COMP519 Web Programming

Lecture 26: Ajax

Handouts

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Contents

Ajax: Motivation


```
<form id='pc'><label>Postcode:</label>
<input type='text' name='pc' value=''>
<br><label>Address:</label>
<select name='adr' id='adr'></select>
</form>
```

- Entering an address into an HTML form is often a two-stage process
  1. Enter a postcode into a text field
  2. Select an entry from a drop-down menu of all addresses for the entered postcode
- To implement this process using PHP
  - Step 1 needs to result in a form submission to a PHP script
  - The PHP script needs to retrieve the addresses for the given postcode from a dabase
  - The PHP script then produces a complete HTML document with an updated form containing options for the drop-down menu
  - That HTML document is send back
  - The user can then perform Step 2

Ajax: Motivation


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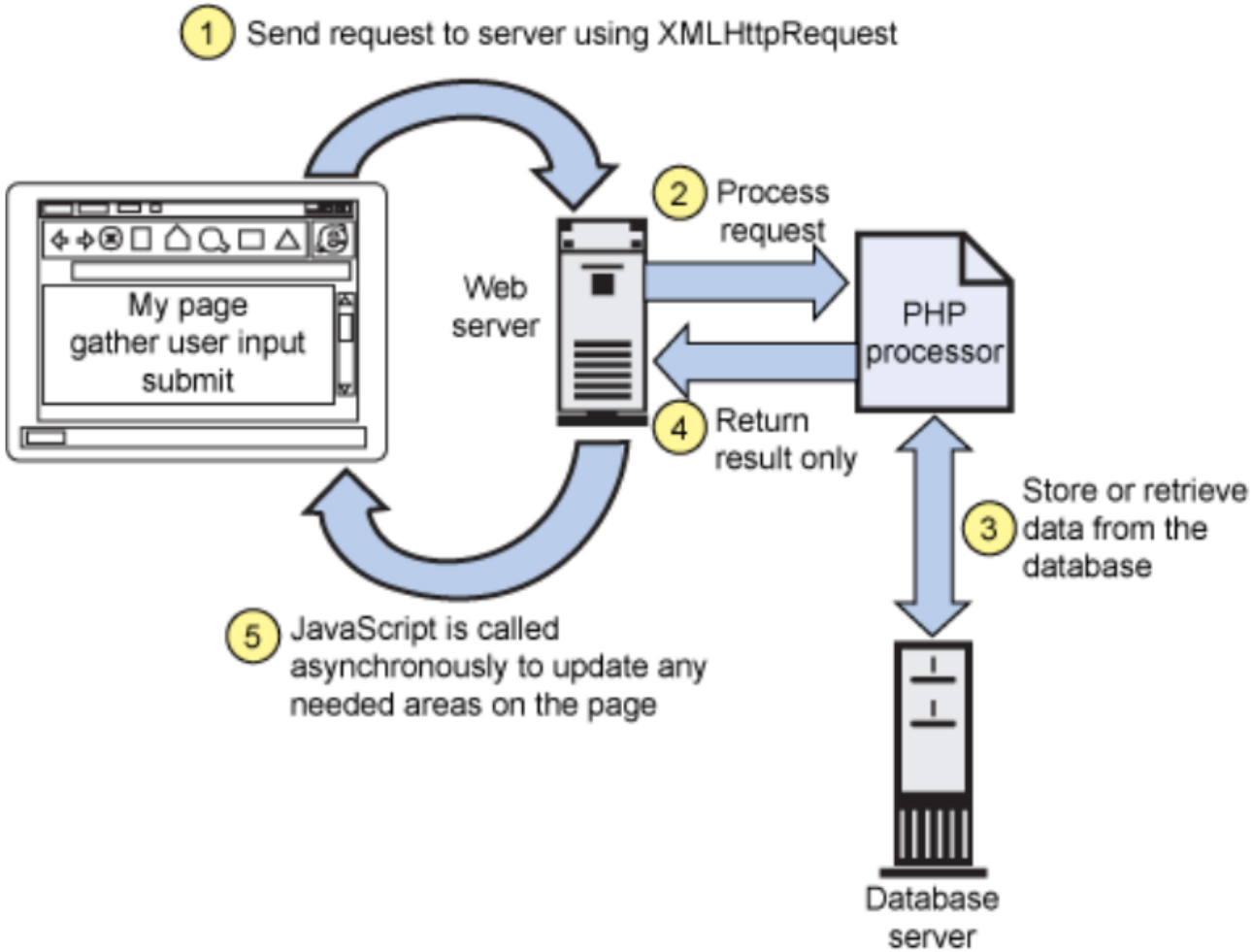
</form>
```

- Entering an address into an HTML form is often a two-stage process
  1. Enter a postcode into a text field
  2. Select an entry from a drop-down menu of all addresses for the entered postcode
- To implement this process using JavaScript
  - A JavaScript event handler is triggered when the user has completed Step 1
  - The JavaScript event handler uses an HTTP request to get the data for the drop-down menu
  - In response the the HTTP request, a PHP script retrieves the addresses for the given postcode from a database and sends them back
  - The JavaScript event handler constructs the drop-down menu
  - The user can then perform Step 2

Ajax: Overview

- Ajax, Asynchronous JavaScript and XML, is a set of JavaScript methods related to `XMLHttpRequest` objects and patterns for their use
- Ajax allows web applications to send and retrieve data from a server asynchronously (in the background)
- On the server-side, PHP scripts are typically used to receive / send data and to deal with related database transactions
- Historically, data was transferred in XML format though nowadays use of JSON is much more common

Ajax: Overview



K. Ramirez: Build Ajax-based Web sites with PHP. IBM, 2 Sep 2008.
`https://www.ibm.com/developerworks/library/wa-aj-php/`
[accessed 21 Nov 2019]

XMLHttpRequest Objects: Properties

`status`
HTTP status code returned by server (200, 403, 404, 500, . . .)
`statusText`
HTTP reason phrase returned by server ("OK", "Forbidden", "Page not found", "Internal Server Error")
`responseText`
Data returned by the server as a string
`responseXML`
Data returned by the server as `XMLDocument` object
`readyState`
Integer reporting the status of the request (0: uninitalised, 1: loading, 2: loaded, 3: interactive, 4: completed)
`onreadystatechange`
function to be called when the readyState property changes

XMLHttpRequest Objects: Methods

`open(`*method*`,`*url*`,`*async*`)`

Prepares an HTTP request by specifying
- the HTTP method *method* (as string),
- the target URL *url* (as string), and
- a boolean value *async* indicating whether the request should be handled asynchronously

```
open('POST','getdata.php',TRUE)
```

`setRequestHeader(`*param*`,`*value*`)`

Sets a parameter *param* to *value* and assigns it to the header of the HTTP request

```
setRequestHeader('Content-type',
                 'application/x-www-form-urlencoded')
```

`send(`*content*`)`

Send the HTTP request, optionally with POST data *content*

XMLHttpRequest Objects: Methods

`abort()`
Stop the current request
`getAllResponseHeaders()`
Returns all parameter/value pairs in the HTTP response as a string
`getResponseHeader(`*param*`)`
Returns the value for parameter *param* in the HTTP response as a string, or `null` if there is no value for *param*
`getResponseHeader('Content-type')`

XMLHttpRequest Objects: Example

```
function createSelectOptionsForPostcode(formData) {
  var request = new XMLHttpRequest()
  request.open('POST','getData.php',true)
  request.setRequestHeader('Content-type',
                           'application/x-www-form-urlencoded')
  request.onreadystatechange = function() {
    if (this.readyState == 4 && this.status == 200) {
      if (this.getResponseHeader('Content-type').indexOf('
    ↪xml') >= 0) {
        // process XML data sent by getData.php
        processXMLResponse(this.responseXML)
      } else if (this.getResponseHeader('Content-type').
    ↪indexOf('json') >= 0) {
        // process JSON data sent by getData.php
        processJSONResponse(this.responseText)
  } } }
  request.send(formData)
}
// createSelectOptionsForPostcode('postCode=L69+9AD')
```

JavaScript and Forms Revisited


```
<form id='pc'><label>Postcode:</label>
<input type='text' name='pc' value=''>
<br><label>Address:</label>
<select name='adr' id='adr'></select>
</form>
```

- The function `createSelectOptionsForPostcode` requires form data as argument, in particular, the user input from the Postcode field
- We can use JavaScript's `FormData` object to deal with that

`FormData([ form ])`
Creates a new FormData object When the optional *form* argument for a HTML form is specified, the FormData object will be populated with the form's current name/value pairs
`append(name, value)`
Adds or updates the name/value pair for *name*
`delete(name)`
Deletes the name/value pair for *name*

JavaScript and Forms Revisited


```
<form id='pc'><label>Postcode:</label>
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```

- The function `createSelectOptionsForPostcode` requires form data as argument, in particular, the user input from the Postcode field
- We can use JavaScript's `FormData` object to deal with that

```
var formElem = document.getElementById('pc')
var inptElem = document.querySelector('input')
inptElem.addEventListener('input', function (e) {
  // Construct FormData object
  var data = new FormData(formElem)
  createSelectOptionsForPostcode(data)
})
```

Retrieving the Data

```php
<?php
// getData.php
// We have a database with a table
//     postcodes(pc VARCHAR(8), address VARCHAR(300))
// We assume that PDO arguments have already been defined
if (isset($_POST['postCode'])) {
  try {
    $pdo     = new PDO($dsn,$db_username,$db_password,$opt);
    $tpl     = "select address from postcodes where pc = ?";
    $stm     = $pdo->prepare($tpl);
    $success = $stm->execute(array($_POST['postCode']));
    $data    = $stm->fetchAll();
    // Construct a HTTP response using a function
    // outputData that we have written
    outputData($data);
  } catch (PDOException $e) {
    outputData(array(0 => array('error' => $e)));
} }
?>
```

Constructing the HTTP Response

Our database query has returned a two-dimensional array, e.g.,

```
array(
  0 => array('address' => '1 Rose Lane, Liverpool'),
  1 => array('address' => 'Lennox, 2 Rose Lane, Liverpool'),
  2 => array('address' => 'Flat A, 3 Rose Lane, Liverpool'),
  ...
)
```

In the HTTP response we can represent this array

- in a user-defined format
- in XML (eXtensible Markup Language) format
  (a 'heavyweight' data-interchange format built on markup with user-defined tags)

```
<?xml version="1.0"?>
<data><item0><address>1 Rose Lane, Liverpool</address></item0>
      <item1><address>Lennox, 2 Rose Lane, Liverpool</address></item1>
      <item2><address>Flat A, 3 Rose Lane, Liverpool</address></item2>
</data>
```

- in JSON format

Constructing the HTTP Response

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```
array(
  0 => array('address' => '1 Rose Lane, Liverpool'),
  1 => array('address' => 'Lennox, 2 Rose Lane, Liverpool'),
  2 => array('address' => 'Flat A, 3 Rose Lane, Liverpool'),
  ...
)
```

In the HTTP response we can represent this array

- in a user-defined format
- in XML format
- in JSON format

  (a lightweight data-interchange format built on (i) primitive values (numbers, strings), (ii) collections of name/value pairs, (iii) ordered lists of values)

```
[{"address":"1 Rose Lane, Liverpool"},
 {"address":"Lennox, 2 Rose Lane, Liverpool"},
 {"address":"Flat A, 3 Rose Lane, Liverpool"}]
```

Constructing the HTTP Response: XML

In PHP, we can use the `SimpleXMLElement` class to construct XML elements

`__construct(string xml)`
xml is a well-formed XML string
`new SimpleXMLElement('<?xml version="1.0"?><data></data>')`
`addChild(string elem [, string str])`
Adds an element *elem* with content *str*, if specified
`addChild('name','Peter')  # <name>Peter</name>`
`addAttribute(string attr [, string val])`
Adds an attribute *attr* with value *val* to an element
`asXML([string fn])`
If a filename *fn* is not specified, returns a string representation of an element in XML 1.0 format, otherwise, writes that string to *fn*
`children()`
Finds the children of an element

Constructing the HTTP Response: XML

```
function arrayToXML($data, &$xml) {
  foreach ($data as $key => $value) {
    if (is_numeric($key)) {
      $key = 'item'.$key; //dealing with <0/>..<n/> issues
    }
    if (is_array($value)) {
      $subnode = $xml->addChild($key);
      arrayToXML($value, $subnode);
    } else {
      $xml->addChild("$key",htmlspecialchars("$value"));
} } }

function outputData($data) {
  $xml = new SimpleXMLElement(
             '<?xml version="1.0"?><data></data>');
  arrayToXML($data,$xml);
  header('Content-type: application/xml');
  echo($xml->asXML());
}
```

https://stackoverflow.com/a/5965940

Constructing the HTTP Response: JSON

In PHP, we can use the `json_encode` function to construct XML elements

```
json_encode(mixed value [, int options [, int dep]])
```

Returns the JSON representation of *value* up to nesting depth *dep* with encoding modified by *options*

Options include

`JSON_UNESCAPED_UNICODE`: Preserve UTF-8 characters

```
json_encode(['name'=>'Peter']) # {"name":"Peter"}
```

```
json_decode(string value [, bool assoc
                          [, int dep [, int options]]])
```

Returns a PHP value for a JSON encoded string *value* up to nesting depth *dep* with decoding modified by *options* and if *assoc* is `TRUE` returns arrays instead of objects for key/value pairs

```
json_decode('{"name": "Peter"}')
```

```
Object with a property "name" that has value "Peter"
```

```
json_decode('{"name": "Peter"}',TRUE)
```

```
Array ["name" => "Peter"]
```

Constructing the HTTP Response: JSON

```
function outputData($data) {
  header('Content-Type: application/json; charset=utf-8');
  echo json_encode($data,JSON_UNESCAPED_UNICODE);
}
```

Processing the HTTP Response: XML

- The XML DOM defines a standard way for accessing and manipulating XML documents / XML document objects
- The XML DOM views an XML document as a tree structure of nodes
  - The entire document is a document node
  - Every XML element is an element node
  - The text in the XML elements are text nodes
  - Every attribute is an attribute node

Document nodes have an attribute

`documentElement`

Returns the root element 'below' a document node

Document nodes and element nodes have a method

`getElementsByTagName(`*name*`)`

Returns a collection of all element nodes in a node tree with the specified tag name *name*

Processing the HTTP Response: XML

- The XML DOM defines a standard way for accessing and manipulating XML documents / XML document objects
- The XML DOM views an XML document as a tree structure of nodes

All nodes have attributes

`nodeName`
Returns the name of a node as a string, for element nodes this is the tag name, for attribute nodes, the attribute name
`nodeValue`
Returns or sets the value of a node as a string, for text nodes this is the text content of the node
`childNodes`
Returns a collection of children of a node, indexed by natural numbers starting from 0
`childNodes.length`
Returns the number of children

Processing the HTTP Response: XML

```
// <data>
//   <item0><address>1 Rose Lane</address></item0>
//   <item1><address>Lennox, 2 Rose Lane</address></item1>
//   <item2><address>Flat A, 3 Rose Lane</address></item2>
// </data>
```

```
function processXMLResponse(xml) {
  var o   = document.createElement('option')
  o.label = 'Select an address'
  o.value = ''
  sel = document.getElementById('adr')
  sel.appendChild(o)
  adrs = xml.getElementsByTagName('address')
  for (i = 0; i < adrs.length; i++) {
    o = document.createElement('option')
    o.label = o.text = adr[i].childNodes[0].nodeValue
    sel.appendChild(o)
} }
```

```
<option value=''>Select an address</option>
<option value='1 Rose Lane'>1 Rose Lane</option>
<option value='Lennox, 2 Rose Lane'>Lennox, 2 Rose Lane</option>
<option value='Flat A, 3 Rose Lane'>Flat A, 3 Rose Lane</option>
```

Processing the HTTP Response: JSON

- The JSON object contains methods for parsing JavaScript Object Notation (JSON) and converting values to JSON
- There is no constructor for new / additional JSON objects

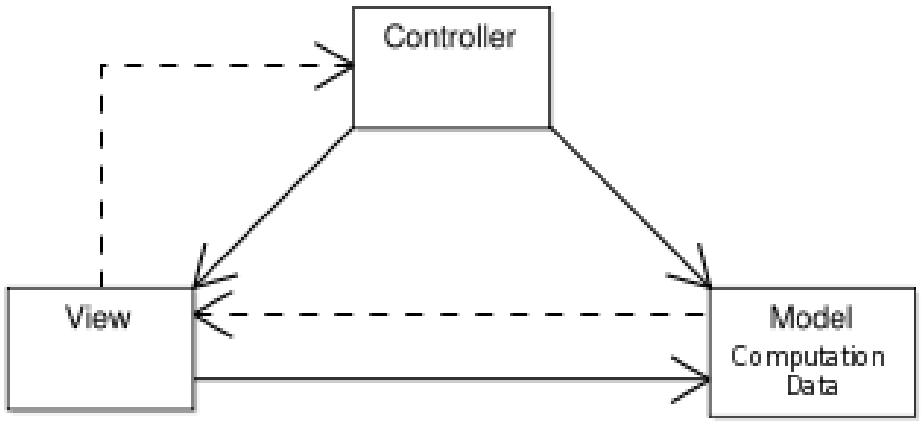
`JSON.parse(`*`text`* `[, `*`reviver`*`])`
Parses a JSON string *`text`* and returns the corresponding JavaScript value transformed further by the optional *`reviver`* function
`JSON.stringify(`*`value`* `[, `*`replacer`* `[, `*`space`*`]])`
Converts a JavaScript value to a JSON string *`value`*, optionally replacing values if a function *`replacer`* and adding space as specified by *`space`*

Processing the HTTP Response: JSON

```
// [{"address":"1 Rose Lane, Liverpool"},
//  {"address":"Lennox, 2 Rose Lane, Liverpool"},
//  {"address":"Flat A, 3 Rose Lane, Liverpool"}]
function processJSONResponse(text) {
  adrs = JSON.parse(text)
  var o = document.createElement("option")
  o.label = "Select an address"
  o.value = ""
  sel = document.getElementById('adr')
  sel.appendChild(o)
  for (i = 0; i < adrs.length; i++) {
    o = document.createElement("option")
    o.label = o.text = adrs[i].address
    sel.appendChild(o)
} }
```

```
<option value=''>Select an address</option>
<option value='1 Rose Lane'>1 Rose Lane</option>
<option value='Lennox, 2 Rose Lane'>Lennox, 2 Rose Lane</option>
<option value='Flat A, 3 Rose Lane'>Flat A, 3 Rose Lane</option>
```

Ajax and Model-View-Controller



- Without Ajax and without JavaScript,
  - a lot of the Controller and
  - all of the Model

  must reside on the server-side and is programmed in PHP
- With Ajax and with JavaScript,
  - all of the Controller and
  - a lot of the Model

  can reside on the client-side and is programmed in JavaScript

Revision and Further Reading

- Read
  - Chapter 18: Using Asynchronous Communication

  of R. Nixon: Learning PHP, MySQL & JavaScript: with jQuery, CSS & HTML5. O'Reilly, 2018.

Revision and Further Reading

- Read
  - Function Reference: XML Manipulation
    `https://www.php.net/manual/en/refs.xml.php`
  - Function Reference: JavaScript Object Notation
    `https://www.php.net/manual/en/book.json.php`

  of P. Cowburn (ed.): PHP Manual. The PHP Group, 24 Nov 2019. `http://uk.php.net/manual/en` [accessed 25 Nov 2019]
- Read
  - Mozilla and individual contributors: Document Object Model (DOM). *MDN Web Docs*, 17 Nov 2019. `https://developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model` [accessed 25 Nov 2019]
  - Mozilla and individual contributors: JSON. *MDN Web Docs*, 4 Nov 2019. `https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/JSON` [accessed 25 Nov 2019]