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Document Object Model

CITS3403: Agile Web Development

Semester 1, 2017

Introduction

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- We've seen JavaScript *core*
  - provides a general scripting language
  - but why is it so useful for the web?
- *Client-side* JavaScript adds collection of objects, methods and properties that allow scripts to interact with HTML documents
  - ➡ dynamic documents
  - ➡ client-side programming
- This is done by bindings to the *Document Object Model* (DOM)

- **What is the Document Object Model?**
  - "The Document Object Model is a *platform- and language-neutral* interface that will allow programs and scripts to *dynamically access and update the content, structure and style of documents*."
  - "The document can be further processed and the results of that processing can be incorporated back into the presented page."

  http://www.w3.org/DOM/

The Document Object Model

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- **Why the Document Object Model?**
  - "*Dynamic HTML*" *(DHTML)* is a term used by some vendors to describe the combination of (X)HTML, style sheets and scripts that allows documents to be animated.
  - The W3C has received several submissions from member companies on the way in which the object model of HTML documents should be exposed to scripts.
  - The W3C DOM Activity is working hard to make sure *interoperable and scripting-language neutral solutions* are agreed upon.

    http://www.w3.org/DOM/

Bindings

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- DOM specifications describe an abstract model of a document
  - API between XHTML document and program
  - Interfaces describe methods and properties
  - Different languages will *bind* the interfaces to specific implementations
    - In JavaScript, data are represented as properties and operations as methods

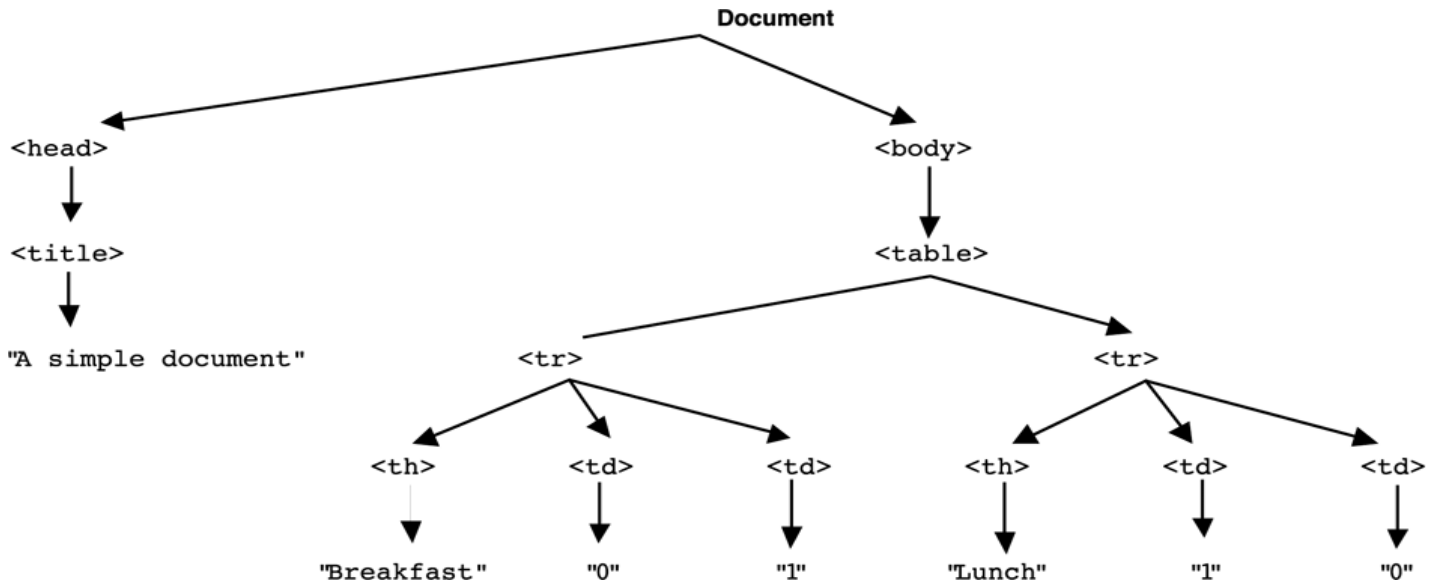
- W3C DOM specifications only define two language bindings for the Document Object Model API
  - Java
  - ECMAScript (JavaScript)
- Third party
  - DOM1: C, C++, PLSQL
  - DOM2: Python, Lingo, C++, PHP
  - DOM3: C++

http://www.w3.org/DOM/Bindings

The DOM Tree

- DOM API describes a *tree* structure
  - reflects the hierarchy in the XHTML document
  - example...

```
<html xmlns = "http://www.w3.org/1999/xhtml">
  <head>
    <title> A simple document </title>
  </head>
  <body>
   <table>
      <tr>
         <th>Breakfast</th>
         <td>0</td>
         <td>1</td>
      </tr>
      <tr>
         <th>Lunch</th>
         <td>1</td>
         <td>0</td>
      </tr>
   </table>
  </body>
</html>
```



Execution Environment

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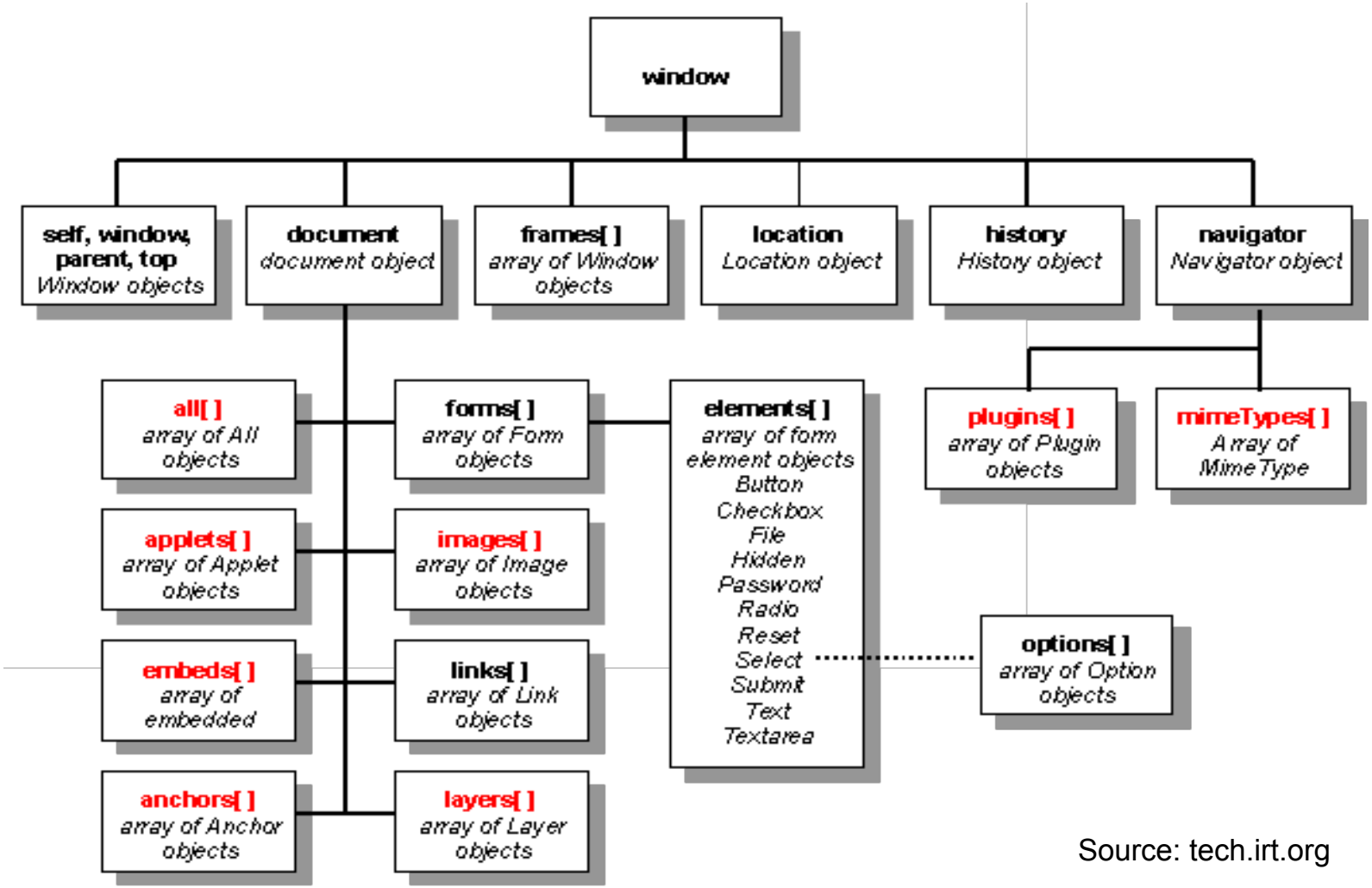
- The DOM tree also includes nodes for the execution environment in a browser
- Window object represents the window displaying a document
  - All properties are visible to all scripts
  - Global variables are properties of the Window object
- Document object represents the HTML document displayed
  - Accessed through document property of Window
  - *Property arrays* for forms, links, images, anchors, …

DOM Tree in More Detail



Source: tech.irt.org

JavaScript and the DOM

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- *Elements* in HTML document correspond to *nodes* on the tree
- These *nodes* bind to JavaScript *Element objects*
- *Attributes* of elements become named *properties* of element node objects
  - `<input type="text" name="address">`
  - The object representing this node will have two properties
    - *type* property will have value "text"
    - *name* property will have value "address"
- Node objects can be addressed in several ways:
  - *arrays* defined in DOM 0
    - forms, elements, images, links,...
    - individual elements are specified by index
  - by *name*
  - by *id*

Method 1: Using DOM Address

- Consider this simple form:

```
<form action = "">
    <input type = "button"  name = "pushMe">
</form>
```

- The *input* element can be referenced (assuming this is the first form in the document) as

```
document.forms[0].element[0]
```

- Problem: index may change when the form changes!

Method 2: Using Name Attributes

- Using the name attributes for form and form elements
  - Reference using Java/JavaScript "." notation

- Example

```
<form name = "myForm"  action = "">
    <input type = "button"  name = "pushMe">
</form>
```

- Referencing the input

```
document.myForm.pushMe
```

- In order to work, all elements from the reference element up to, but not including, the body must have a name attribute
- Problem: This violates XHTML standards in some cases - may cause validation problems
  - XHTML 1.1 standard does not allow *name* attribute in form element
- Names are nevertheless required on form elements by server-side scripts

Method 3: Using ID

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- Using `getElementById` with id attributes (cf CSS)
  - id attribute value must be unique for an element
- Example:
  - Set the id attribute of the input element

```
<form action = "">
  <input type="button" id="turnItOn">
</form>
```

  - Then use `getElementById`

```
document.getElementById("turnItOn")
```

Other Access Methods

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- A range of other "short cut" methods may be provided
- Eg. `getElementsByTagName`

```
var tables = document.getElementsByTagName("table");
alert("This document contains " + tables.length + " tables");
```

- Checkboxes and radio buttons have an implicit array, which has their name as the array name

```
<form id = "topGroup">
  <input type = "checkbox"  name = "toppings"
         value = "olives" />
  ...
  <input type = "checkbox"  name = "toppings"
         value = "tomatoes" />
</form>
...
var numChecked = 0;
var dom = document.getElementById("topGroup");
for index = 0; index < dom.toppings.length;index++)
  if (dom.toppings[index].checked]
    numChecked++;
```

DOM Tree Traversal and Modification

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- As we've seen each element in an XHTML document has a corresponding `Element` object in the DOM representation
- The `Element` object has methods to support
  - *Traversing the document*
    - that is, visiting each of the document nodes
  - *Modifying the document*
    - for example, removing and inserting child nodes

- Various properties of `Element` objects are related nodes, eg:
  - `parentNode` references the parent node of the Element
  - `previousSibling` and `nextSibling` connect the children of a node into a list
  - `firstChild` and `lastChild` reference children of an Element
    - These would be text nodes or further element nodes contained in the element
  - `childnodes` returns a `NodeList` (like an array) of children

Example

```
<script>
// This recursive function is passed a DOM Node object and checks to see if
// that node and its children are XHTML tags; i.e., if the they are Element
// objects. It returns the total number of Element objects
// it encounters. If you invoke this function by passing it the
// Document object, it traverses the entire DOM tree.

function countTags(n) {                          // n is a Node
    var numtags = 0;                             // Initialize the tag counter
    if (n.nodeType == 1 /*Node.ELEMENT_NODE*/)   // Check if n is an Element
        numtags++;                               // If so, increment the counter
    var children = n.childNodes;                 // Now get all children of n
    for(var i=0; i < children.length; i++) {     // Loop through the children
        numtags += countTags(children[i]);       // Add and recurse on each one
    }
    return numtags;                              // Return the total number of tags
}
</script>

<!-- Here's an example of how the countTags(  ) function might be used -->

<body onload="alert('This document has ' + countTags(document) + ' tags')">
This is a <i>sample</i> document.
</body>

<!-- From: JavaScript: The Definitive Guide (4th Ed) -->
```

Example: JavaScript vs DOM

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- Blue JavaScript, red DOM...

```
// point anchorTags to a DOM NodeList
var anchorTags = document.getElementsByTagName("a");
// display the href attribute of each element in the NodeList
for (var i = 0; i < anchorTags.length ; i++){
  alert("Href of this a element is : " + anchorTags[i].href + "\n");
}
```

From: The DOM and JavaScript: http://developer.mozilla.org/en/The_DOM_and_JavaScript

DOM Tree Modification

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- There are also methods that allow you to modify or construct a DOM tree. eg:
  - The `insertBefore` method inserts a new child of the target node
  - `replaceChild` will replace a child node with a new node
  - `removeChild` removes a child node
  - `appendChild` adds a node as a child node at the end of the children

➡ you can construct part or whole document dynamically!

More Objects and Methods

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- See for example: http://www.w3schools.com/htmldom/dom_reference.asp
  - eg. document methods
    - getElementByID()
    - getElementsByName()
    - getElementsByTagName()
    - open()
    - close()
    - write()
    - writeln()

Example

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```
<script type="text/javascript">
function createNewDoc() {
  var newDoc=document.open("text/html","replace");
  var txt="<html><body>Learning about the DOM is FUN!</body></html>";
  newDoc.write(txt);
  newDoc.close();
}
</script>

<!-- From: http://www.w3schools.com -->
```

The canvas Element

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- The `canvas` Element
  - Creates a rectangle into which bit-mapped graphics can be drawn using JavaScript
  - Optional attributes: `height`, `width`, and `id`
    - Default value for `height` and `width` are `150` and `300` pixels
    - The `id` attribute is required if something will be drawn

```
<canvas id = "myCanvas" height = "200"
        width = "400">
   Your browser does not support the canvas
     element
 </canvas>
```

- This can be used to create interactive animations and games in just HTML and javascript:

https://developer.mozilla.org/en-US/docs/Games/Tutorials/2D_Breakout_game_pure_JavaScript

Example

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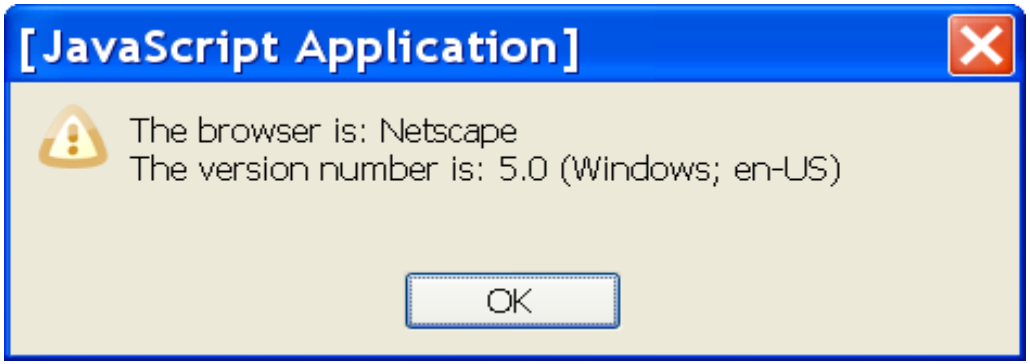
- The navigator Object
  - Properties of the `navigator` object allow the script to determine characteristics of the browser in which the script is executing
  - The `appName` property gives the name of the browser
  - The `appVersion` gives the browser version

```
<!DOCTYPE html>
<!-- navigate.html
     A document for navigate.js
     -->
<html lang = "en">
  <head>
    <title> navigate.html </title>
    <meta charset = "utf-8" />
    <script type = "text/javascript"  src = "navigate.js" >
    </script>
  </head>
  <body onload = "navProperties()">
  </body>
</html>
```

Output From navigate.html



- Note that the browser was actually FireFox and the version is 2.0.0.4

Example

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- The history object?

History Object Properties

Property	Description
length	Returns the number of URLs in the history list

History Object Methods

Method	Description
back()	Loads the previous URL in the history list
forward()	Loads the next URL in the history list
go()	Loads a specific URL from the history list