     <input type='text' name='CUNAME' value='Acme Welding' />
  </td>
</tr>
```

PHP code for `Form_Input` class

```php
<?php
class Form_Input {
    private $name;
    protected $type;
    public $value = '';
    public $label = '';
    protected $isOutputOnly = false; // boolean

    public function __construct($name, $type='text') {
        $this->name = $name;
        $this->type = $type;
    }

    public function setType( $type ) {
        $this->type = $type;
    }

    public function setOutputOnly() {
        $this->isOutputOnly = true;
    }
```

Form_Input class (cont'd.)

```
    public function render() {
        $html = "<input type='{$this->type}'
                        name='{$this->name}'
                        value='{$this->value}' ";
        if ($this->isOutputOnly) {
            $html .= ' disabled="disabled" '
                   . ' class="output-only" ';
        }
        $html .= ' />';
        return $html;
    }
    public function renderTableRow() {
        $html =
            "<tr>
                <td align='right' style='vertical-align:top'>
                    {$this->label}  
                </td>
                <td align='left' style='vertical-align:top'>
                    {$this->render()}
                </td>
            </tr>";
        return $html;
    }
}
```

Application using `Form_Input` - *PHP*

```php
require_once 'Form_Input.php';

$inpCustNumber = new Form_Input('CUNUM');
$inpCustNumber->label = 'Customer Number';
$inpCustNumber->value = 61325;
$inpCustNumber->setOutputOnly();

$inpCustName = new Form_Input('CUNAME');
$inpCustName->label = 'Customer Name';
$inpCustName->value = 'Acme Welding';

$inpIsBizCust = new Form_Input('CUBUSINESS', 'checkbox');
$inpIsBizCust->label = 'Business account?';

// Page to return to after form processing
$caller = new Form_Input('caller', 'hidden');
$caller->value = $_SERVER['HTTP_REFERER'];

$submit = new Form_Input('saveButton', 'submit');
$submit->value = 'Save Changes';
```

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Application using `Form_Input` - *HTML*

```
<html>
    <head>
        <link rel="stylesheet" type="text/css" href="styles.css" />
    </head>
    <body>
        <form>
            <?php echo $caller->render(); ?>
            <table border=0 width="50%">
                <caption>Customer Information</caption>
                <?php
                echo $inpCustNumber->renderTableRow();
                echo $inpCustName->renderTableRow();
                echo $inpIsBizCust->renderTableRow();
                echo $submit->renderTableRow();
                ?>
            </table>
        </form>
    </body>
</html>
```

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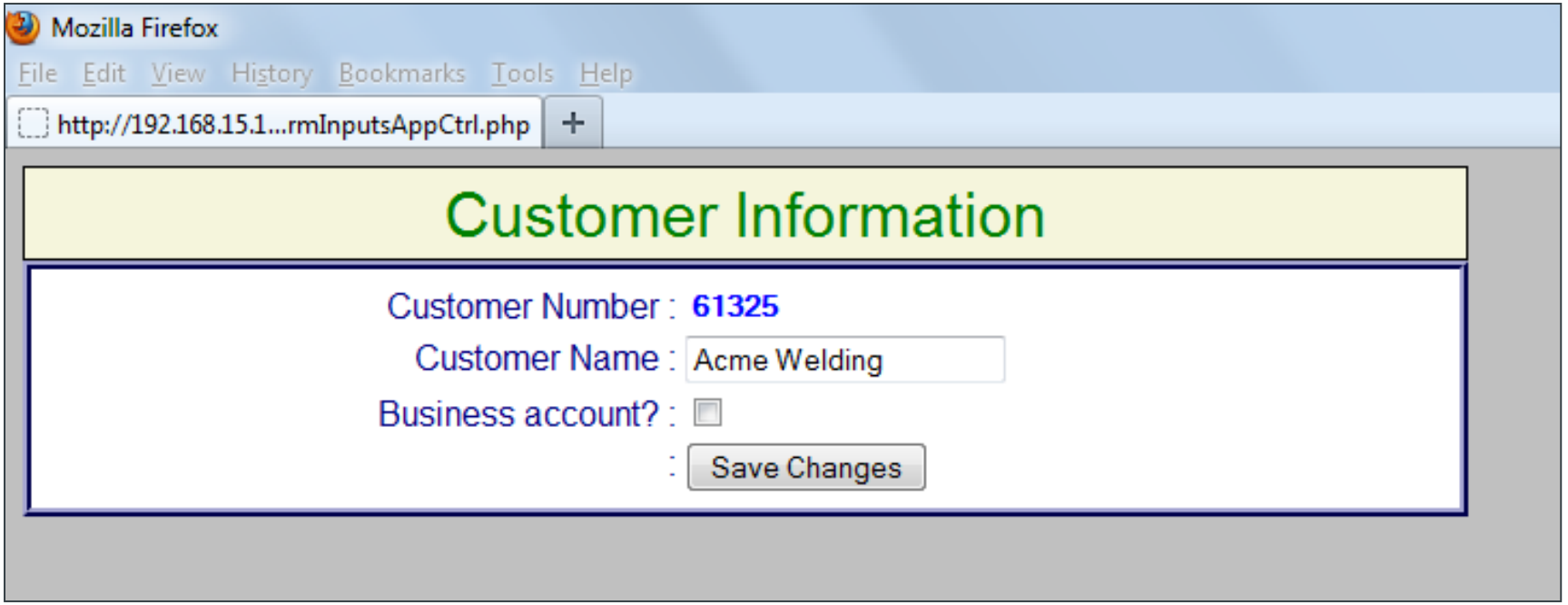
Customer Input Form – Rendered in FF



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Summary

Summary

- OO = encapsulation of data and related functionality
- Class definitions
  - templates for instantiating objects,
  - each object has its own data space.
- Object Instantiation
  - new keyword
- Object member access operator (->)
- $this : access internal members within a class
- Applications: bring class definitions in using require_once()

Summary (cont'd.)

- **Member visibility - public and private**
  - public is default
  - private is better
- **Getter and Setter methods**
  - control access to object's data
- **Constructor method (__construct)**
  - object initialization
- **Exception handling,**
  - PHP's built-in class: Exception
  - throw new Exception
  - try / catch

More Information

- **PHP.net:**
  - http://php.net/manual/en/language.oop5.php
  - www.php.net/manual/en/class.exception.php

Thanks for attending!

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