JavaScript in Browser

JavaScript in browser supports document object i.e. page's root node.

Its *writeln()* function in *simple.js* overwrites contents of loaded page.

```
document.writeln("Hello World!");
```

Code in *simple.js* can be imported and run with *simple.html*

```
<!DOCTYPE html>
<html>
  <body>
    <script src="simple.js"></script>
  </body>
</html>
```

Script can also be declared inline in head or body of HTML with

```
<!DOCTYPE html>
<html>
  <body>
    <script> document.writeln("Hello World!"); </script>
  </body>
</html>
```

Example is functionally equivalent to

```
<!DOCTYPE html>
<html>
  <body> Hello World! </body>
</html>
```

Inline JavaScript can be invalid XML - space after "<" is illegal!

```
function negative(x) { if ( x < 0 ) return true; return false; }
```

Similarly "&" not in entity declaration like " " is invalid XML.

Putting offending code in CDATA section hides it from XML parser

```
<script>
  /* <![CDATA[ */
    function negative(x) { if ( x < 0 ) return true; return false; }
  /* ]]> */
</script>
```

Commenting out CDATA section hides it from JavaScript engine.

Only XHTML markup with inline JavaScript *may* need this.

Generating Variety in Pages

One use of JavaScript is to create variety in web pages.

colours.js uses 3 functions to make table of random colours:

```
function getHue(range) {
  var c = function () { return Math.floor(Math.random()*range); }
  return "rgb(" + c() + "," + c() + "," + c() + ")";
}

function getTable(size, range) {
  var s = "<table>";
  for (var i=0; i<size; i++) {
    s += "<tr>";
    for (var j=0; j<size; j++)
      s += "<td style=\"background-color:" + getHue(range) +
           "\">" + "     </td>";
    s += "</tr>";
  }
  s += "</table>";
  return s;
}

var s = getTable(Math.floor(Math.random()*40 + 1), 256);
document.writeln(s);
```

getHue() uses *anonymous function* in constructing its reply.

Code uses 2 functions of builtin object Math

floor(n) returns nearest integer below *n*

random() generates random number between 0 and 1

colours.html invokes *colours.js*

```
<html>
  <body>
    <script src="colours.js"></script>
  </body>
</html>
```

Patchwork is defined as table with up to 40 rows and columns.

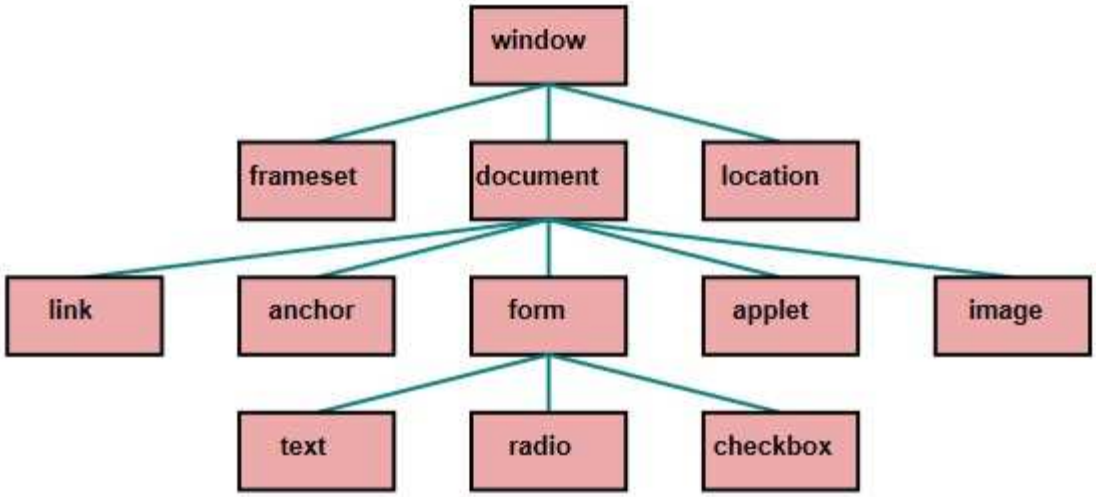
Document Object Model

Document Object Model

- applies to parsed HTML and XML content in DOM systems
- defines objects and interfaces to access and manipulate it
- has versions - levels 0, 1, 2, 3, 4 (and *alleged* living standard)

DOM 0 is informal, only applies to HTML and doesn't consider XML.

DOM 0 views HTML components rendered in window as a hierarchy.



DOM 0 supports designations such as

window.location.href	URL of currently loaded page
document.forms	array of forms in document
document.forms[0]	array of objects in 1st form in document
document.forms[1].elements[3]	4th element in 2nd form in document

DOM 0 can address form controls using *name* attributes:

```
<form name="form2" ... >
  <input type="text" name="txt3" ... >
</form>
```

document.form2.txt3.value refers to contents of this text entry box.

Page Element Scripting

HTML 4 let page elements register event handlers via attributes.

Value of attribute is script that's run when event occurs with element.

Simple calculator can be realised this way:

```
<input size="15" onchange="this.value = eval(this.value)">
```

eval() computes expression's value and result replaces it.

Keyword *this* reidentifies page element in question.

Event handler attributes for elements include

onchange	form control loses focus after changing during focus
onclick	pointing device is clicked over element
onkeypress	key is pressed and released over element
onmouseover	pointing device is moved onto element
onselect	user selects some text in text field

Hyperlinks can be activated by a *mouse over* event.

Put cursor over one of *Edinburgh * Heriot-Watt * Edinburgh Napier*

```
<script>
  function go(hei) {
    window.location.href = "http://www." + hei + ".ac.uk";
  }
</script>
<p>
  Put cursor over one of
  <em onmouseover='go("ed")'>Edinburgh</em> *
  <em onmouseover='go("hw")'>Heriot-Watt</em> *
  <em onmouseover='go("napier")'>Edinburgh Napier</em>
</p>
```

Mouse Over event triggers function call which triggers hyperlink.

Changing value of *window.location.href* loads its new URL.

Document Object Model 1

DOM 0 doesn't allow all parts of loaded HTML to be addressed.

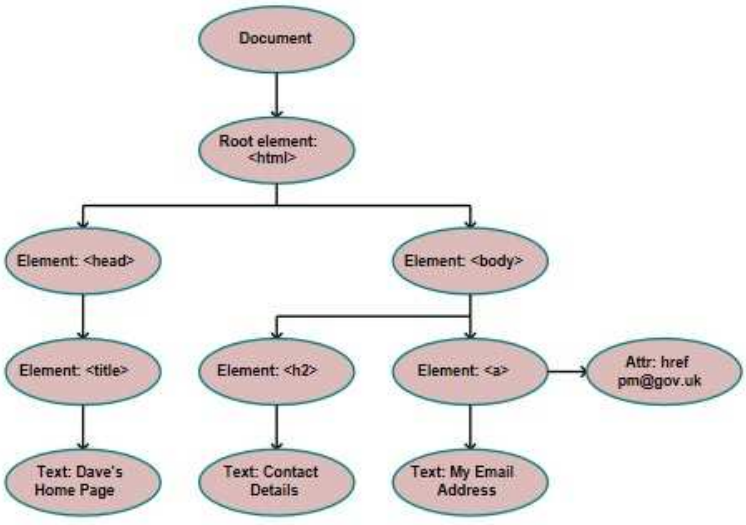
DOM 1 introduced a systematic, comprehensive scheme

Core interface	applicable to any document
HTML interface	for accessing and manipulating parsed HTML

Nodes in DOM 1 hierarchy include the following types

document	whole HTML or XML document
element	element such as a *table* or *tr*
attribute	attribute of element such as *class* or *id*
text	text or CDATA
entity	escape sequence like ♅ for symbol for uranus
comment	comment

Nodes are root nodes, leaf nodes or have 1+ children and a parent.



Crucial DOM 1 methods include

getElementById()	get element by its unique ID attribute value
getElementsByTagName()	get all elements with given tag name

Form Validation and DOM

Validation code can use DOM addresses to access form elements to

- ensure user has supplied all *essential* form details
- check datatypes entered in form are *valid* values

User can be warned by a popup *alert* if errors are found.

Form uses return value of *checkData()* to control its submission:

```
<form onsubmit="return checkData()"
      action="http://www2.macs.hw.ac.uk/~hamish/echo.php">
  Name <input name="Name" id="user" size="40"> <p>
  Sex <select name="Sex">
        <option> male <option selected> female </select>
  Age <input name="Age" id="age" size="3"> <input type="submit">
</form>
```

JavaScript function *checkData()* performs checks

```
function checkData() {
 var name = document.getElementById("user").value;
 if ( name.length < 2 || (/[^A-Za-z\s\-]/).test(name) ) {
   alert("Name should have 2 or more letters, hyphens, spaces");
   return false;
 }
 var age = document.getElementById("age").value;
 if ( age.length == 0 || (/[^0-9]/).test(age) ||
      age < 0 || age > 120 ) {
   alert("Please give age between 0 and 120");
   return false;
 }
 return true;
}
```

Names may only have 2+ alphabetic letters, spaces and hyphens.

Ages may only have 1+ digits and lie between 0 and 120.

HTML 5 form attributes can *sometimes* be used for same checks

```
<form action="http://www2.macs.hw.ac.uk/~hamish/echo.php">
  Name <input name="Name" pattern="[A-Za-z\s\-]{2,}" size="40"
              title="2+ letters, hyphens, spaces" required> <p>
  Sex <select name="sex">
        <option> male <option selected> female </select>
  Age <input name="Age" type="number" min="0" max="120" required>
  <input type="submit">
</form>
```

DOM 2+ Specifications

DOM 2 recommended in 2000 supports 6 specifications:

DOM 2 Core	extends functionality of DOM 1 Core offers key ECMAScript Bindings
DOM 2 Views	extension of DOM 2 Core obsoleted by HTML 5
DOM 2 Events	generic event system for scripts methods to add event listeners and handlers
DOM 2 CSS	interfaces for dynamic access/update of style sheets enables script control of any style property
DOM 2 HTML	enhances script access/update of (X)HTML documents
DOM 2 Traversal	lets scripts traverse range of content in document

DOM 3 recommended in 2004 supports 3 specifications

DOM 3 Core	extends functionality of DOM 2 Core adds and extends methods relating to XML
DOM 3 Load and Save	lets scripts load and save XML documents covers serializing DOM document into XML
DOM 3 Validation	guides scripts updating pages validly

Other useful DOM 3 related specifications include

DOM 3 Events	builds on functionality of DOM 2 Events event flow, handler registration, contextual data
DOM 3 XPath	functions to access DOM via XPath expressions

DOM 4 was recommended in 2015

- consolidates DOM level 3, Selectors API level 2, UIEvents etc.
- offers mutation observers to replace mutation events

DOM Living Standard adds WhatNG wish list for DOM.

DOM API Examples

DOM 2 Core created JavaScript function and property API for nodes:

appendChild(el)	add *el* as child of invoking element
createElement(tagname)	create element of *tagname*
getAttribute(name)	get value of attribute *name* of element
removeChild(el)	remove child *el* of element
setAttribute(name, value)	set *name* attribute of element to *value*

Node properties - *childNodes*, *nodeType*, *nodeValue*, *parentNode*

For example to replace "Up" image in page with a new one

```
function makeMiserable() {
  var minion = document.createElement("img");
  minion.setAttribute("src", "minion.jpg");
  minion.setAttribute("alt", "Despicable Me");
  var up = document.getElementsByTagName("img")[1];
  var parent = up.parentNode;
  parent.removeChild(up);
  parent.appendChild(minion); }
```

innerHTML interface provides shortcut for making DOM changes

```
function makeSad() {
  var e = document.getElementsByTagName("img")[1].parentNode;
  e.innerHTML = "<img src='minion.jpg' alt='Despicable Me'/>"; }
```

It parses HTML to DOM subtree to replace a node's children.

DOM 2 also added event listeners to attach callbacks to events.

Hover sensitive warning can be set over an image

```
function setWarning() {
  handler = function(e) { alert("Hands Off!"); }
  var el = document.getElementById("treasurechest");
  el.addEventListener("mouseover", handler); }
```

Event listener callback can be removed with same arguments

```
function unsetWarning() {
  var el = document.getElementById("treasurechest");
  el.removeEventListener("mouseover", handler); }
```

CSS Selectors and DOM Style

CSS Selectors use patterns to match nodes in DOM tree structure.

Selectors API level 1 from 2013 is current W3C recommendation.

API enables use of CSS selectors to match DOM nodes

querySelector() first node matching CSS selector argument

querySelectorAll() all nodes matching CSS selector argument

CSS selectors provide powerful way to specify bits of DOM to change.

Alternative approach would be to use DOM 3 XPath expressions.

DOM 2 CSS

- adds *style* property interface to get/set CSS 2 properties
- renames CSS properties in JavaScript without use of "-"

CSS property "font-size" in JavaScript becomes "fontSize".

Emphasized text in page can be made larger and smaller with

```
function changeFontSize(size) {
  var a = document.querySelectorAll('em');
  for ( var i in a ) {
    if ( i != undefined )
      a[i].style.fontSize = size + 'pt';
  }
}
```

DOM 2 API can also be used to add style directives to page

```
function addStyle() {
  var el = document.createElement("style");
  var tn = document.createTextNode("body { font: 20px verdana; }");
  var tn1 = document.createTextNode("p { line-height: 200%; }");
  el.appendChild(tn);
  el.appendChild(tn1);
  document.head.appendChild(el);
}
```

DOM 2 function *createTextNode()* adds text to loaded page.

Debugging Page Scripts

JavaScript errors

- cause all of that segment of code to be ignored
- are notified to JavaScript console if it is running

JavaScript console or debugging alerts can be found

Internet Explorer	under Tools, Internet Options, Advanced enable "Disable script debugging (Internet Explorer)"
Mozilla Firefox	under Developer, Browser Console
Chrome	under More tools, Developer tools

Illegal JavaScript such as the script

```
<html>
<body>
  <script>
   banana
  </script>
</body>
</html>
```

produces error message alert in IE if that facility is enabled

```
Line: 4
Error: 'banana' is undefined
```

In Chrome following error message is given in JavaScript console

```
Uncaught ReferenceError: banana is not defined
at script.html:4
```

JavaScript errors are very common in web pages.

It is good practice to *check for errors* when developing JavaScript.

Loading JavaScript from separate script can also ease debugging.

```
<script src="myscript.js"></script>
```

Things To Do

Browse JavaScript Guide and Reference
https://www.w3schools.com/js and https://www.w3schools.com/jsref

Browse JavaScript HTML DOM Tutorial
https://www.w3schools.com/js/js_htmldom.asp

Browse DOM Level 2 Specification: ECMAScript Language Bindings
https://www.w3.org/TR/DOM-Level-2-Core/ecma-script-binding.html

Try *Quiz on Lecture*

Do *Exercise 6*

Key Points

- The Document Object Model from version 1 onwards standardises the objects and interfaces for accessing and updating the content, structure and style of loaded HTML (and XML) documents.

- Key DOM methods for accessing parts of loaded web pages are *getAttribute()*, *getElementById()*, *getElementsByTagName()*, *querySelector()*, *querySelectorAll()*.

- Key DOM methods for updating loaded web pages are *setAttribute()*, *appendChild()*, *removeChild()*, *createElement()*, *addEventListener()*, *removeEventListener()*.

- Key DOM node properties in loaded web pages are *childNodes*, *nodeType*, *nodeValue*, *parentNode*, *innerHTML*, *style*.