COMP519 Web Programming

Lecture 17: JavaScript (Part 8)

Handouts

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Contents

Window and Document objects

JavaScript provides two objects that are essential to the creation of dynamic web pages and interactive web applications:

document object

- an object-oriented representation of a web page (HTML document) that is displayed in a window
- allows interaction with the Document Object Model (DOM) of a page

  Example: `document.writeln()` adds content to a web page

Document Object Model

A platform- and language-neutral interface that allows programs and scripts to dynamically access and update the content, structure and style of HTML, XHTML and XML documents

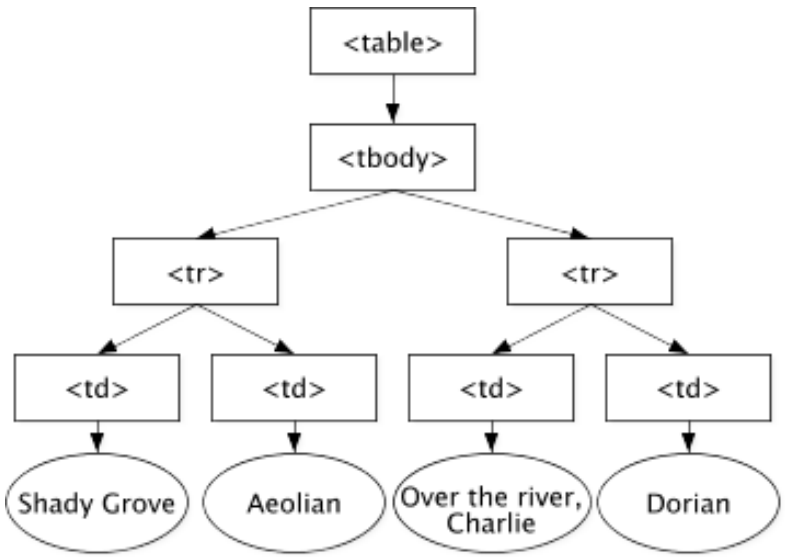
Document Object Model

Example:

The HTML table below

```
<table>
  <tbody>
    <tr>
      <td>Shady Grove</td>
      <td>Aeolian</td>
    </tr>
    <tr>
      <td>Over the River, Charlie</td>
      <td>Dorian</td>
    </tr>
  </tbody>
</table>
```

is parsed into the following DOM



Arnaud Le Hors, et al, editors: Document Object Model (DOM) Level 3 Core Specification, Version 1.0, W3C Recommendation 07 April 2004. World Wide Web Consortium, 2004. https://www.w3.org/TR/DOM-Level-3-Core/ [accessed 9 January 2017]

Accessing HTML Elements: Object Methods

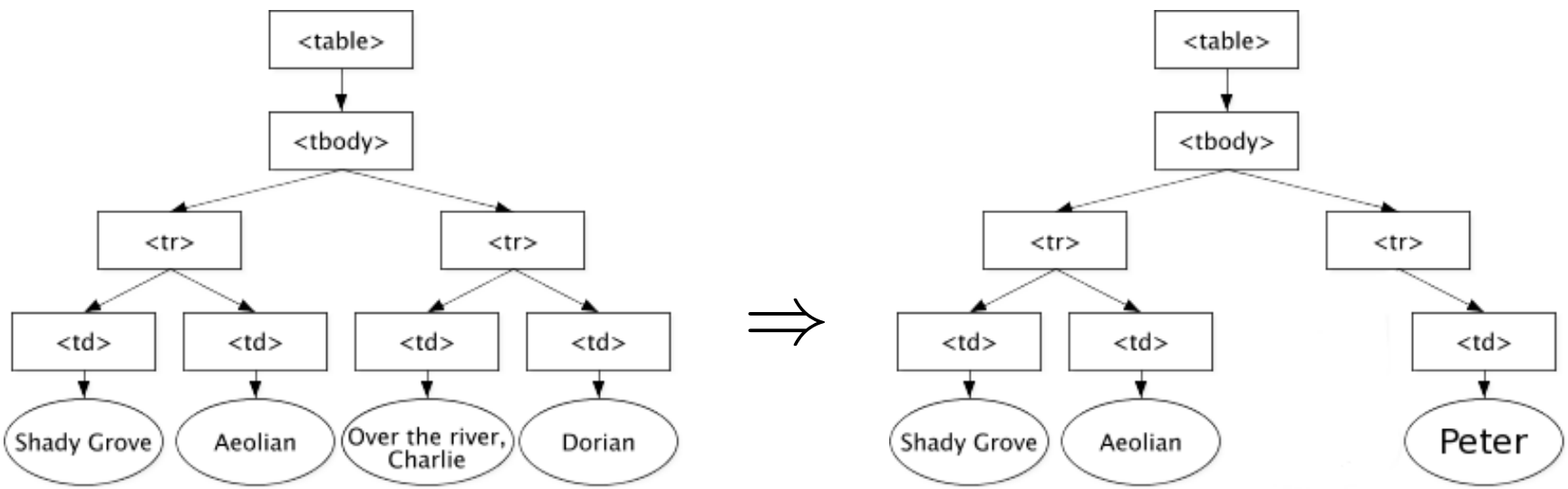
Example:

```
// access the tbody element from the table element
var myTbodyElement = myTableElement.firstChild;

// access its second tr element; the list of children starts at 0 (not 1).
var mySecondTrElement = myTbodyElement.childNodes[1];

// remove its first td element
mySecondTrElement.removeChild(mySecondTrElement.firstChild);

// change the text content of the remaining td element
mySecondTrElement.firstChild.firstChild.data = "Peter";
```



Accessing HTML Elements: Names (1)

Instead of using methods such as `firstChild` and `childNodes[n]`, it is possible to assign names to denote the children of an HTML element

Example:

```
<form name="form1" action="">
<label>Temperature in Fahrenheit:</label>
<input type="text" name="fahrenheit" size="10" value="0"><br>
<label>Temperature in Celsius:</label>
<input type="text" name="celsius"    size="10" value="">
</form>
```

Then – `document.form1`
Refers to the form named `form1`

– `document.form1.celsius`
Refers to the text field named `celsius` in `document.form1`

– `document.form1.celsius.value`
Refers to the attribute `value` in the text field named `celsius` in `document.form1`

Accessing HTML elements: Names (2)

Accessing HTML elements by giving them names and using paths within the Document Object Model tree structure is still problematic

⇝ If that tree structure changes, then those paths no longer work

Example:

Changing the previous form to

```
<form name="form1" action="">
<div class="field" name="fdiv">
<label>Temperature in Fahrenheit:</label>
<input type="text" name="fahrenheit" size="10" value="0">
</div>
<div class="field" name="cdiv">
<label>Temperature in Celsius:</label>
<input type="text" name="celsius"    size="10" value="" >
</div>
</form>
```

means that `document.form1.celsius` no longer works as there is now a `div` element between form and text field, we would now need to use `document.form1.cdiv.celsius`

Accessing HTML elements: IDs

A more reliable way is to give each HTML element an ID (using the `id` attribute) and to use `getElementById` to retrieve an HTML element by its ID

Example:

```
<form id="form1" action="">
Temperature in Fahrenheit:
<input type="text" id="fahrenheit"  size="10" value="0"><br>
Temperature in Celsius:
<input type="text" id="celsius"     size="10" value="" ><br>
</form>
```

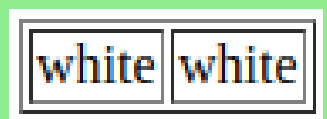
Then

- `document.getElementById('celsius')`
  Refers to the HTML element with ID `celsius` `document`
- `document.getElementById('celsius').value`
  Refers to the attribute `value` in the HTML element with ID `celsius` in `document`

Manipulating HTML elements (1)

It is not only possible to access HTML elements,
but also possible to change them on-the-fly

```
<html><head><title>Manipulating HTML elements (1)</title>
<style>
  td.RedBG { background: #f00; }
</style>
<script>
function changeBackgroundBlue(id) {
  document.getElementById(id).style.background = "#00f";
  document.getElementById(id).innerHTML = "blue";
}
function changeBackgroundRed(cell) {
  cell.className = "RedBG";
  cell.innerHTML = "red";
}
</script></head><body>
<table border="1"><tr>
 <td id="0" onclick="changeBackgroundBlue('0');">white</td>
 <td id="1" onclick="changeBackgroundRed(this);">white</td>
</tr></table></body></html>
```

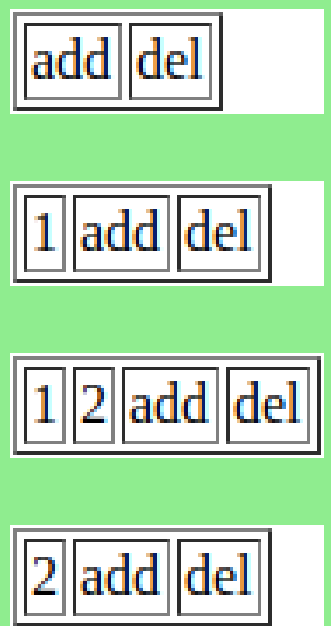


http://cgi.csc.liv.ac.uk/~ullrich/COMP519/examples/jsBG.html

Manipulating HTML elements (2)

It is not only possible to access HTML elements,
but also possible to add new ones and remove old ones on-the-fly

```
<html><head><title>Manipulating HTML elements (2)</title></head>
<body><table border="1"><tr>
<td onclick="addLeft(this);">add</td>
<td onclick="removeLeft(this.parentNode);">remove</td>
</tr></table><script>
function addLeft(node) {
  // Maintain a counter that is incremented with each call
  addLeft.counter = addLeft.counter || 0;
  addLeft.counter++;
  // Create a new TD element with counter as content
  newTD = document.createElement('td');
  newTD.innerHTML = addLeft.counter;
  newTD.setAttribute('id',addLeft.counter);
  // Add the new TD element before the current one
  node.parentNode.insertBefore(newTD,node);
}
function removeLeft(parent) {
  parent.removeChild(parent.firstChild);
}
</script></body></html>
```



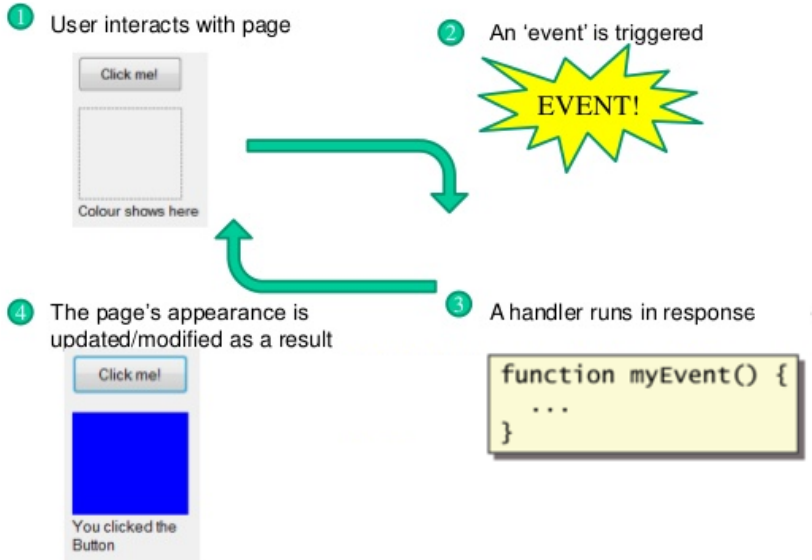
http://cgi.csc.liv.ac.uk/~ullrich/COMP519/examples/jsTD.html

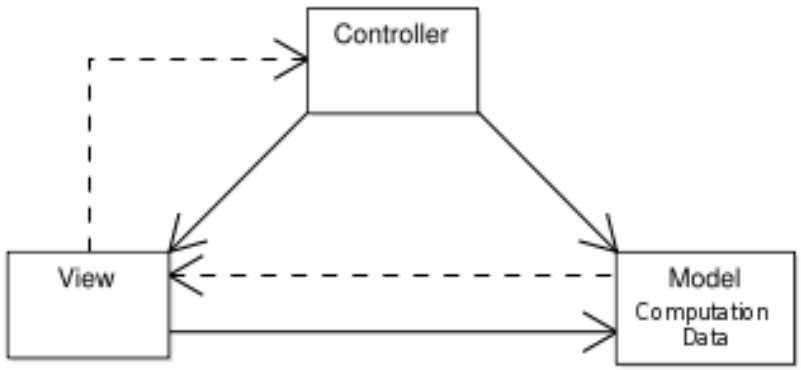
Event-driven JavaScript Programs

- The JavaScript programs we have seen so far were all executed sequentially
  - programs have a particular starting point
  - programs are executed step-by-step, involving control structures and function execution
  - programs reach a point at which their execution stops

Event-Driven JavaScript Programs

- Web applications are event-driven
  ⇝ they react to events such as mouse clicks and key strokes





nickywalters: What is Event Driven Programming?
SlideShare, 7 September 2014.
`https://tinyurl.com/ya58xbs9` [accessed 5/11/2017]

- With JavaScript,
  – we can define event handler functions for a wide variety of events
  – event handler functions can manipulate the `document` object (changing the web page in situ)

Event Handlers and HTML Elements

- HTML events are things, mostly user actions, that happen to HTML elements
- Event handlers are JavaScript functions that process events
- Event handlers must be associated with HTML elements for specific events
- This can be done via attributes

```
<input type="button" value="Help"  onclick="Help()">
```

- Alternatively, a JavaScript function can be used to add a handler to an HTML element

```
// All good browsers
window.addEventListener("load", Hello)
// MS IE browser
window.attachEvent("onload", Hello)
```

More than one event handler can be added this way to the same element for the same event or different events

Event Handlers and HTML Elements

- As our scripts should work with as many browsers as possible, we need to detect which method works:

```
if (window.addEventListener) {
   window.addEventListener("load", Hello)
} else {
   window.attachEvent("onload", Hello)
}
```

- Event handlers can also be removed

```
if (window.removeEventListener) {
   window.removeEventListener("load", Hello)
} else {
   window.detachEvent("onload", Hello)
}
```

Events: Load

- An (on)load event occurs when an object has been loaded
- Typically, event handlers for onload events are associated with the window object or the body element of an HTML document

```
<!DOCTYPE html>
<html lang="en-GB">
  <head>
    <title>Onload Example</title>
    <script>
      function Hello() { alert("Welcome to my page!")  }
    </script>
  </head>
  <body onload="Hello()">
    <p>Content of the web page</p>
  </body>
</html>
```

http://cgi.csc.liv.ac.uk/~ullrich/COMP519/examples/jsOnload.html

Events: Focus / Change

- A focus event occurs when a form field receives input focus by tabbing with the keyboard or clicking with the mouse
  ⇝ `onFocus` attribute
- A change event occurs when a select, text, or textarea field loses focus and its value has been modified
  ⇝ `onChange` attribute

Example:

```
<form name="form1" method="post" action="process.php">
  <select name="select" required
          onChange="document.form1.submit();">
    <option value="">Select a name</option>
    <option value="200812345">Tom Beck</option>
    <option value="200867890">Jim Kent</option>
  </select>
</form>
```

Events: Focus / Change

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```
<form>
<label>Temperature in Fahrenheit:</label>
<input type="text" id="fahrenheit" size="10" value="0"
 onchange="document.getElementById('celsius').value =
 FahrenheitToCelsius(parseFloat(
  document.getElementById('fahrenheit').value)).toFixed(1);"
 ><br>
<label>Temperature in Celsius:</label>
<input type="text" id="celsius"
 size="10" value="" onfocus="blur();"></form>
```

http://cgi.csc.liv.ac.uk/~ullrich/COMP519/examples/jsOnchange.html

Events: Blur / Click

- A blur event occurs when an HTML element loses focus
  $\rightsquigarrow$ `onBlur` attribute
- A click event occurs when an object on a form is clicked
  $\rightsquigarrow$ `onClick` attribute

Example:

```
<html><head><title>Onclick Example</title></head><body>
<form name="form1" action="">
  Enter a number here:
  <input type="text" size="12" id="number" value="3.1">
  <br><br>
  <input type="button" value="Double"
    onclick="document.getElementById('number').value =
    parseFloat(document.getElementById('number').value)
    * 2;">
</form></body></html>
```

`http://cgi.csc.liv.ac.uk/~ullrich/COMP284/examples/jsOnclick.html`

Events: MouseOver / Select / Submit

- A keydown event occurs when the user presses a key
  $\rightsquigarrow$ `onkeydown` attribute
- A mouseOver event occurs once each time the mouse pointer moves over an HTML element from outside that element
  $\rightsquigarrow$ `onMouseOver` attribute
- A select event occurs when a user selects some of the text within a text or textarea field
  $\rightsquigarrow$ `onSelect` attribute
- A submit event occurs when a user submits a form
  $\rightsquigarrow$ `onSubmit` attribute

Events and DOM

- When an event occurs, an event object is created
  ⇝ an event object has attributes and methods
  ⇝ event objects can be created by your code
  independent of an event occurring
- In most browsers, the event object is passed to event handler functions as an argument
- In most versions of Microsoft Internet Explorer, the most recent event can only be accessed via `window.event`

```
<html><body onKeyDown="processKey(event)">
 <script>
  function processKey(e) {
    e = e || window.event
    document.getElementById("message").innerHTML =
      String.fromCharCode(e.keyCode)+' has been pressed' }
 </script>
 <!-- key code will appear in the paragraph below -->
 <p id="message"></p>
</body></html>
```

Example: Two-Player Board Game

- We want to develop a two-player board game along the lines of Tic-Tac-Toe
- The full code is available at

  `http://cgi.csc.liv.ac.uk/~ullrich/COMP519/examples/jsBoard.html`

- The interface will consist of a 3x3 table representing the board and a section for messages, both of which will be generated dynamically

```
<body>
  <table id="t1"></table>
  <div id="m1"></div>
  <script>...</script>
</body>
```

Example: Two-Player Board Game

- Following the Model-View-Controller paradigm we need a model of the game, including the board and overall state of the

```
var board = [[0,0,0],[0,0,0],[0,0,0]];
var free  = 9;  // free positions on the board
var turn  = 1;  // alternates between 0 and 1
```

- We will use 0 to represent an empty position on the board
  1 to represent a position taken by player 1
  2 to represent a position taken by player 2
- We have a function that turns these values into 'nice' representations

```
function numToLetter(num) {
  switch (num) {
    case 0: return " "
    case 1: return "O"
    case 2: return "X"
  }
}
```

Example: Two-Player Board Game

- We need a function to show a message to the user and another to clear that message

```
function showMessage(message,style) {
   m1 = document.getElementById("m1");
   m1.innerHTML = message;
   m1.style.display = "block";
   m1.className = style;
}

function clearMessage() {
   m1 = document.getElementById("m1");
   m1.style.display = "none";
}
```

Example: Two-Player Board Game

- The `play` function implements the turn of a user

```
function play(x,y,event) {
  clearMessage();
  console.log("x = " + x + " y = " + y);
  console.log("b = " + board[y][x]);
  if (board[y][x] > 0) {
     showMessage("Grid position [" + x + "," + y +
                 "] already occupied","RedBG");
  } else {
    board[y][x] = 2 - turn;
    free--;
    event.target.innerHTML = numToLetter(2 - turn);
    turn = 1 - turn;
  }
}
```

- Arguments x and y are the co-ordinates on which the player as placed a piece
- `event` is the event that was triggered and `event.target` gives us the HTML element / table cell on which it was triggered

Example: Two-Player Board Game

- At the start we create a representation of the board

```
function init(table) {
  for (j=0; j<board.length; j++) {
    var tr = document.createElement("tr");
    table.appendChild(tr);
    for (i=0; i<board[j].length; x++) {
      var td  = document.createElement("td");
      var txt = document.createTextNode(
                    numToLetter(board[j][i]);
      td.appendChild(txt);
      td.setAttribute('id',"" + x + y);
      td.addEventListener("click",play.bind(null,i,j));
      tr.appendChild(td);
} } }
table = document.getElementById('t1');
init(table);
```

- `play.bind` makes sure that parameters x and y of `play` are bound to the current values of i and j

Example: Two-Player Board Game

- Finally, we add some CSS directives to improve the visual appearance of the game

```
<style>
td { border:          1px solid black;
     width:           2em;
     height:          2em;
     text-align:      center;
     vertical-align: middle;
 }
div.RedBG  {
     background-color: #f00;
}
div.GreenBG  {
     background-color: #0f0;
}
</style>
```

Example: Adding a Computer Player / Delays

```
var processing = false

async function play(x,y,event) {
  if (!processing) {
    processing = true;
    clearMessage();
    if (board[y][x] > 0) {
     showMessage("Grid position [" + x + "," + y +
                 "] already occupied","RedBG");
    } else {
      board[y][x] = 2 - turn; free--;
      event.target.innerHTML = numToLetter(2 - turn);
      turn = 1 - turn;
      await sleep(250); // sleep 250ms
      computerMove();
      processing = false
} } }

function sleep(ms) {
  return new Promise(resolve => setTimeout(resolve, ms)) }
```

Example: Two-Player Board Game

Possible improvements:

- We should detect that the board is full (`free == 0`) and end the game with an appropriate message
- We should detect a winning placement of pieces on the board, end the game and declare a winner
- If we have a computer player, then we need to implement `computerMove`

Revision and Further Reading

- Read
  - Chapter 21: Introduction to JavaScript: Events
  - Chapter 22: Using JavaScript: Meet the DOM

  of J. Niederst Robbins: Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics (5th ed). O'Reilly, 2018.
  E-book `https://library.liv.ac.uk/record=b5647021`
- Read
  - Chapter 10: The Document Object Model
  - Chapter 12: Events

  of N. C. Zakas: Professional JavaScript for Web developers. Wrox Press, 2009.
  Harold Cohen Library 518.59.Z21 or
  E-book `http://library.liv.ac.uk/record=b2238913`