# Easy Viewing

## Design Patterns in View

*Using design patterns in development gives us a lot of advantages. It promotes loose-coupling, eases redevelopment, allows code reuse, and so on. However, improper use would give us ultra spaghetti code as they are scattered into multiple objects. This article demonstrates how design patterns can make our lives easier in common head aching cases.*

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**Background: MVC Pattern**

In this article, we shall look at why Model-View-Controller (MVC) could be useful. Let us look at two examples: course registration and online XSL file generation (see Fig. 1 and 2).

In both cases, the applications repeat the same processes, namely:

- Obtaining data from disk
- Optimising the data and generating an input form for users
- Acquiring user input
- Processing user input and generating acknowledgement
- Saving the data back to disk

This process is applicable to web applications, like online shopping and attendance record systems.

Repetition of the processes is tantamount to reuse. It would be tedious to rewrite entire applications when only the presentation of the form and format of the dataset is changed. There should be a way to reuse the application's 'framework' only by altering parameters. And, this is what breeds the idea of MVCs.

In a web application, the Controller is responsible for accepting user inputs and performing error checking/correction. Based on the user request, it determines which Model and View should be used. While the Model is responsible for business logic and accessing data in disk, the View is solely for presentation purposes. In the example of course registration, the steps and the corresponding responsibilities of each object are as followed:

- The Model gets the data from the course database
- The View is updated and course registration form is generated for students
- Students choose the course according to the vacancy, and submit the form
- The Controller retrieves students' inputs and performs error detection
- The Model is informed of the students' inputs, and it updates the course database
- The View to display the acknowledgement is chosen, and registration result is displayed to the students

This relationship is detailed in Fig. 3.

While there may be similarities in the functionalities of web applications, an efficient user interface plays an integral role in its success. In the following section, we will look into how design patterns can be employed in constructing Views to deal with several common problems. For example, how to avoid writing repetitive codes by reusing presentation designs, enable redevelopment by promoting loose-coupling

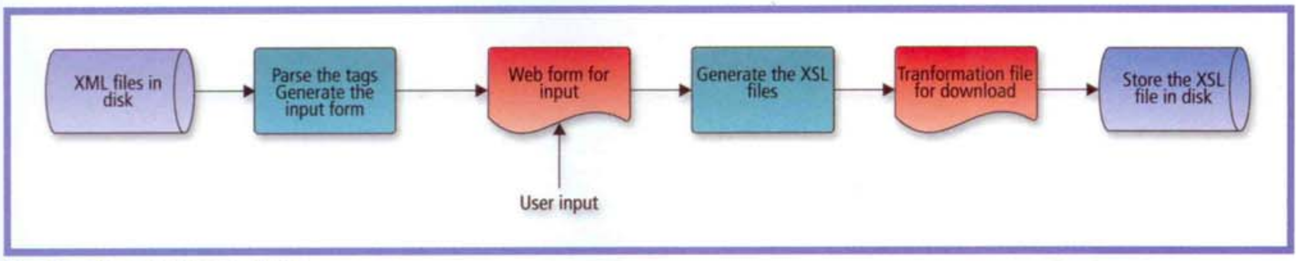

XML files in disk
Parse the tags Generate the input form
Web form for input
Generate the XSL files
Tranformation file for download
Store the XSL file in disk
User input

Fig. 1: Online XSL file generation

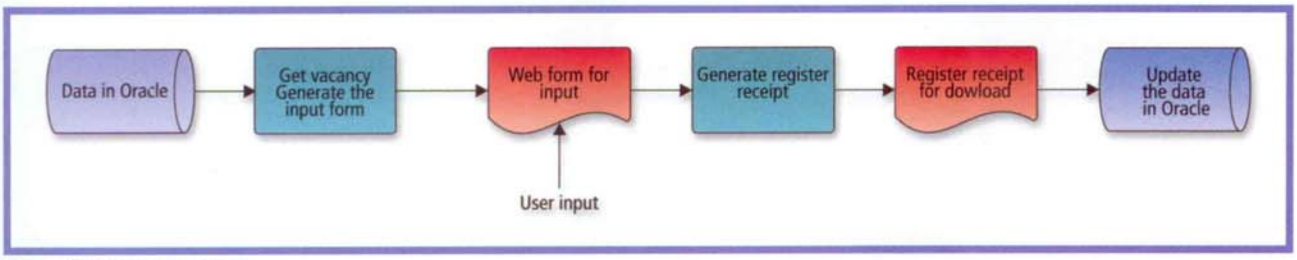

Data in Oracle
Get vacancy Generate the input form
Web form for input
Generate register receipt
Register receipt for dowload
Update the data in Oracle
User input

Fig. 2: Course registration

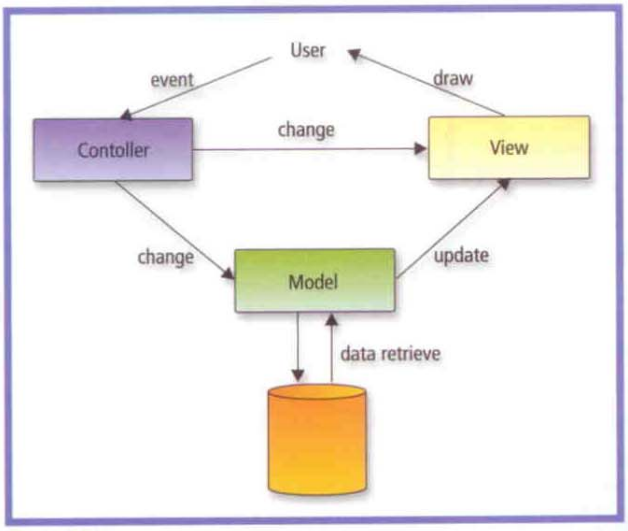


Fig. 3: MVC

between form components, and minimise classes spanned out by choosing the right design pattern to use.

### Different Implementation for the Same Presentation

The need for different implementation of the same presentation originates from the popular use of mobile devices; while web browsers require HTML/XHTML, WAP phones need WML. Since the logic for building the form is the same, only the implementation for the form's components differs as per the various requirements of markup languages. In such situations, the Bridge pattern enables separation of the implementation and logic.

In this example, there are two kinds of form that we are interested in: the map quest form and a course registration form. The logic in constructing the forms is encapsulated in the objects *MapQuestBuilder* and *RegisterBuilder*. They require the same component, *Table*, to build the form. In Listing 1, we assume there is a certain way of learning about the implementation the user requires. Based on that information, different *Table* objects will be instantiated to build the form without changing the logic of the *Builder*, since all the *Table* objects share the same interface.

This example shows how to separate the implementation from the logic, to enable easy addition/reuse of components and switching the implementation of components without affecting the logic.

Fig. 4 shows that *Builder* can be added easily, and all objects can share components to construct different kinds of forms.

### Maintaining States

Often, the user interface generated and the actions to be performed depend on the state of user; for example, whether a student has enough points to register for a course. One way to achieve this is to first perform state checking. The simplest way to check states is to use if-else statements. However, this type of checking introduces too many if-else statements. Additionally, if the number of possible states becomes too large, it will be hard for developers to keep track of the state transitions and the relationship between different states. Using the State pattern can solve this problem.

As shown in Listing 2, in State pattern, actions are performed according to the state of the user. The transformation of state can be

## Listing 1:

```
<?php
 /**
  * Constructor
  */
function MapQuestBuilder($language)
{
  if ($language == "XHTML") {
     $this->table = new XHTMLTable();
  } elseif ($language == "WML") {
     $this->table = new WMLTable();
  } else //default HTML implementation {
     $this->table = new HTMLTable();
  }
 $this->statement = "";
}
//Instance methods.
/**
* Draw the input form
**/
function DrawForm()
{
  $this->statement .=
   $this->table->tableStart(1, 1);
  $this->statement .=
   $this->table->rowStart();
  $this->statement .=
   $this->table->
    tableHeader ("Table Content", 1, 1);
  $this->statement .= $this->table->rowEnd();
  $this->statement .=
   $this->table->tableEnd();
  return $this->statement;
}
?>
```

## Listing 2:

```
<?php
class NormalState extends State
{
  function checkState()
  {
    if ( $_SESSION['quota']+1 > $limit ) {
      $_SESSION['state'] =
       new ExceedState(); // change state
    }
  }
  function register()
  {
    // register course
  }
}
class ExceedState extends State
{
  function checkState()
  {
    if ( $_SESSION['quota']-1 <= $limit ) {
      $_SESSION['state'] =
       new NormalState(); // change state
    }
  }
  function register()
  {
    printf("You do not have enough
       credits.");
  }
}
$_SESSION['state']->checkState();
$_SESSION['state']->register();
?>
```

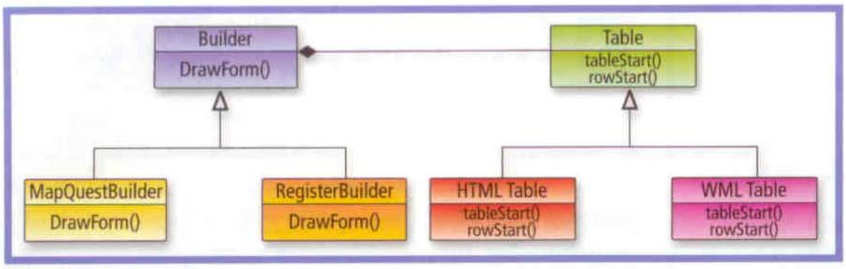


Fig. 4: Bridge pattern

encapsulated in the State objects, so it is not necessary to write out messy if-else blocks. Also, by using State pattern, we can have a clear picture on the state transitions.

Sometimes, an event might only trigger actions in a particular state. The State pattern helps to alleviate the problem of having to check the conditions in different states, by *subclassing* all state classes from a generic state class that provides default behaviours to all events. Then, for each state subclass, only the methods that respond to the events handled in the state need to be overridden. Listing 3 shows an example.

### Double Dispatch

In the first example, the methods of *Table* are fixed as *tableStart*, *rowStart*, and so on. Inflexibility might arise if you want to add more methods, since all the classes (including the base class) need to be changed. The Visitor pattern can be put to use in such situations (see Fig. 5). The Visitor would be responsible for the operation, and the component would accept these Visitors when performing different actions. Hence, when more actions are added, all we need to do is to add a class of type Visitor.

For the course registration example, we will need to display different nodes, like course and activity nodes, in the form. We started with one Visitor – *PrintVisitor*, and each node had a callback to the Visitor to perform the print action. To add an action, say, to perform searches on the Nodes, we just need to add *SearchVisitor*. The Visitor pattern is especially useful for separating objects from unrelated operations. It is assumed that the Node does not need to provide too much detail about the operations; otherwise, it would break the encapsulation rule.

Each visitor should identify the node type so that corresponding actions can be carried out. In PHP, this can be done by the new *instanceof* keyword, as shown in Listing 4.

Of course, the disadvantage of using this approach would be introducing too many if-else statements. This breaks the idea of encapsulation as the Visitor knows too much about the Node. The primary problem here is that only single dispatch is supported in PHP, meaning that the function to be run depends on the function name and type of object associated with the called function.

The Visitor pattern helps alleviate this problem by emulating "double dispatch". In double dispatch, the function to be run also depends on the type of object, which is passed to the function as an argument, in addition to the two criteria mentioned. See Listing 5 for an example.

In the example, when *CourseNode.Accept()* is called, the node type is identified and passed to *PrintVisitor.Visit()* via the "this" pointer. When *PrintVisitor.Visit()* is called, the type of node and visitor is identified before the correct implementation is chosen.

To increase the number of states, the Visitor pattern can be used together with the State pattern, by providing a visitor-type parameter to the *checkState()* method, as shown in Listing 6. The only inconvenience of this approach is that all *checkState()* methods in the state subclass must call the overridden *checkState()* method in the base state class.

### Complex Components

There are several patterns that enable us to manipulate complex components. The simplest method is by delegation, which distributes the heavyweight processes to other objects. According to the Strategy pattern, each object may share the same interface such that the client using them is ignorant about the change of objects.

The next task is to draw menus in table cells in our first example with *Table* and *Builder*. The responsibility of drawing the menus can be encapsulated in different *Menu* objects, which share the same interface. In our case, more *Menu* objects can be added by subclassing, and the *Builder* can change the *Menus* without altering the code.

The Command pattern (see Fig. 6) is also employed in this example (see Listing 7). The *Builder* fixes the menu content by parameterising the *Menu* object. The *Menu* object is passed to the *Table*, and *$menu.Draw()* is called to draw the different *Menu*. Only *Builder*, which controls the logic of the form, knows about the content of *Menu*. This effec-

**Listing 3:**

```
<?php
class State
{
  function checkState()
  {
  }
  function register()
  {
  }
}
class ExceedState extends State
{
  function checkState()
  {
  if ( $_SESSION['quota']-1 <= $limit ) {
    $_SESSION['state'] = new NormalState();
    // change state
  }
  }
  // register() is not overridden
  // since no action needs to be taken
}
?>
```

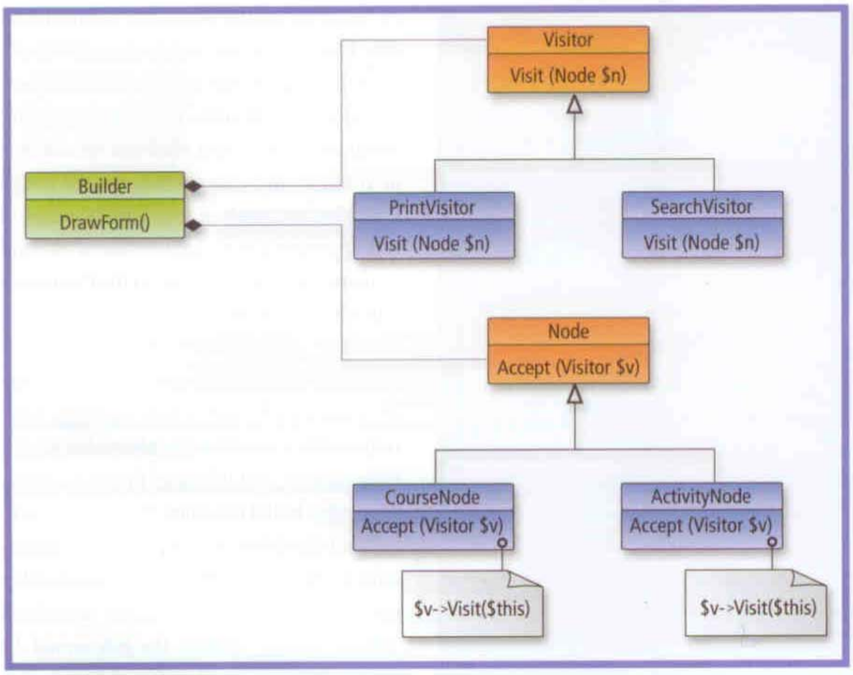


Fig. 5: Visitor pattern

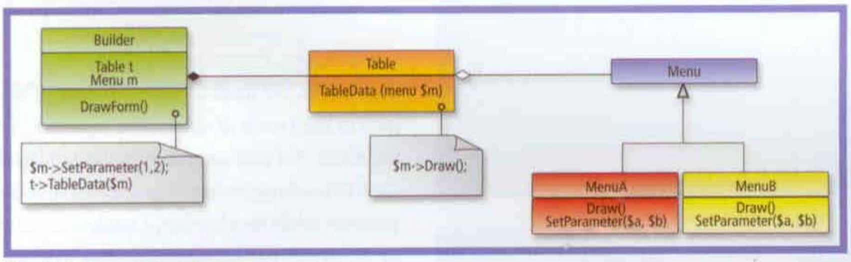


Fig. 6: Command pattern

tively ensures encapsulation, as the *Table* is ignorant about how the *Menu* changes.

Additional flexibility can be introduced with a string being used as a callback. As a result, even the callback function call in *Table* can be determined in *Builder*; such that *Table* remains ignorant about the action to manipulate both *Menu* and the *Menu* content.

This could be applied to an application for displaying library items, like books, CDs and magazines. The *Table* will have no idea of what it is displaying, since the *Builder* controls it.

To construct a form with even more complex structure, Chain of Responsibility can be employed (see Fig. 7). This is done by delegating the responsibilities in drawing a complex component to multiple objects. All these components should share the same interface, and the chain in performing the action can be arranged by the Composite pattern. With Composite pattern, the same abstract class represents the primitives and the container, such that recursive composition can be used and any discrimination can be avoided.

As shown in Fig. 7, it is the *Component*, instead of the *Builder*, which decides what oth-

## Listing 4:

```
<?php
function Visit(Node $node)
{
  // checking node type manually
  if ($node instanceof CourseNode) {
     $this->statement .= $node->Name;
  } else if ($node instanceof ActivityNode) {
     $this->statement .= $node->Time;
  }
}
?>
```

## Listing 5:

```
<?php
class CourseNode
{
  function Accept(Visitor $visitor)
  // the type of node is identified
  {
    $visitor->Visit($this);
    // concrete type of node is passed
    // to the visitor
  }
}
class PrintVisitor
{
  function Visit(CourseNode $node)
  // the type of visitor is identified
  {
    $this->statement .= $node->Name;
    // here, both the types of node and
    // visitor are known
  }
  function Visit(ActivityNode $node)
  {
    $this->statement .= $node->Time;
  }
}
?>
```

## Listing 6:

```
class State
{
  function checkState(Visitor $visitor)
  {
    $visitor->Visit($this);
  }
}
class ExceedState extends State
{
  function checkState(Visitor $visitor)
  {
    if ( $_SESSION['quota']-1 <= $limit ) {
      $_SESSION['state'] =
      new NormalState(); // change state
    } else {
    // some more if-else block to check
    // conditions and change state if necessary
    State::checkState($visitor);
    }
  }
}
```

er components they would use to finish their job. This adds loose coupling, since the objects that request the action would not know how it is done. Besides, more flexibility is introduced as the object used can be changed at runtime and components can be added easily by subclassing. One disadvantage of this approach is that the interface of all components must be the same, so the Composite pattern treats them equally.

In Listing 8, *Builder* delegates the responsibility of drawing the entire table to *Table*. *Table* notices that it would not be able to handle the table content, and delegates the job to *Menu*. *Menu* checks if it can finish the drawing by itself or it should further delegate the responsibility to others. In this case, each action caller can toss the unfinished job to the next object without caring whether the job would be thrown further. However, we have to ensure there is a recipient at the end of every chain.

### Creating by Prototype

Sometimes, we need to have an array of objects to keep track of different components in the form. For example, one application may need to keep track of a group of *Library* components, while another keeps track of a group of *Supermarket* components. The simplest method is to have different factories for different forms (see Fig. 8). But it would be wasteful to have so many factories if the construction logic of initiating the component is the same.

The Prototype pattern's construction framework can be used repeatedly for creating different components (see Fig. 9). The *Form* is given the prototype objects and it can use the same construction process with those objects cloned to build the entire form. The prototype object can be changed easily during runtime,

## Listing 7:

```
class Table
{
  // code for constructor and other instance
  // methods

  // Draw table content
  function tableData ($obj, $function,
       $colspan, $rowspan)
  {
  $statement = "<TD COLSPAN=$colspan
         ROWSPAN=$rowspan>";
  //command pattern
  $statement .= $obj->$function();
  $statement .= "</TD>";
  $statement .= "\n";
  return $statement;
  }
}
class Builder
{
  // code for constructor and other instance
  // methods

  // Build the form
  function build($info)
  {
// parameterize the action of drawing the menu
    $this->menu->setData($info);
    $this->statement .=
      $this->table->tableData($this->menu,
      "drawValue", 1, 1);
      //specify the callback drawValue
  //...some more codes for drawing the menu
  }
}
class Menu
{
  // code for constructor and other instance
  // methods

  // Set the parameter of Menu
  function setData($info)
  {
    $this->name = $info->getName();
    //...some more codes to parameterize the
    //menu
  }
  // Draw the value
  function drawValue()
  {
    $statement = $this->name;
    return $statement;
  }
}
```

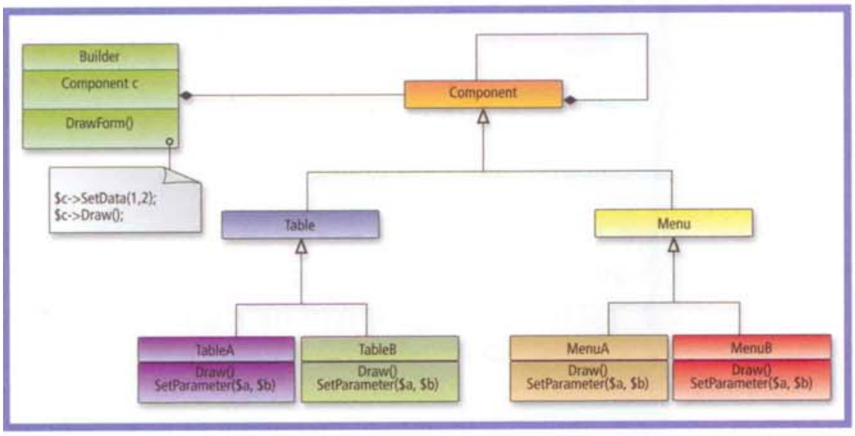
## Listing 8:

```
class Table
{
  //...some code
  // Draw table content
  function draw ($info)
  {
    if ($info->getType() == "menu") {
      $this->component = new Menu();
    } //..some more if-else block
    $this->statement =
     $this->component->Draw($info);
    return $this->statement;
    }
}
class Builder
{
  //...some codes
  // Build the form
  function build($info)
  {
    $this->component = new Table();
    $this->statement =
     $this->component->Draw($info);
  }
}
class Menu
{
  //...some codes
 // Set the parameter of Menu
  function draw ($info)
  {
    //code to check if further delegation
    // is needed

    if ($canHandle) {
      return $this->statement;
    } else if ($info->getType() == "menu") {
    //delegation to other objects
      $this->component = new content();
      $this->statement =
       $this->component->Draw($info);
      return $this->statement;
    }
  //..some more if- else block
  }
}
```

## Listing 9:

```
//Get multiple DataTransfers from Model,
// register in session
foreach ($values as $valueObject) {
   $obj =& $valueObject->getData();
   $name = $obj->getName();
   ${$name} = $obj;
   $_SESSION["$name"] = $obj;
}
```



```
$c->SetData(1,2);
$c->Draw();
```

Fig. 7: Chain of responsibility pattern

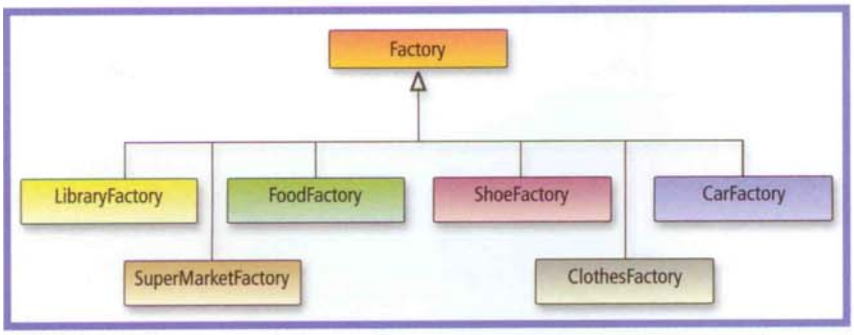


Fig. 8: Many factories

to allow for more dynamics. This is only possible with the new clone method in PHP 5.

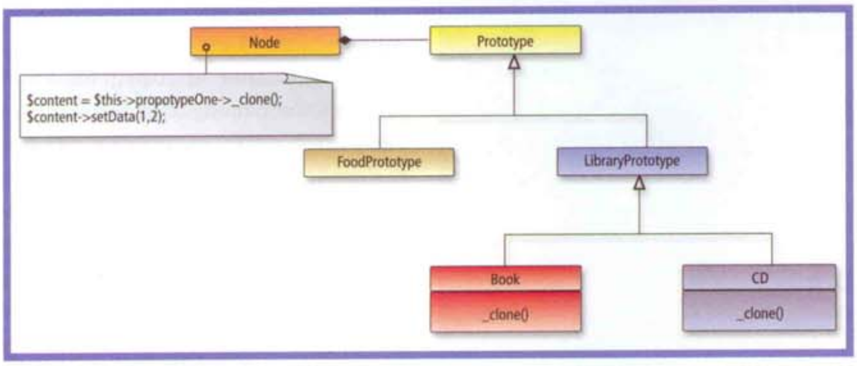
### Final Remarks on View

To transfer objects among Model, View, and Controller, we can create an object, say, *DataTransfer* with set/get methods to encapsulate all the data. This will help separate the data structure from the logic so they can be modified easily. This is especially true for PHP with its increasing third-party library list, and it is not surprising to see there are new libraries that provide data structures which fit the application better.

The *DataTransfer* object helps transfer data between forms. Otherwise, we would have to use Get/Post, which only deals with primitive type data. We can put everything we want to send in *DataTransfer*, serialise and register it in session. In this case, other forms can make use of the same object. Furthermore, the serialised object can be saved in files for logging or security use.

### Constraints in View

There is one advantage of MVC that cannot be applied to web applications. When new information is injected into the Model, it cannot update the View at once, because the web browser will not request new information unless the user refreshes it, which is referred to as the pull approach. However, the many advantages of the MVC model are sufficient to make it a valuable part of the development process.



```
$content = $this->propotypeOne->_clone();
$content->setData(1,2);
```

Fig. 9: Prototype pattern

### Conclusion

In this article, we have introduced various ways to utilise different design patterns to ease the development of applications, like implementing different interfaces for the same presentation, maintaining states, building complex components, and creating objects by prototypes. These patterns, if used properly, help reduce development time, as well as make extensions of existing applications as easy as possible.

*Man-ping Grace Chau and Ka-hung Hui are year-three undergraduate students at the Chinese University of Hong Kong, majoring in Information Engineering. They are also team mates of the school IT team, responsible for developing and maintaining over 10 systems in PHP for the entire school, including all kinds of attendance record systems, as well as school project databases.*

### Links & Literature

- phpPatterns' Intro to MVC: http://www.phppatterns.com/index.php/article/articleview/11/
- HowTo on the MVC Framework: http://st-www.cs.uiuc.edu/users/smarch/st-docs/mvc.html
- Ootips.com's introduction to MVC: http://ootips.org/mvc-pattern.html
- Tony Marston's introduction to MVC: http://www.tonymarston.net/php-mysql/model-view-controller.html
- For more information about design patterns, please refer to Design Patterns – Element of Reusable Object Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, from Addison Wesley (ISBN 0201633612)