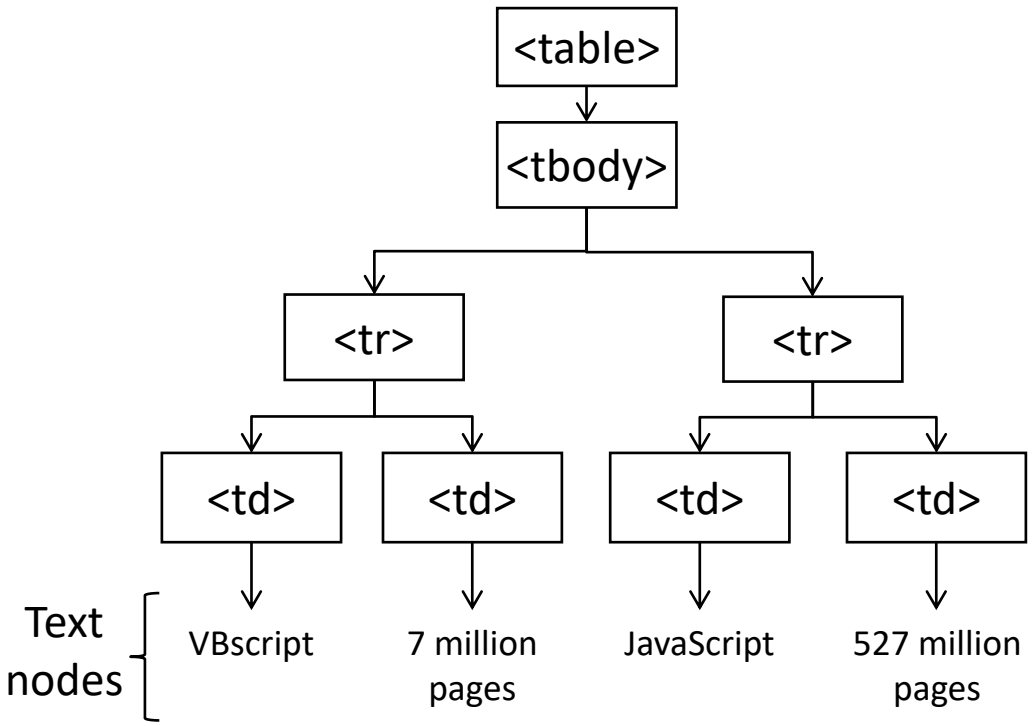
COMP 4021
Internet Computing

Document Object Model (DOM)

This Presentation

- This presentation considers the following:
  - Simple DOM example
  - DOM representation
  - Using relations to traverse the DOM tree – examples
  - Referring to nodes in DOM - three methods

Simple DOM Example




```
<table>
    <tbody>
    <tr>
        <td>VBscript</td>
        <td>7 million pages</td>
    </tr>
    <tr>
        <td>JavaScript</td>
        <td>527 million pages</td>
    </tr>
    </tbody>
</table>
```

The DOM Standard

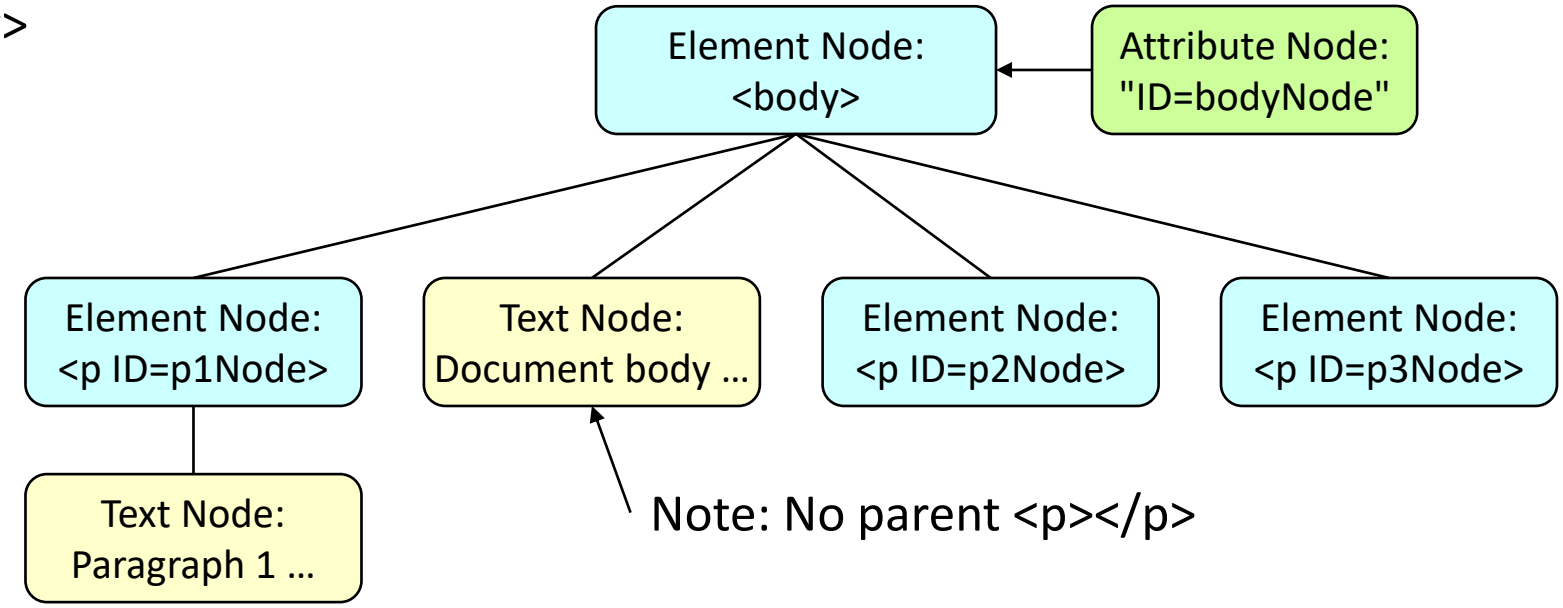
- Scripting languages (not only JavaScript) can access any part of the DOM including relationships (parent/sibling, etc.)
- You can actively alter, create and destroy *any* part of the DOM structure, at *any* time
- The same code will work for all browsers, e.g., IE, Firefox and Opera without any changes
- The same techniques can also be used in lots of other languages i.e. Java, C++, PHP, etc.

A Simple (Incomplete) DOM Example

```
<body id="bodyNode">
<p id = "p1Node">Paragraph 1 …</p>
Document body …
<p id = "p2Node"></p>
<p id = "p3Node"></p>
</body>
```

Three types of nodes:

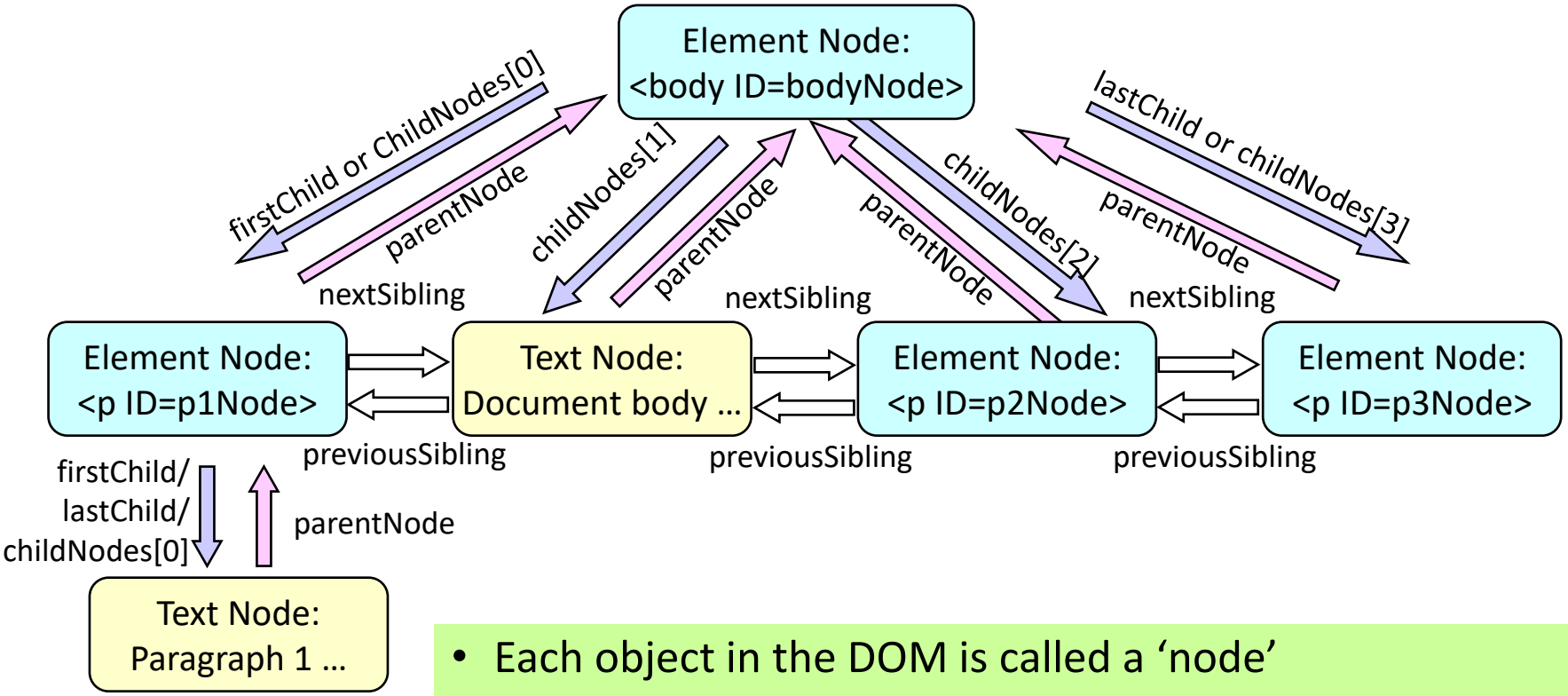
- Element nodes, e.g., <p>
- Text nodes, e.g., Paragraph 1 …
- Attribute nodes, e.g., id="bodyNode"



Accessing DOM

- From JavaScript:
  - Using getElementByID, etc.
  - Using querySelectorAll(“*”) using CSS selectors
  - Using DOM API
- From CSS:
  - Using CSS selectors

Some Relationships (API) of the Example



- Each object in the DOM is called a ‘node’
- Both nodes and relationships between nodes are shown
- Any node can be given a name (the ID attribute) for reference by other nodes and scripts

DOM Nodes

- Everything in the HTML DOM is a **node**:
  - Document node: The HTML document itself is a “document” object
    - The root node and the "owner" of all other nodes
    - Provide properties and methods to access all nodes from JavaScript
  - Element nodes: All HTML elements
  - Attribute nodes: All HTML attributes
  - Text nodes: Text surrounded by HTML elements
  - Comment nodes: Comments
- Window vs. document objects
  - document is part of the window; window is NOT part of the DOM;
  - window.document: document contained by window
  - document.defaultView: the window containing document

Document Object in DOM

- Each page loaded into browser has an **document** object
- **document** provides global functions of a page (e.g., getting the page's URL and creating new elements in the document)
- JavsScript can get document by window.document
- To get **document** containing element **n: n**.ownerDocument
- **document** interfaces: Document, Node and EventTarget
- Document.documentElement: the root element of the document (typically <html> element for HTML documents).
- What do document.documentElement.innerHTML and document.body.innerHTML show?

Using Node Relations

- Scripts can access all of these relations between nodes:
  - parentNode
  - childNodes[], firstChild, lastChild
  - previousSibling, nextSibling
  - and more...

- There is more than one way to write some things
  i.e. childNodes[0] is the same as firstChild
- childNodes.length returns the number of child nodes
  - So childNodes[childNodes.length-1]equals lastChild

Using Relations to Traverse the Tree - 1

- Given any node ‘node’ in DOM, traverses up the branches, each time adding the name of the parent to a string, until the root is reached
- The result is to create a string which contains the path from the root to the starting ‘node’,
  - e.g., #document->HTML->BODY->UL->LI->A

- Note: DOM will include some elements even when you did not use them:
  - <tbody> in this example
  - <head> also included

Run Demo

```
function click()  {
    var node=this;  // this = current object

    tree=node.nodeName;
    while (node.parentNode) {
        node = node.parentNode;
        tree = node.nodeName + " -> " + tree;   }
    alert(tree);    }
```

Using Relations to Traverse the Tree - 2

- Use recursion to visit every node in the DOM; attach *onmouseover* event to execute *do_someth* function

```
function processChildren(node) {
    var currentNode = node.firstChild;   // start with the first child
    do {
        currentNode.onmouseover = do_someth;    // do something with node
        if (currentNode.hasChildNodes) {              // if node has children
            processChildren(currentNode);     }       // process them (recursive)
    currentNode = currentNode.nextSibling;        // move to the next sibling

    } while (currentNode != node.lastChild          // repeat until last child
            && currentNode != null)                    // or until nothing more     }
```

- Traversal of the entire DOM can be done in different ways
- Upon reaching a node, attach an event handler **do_someth** (function not shown, e.g., change the background colour of the node)

How to Locate One Particular Thing?

- Method 1: Use the exact DOM path
  - May be hard to work out the exact position
  - Easy to make mistakes
  - Load into another browser – DOM may be a bit different, not work!
- Method 2: Use getElementsByTagName()
  - Require you to know the exact tag name (I.e. is it h2 or h3?)
  - Also, there might be several nodes of that type, so you have to know exactly which one it is (I.e. first one? second one?)
- Method 3: Use getElementById()
  - If you give the nodes unique names then this method is the easiest to refer to them

Methods 1, 2, 3 - Examples

Address DOM by absolute path; why doesn't it work? Check DOM examples1

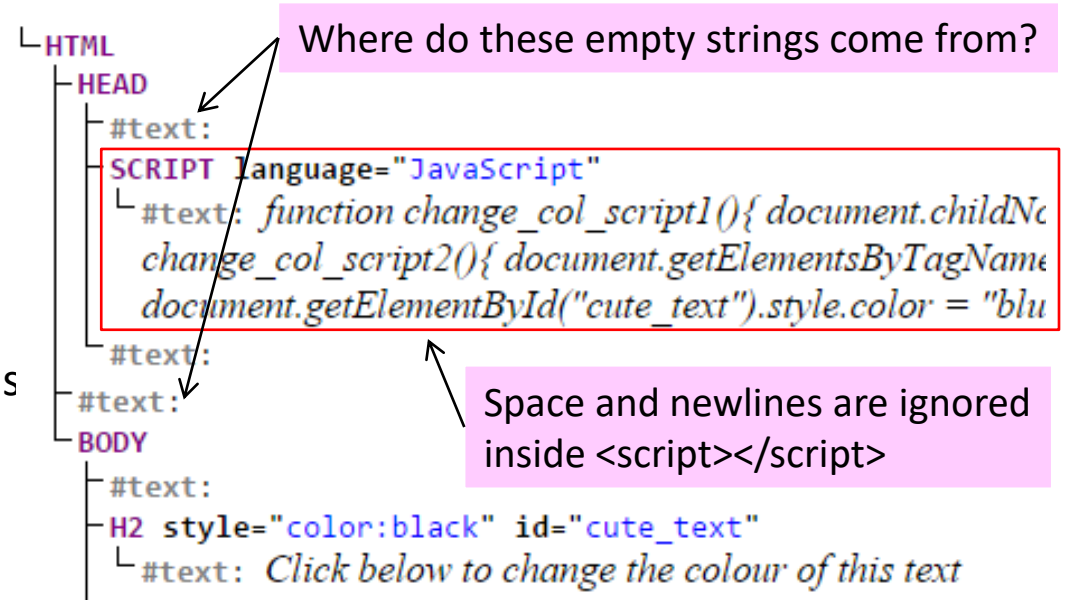
```
<html>  <head>  <script language="JavaScript">
   function change_col_script1() {
      document.childNodes[0].childNodes[1].childNodes[0].style.color="red";     }
   function change_col_script2() {
      document.getElementsByTagName("h2")[0].style.color = "yellow";      }
   function change_col_script3() {
      document.getElementById("cute_text").style.color = "blue";      }
</script>   </head>
<body>
<h2 id="cute_text">Click below to change the colour of this text</h2>
<form>
   <input onclick="change_col_script1()" type="button" value="Change using method 1">
   <input onclick="change_col_script2()" type="button" value="Change using method 2">
   <input onclick="change_col_script3()" type="button" value="Change using method 3">
</form>   </body>   </html>
```

Run Wrong Demo

Run Correct Demo

Why Absolute Addressing does not Work?

```
<html>
<head>  <script language="JavaScript">
    function change_col_script1() {
        document.childNodes[0].childNodes[1].childNodes[0].style.color="red";     }
    … …

</script>
</head>
<body>
<h2 id="cute_text">
Click below to change the colour of this
</h2>
… …
```



Exercise: Draw the DOM graphically; correct the statement

Peculiar Things about DOM

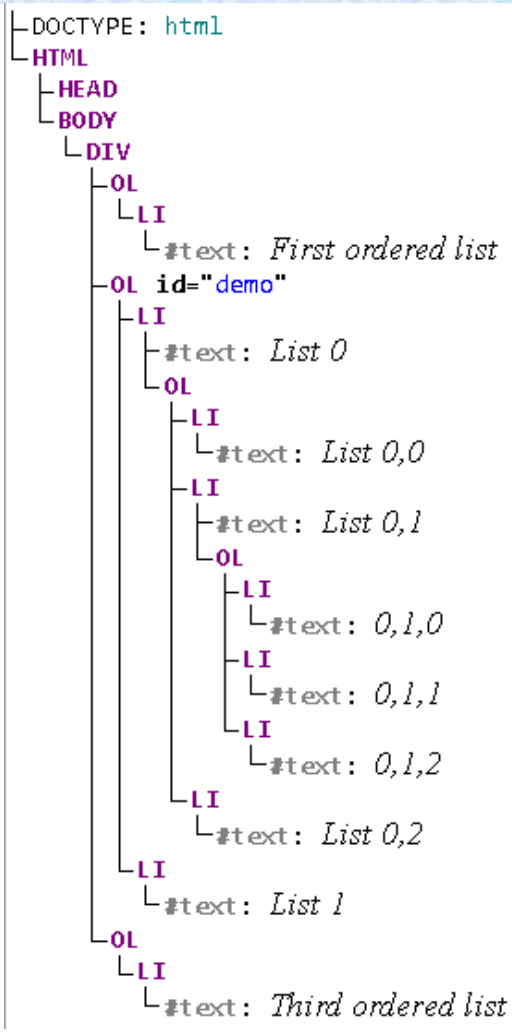
- All spaces and newlines are stored as text values in DOM
  - What is difference between:

<body></body>	<body> </body>	<body> Hi </body>

- cannot be nested; is a perfect nested structure, but the DOM engine will transform it:
  - will be treated as
    - The second automatically terminates the first by adding
    - Dangling is compensated with a before it
  - HTML spec: "The P element represents a paragraph. It cannot contain block-level elements (including P itself)."
  - A paragraph is a container for text content with non-blocking elements (e.g., <a>, , etc., but not and)

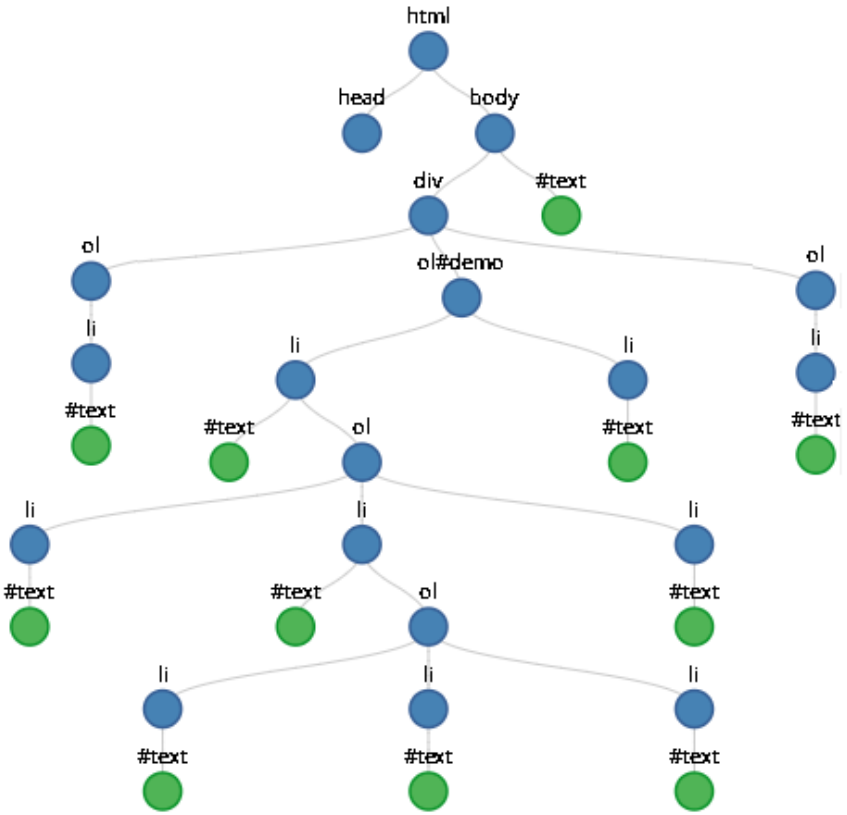
Using DOM Viewers: Live DOM Viewer

```
<!DOCTYPE html>
<div
><ol><li>First ordered list</li></ol
><ol id="demo"
  ><li>List 0<ol
              ><li>List 0,0</li
              ><li>List 0,1<ol
                            ><li>0,1,0</li
                            ><li>0,1,1</li
                            ><li>0,1,2</li
                          ></ol
              ></li
              ><li>List 0,2</li
            ></ol></li
  ><li>List 1</li
></ol
><ol><li>Third ordered list</li></ol></div>
```



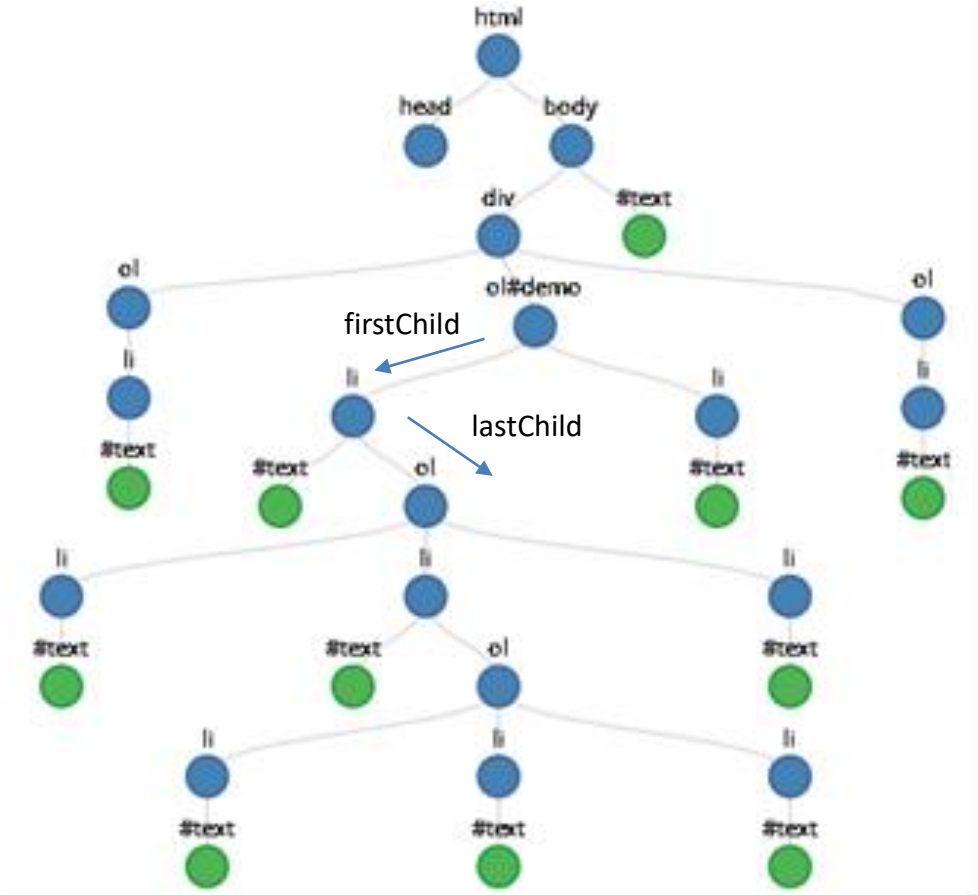
Using DOM Viewers: d3 DOM Visualizer

```
<!DOCTYPE html>
<html>
   <body><div><ol><li>First ordered list</li></ol
   ><ol id="demo"
   ><li>List 0
      <ol><li>List 0,0</li
      ><li>List 0,1
            <ol><li>0,1,0</li
               ><li>0,1,1</li
               ><li>0,1,2</li
            ></ol
      ></li
      ><li> List 0,2</li
      ></ol
      ></li
      ><li>List 1</li
      ></ol
   ><ol><li>Third ordered list</li></ol
   ></div>
   </body></html>
```



Examples for DOM Traversal (a)

a) here=document.getElementById("*demo*");
here.firstChild.lastChild.parentNode.style.color="red";



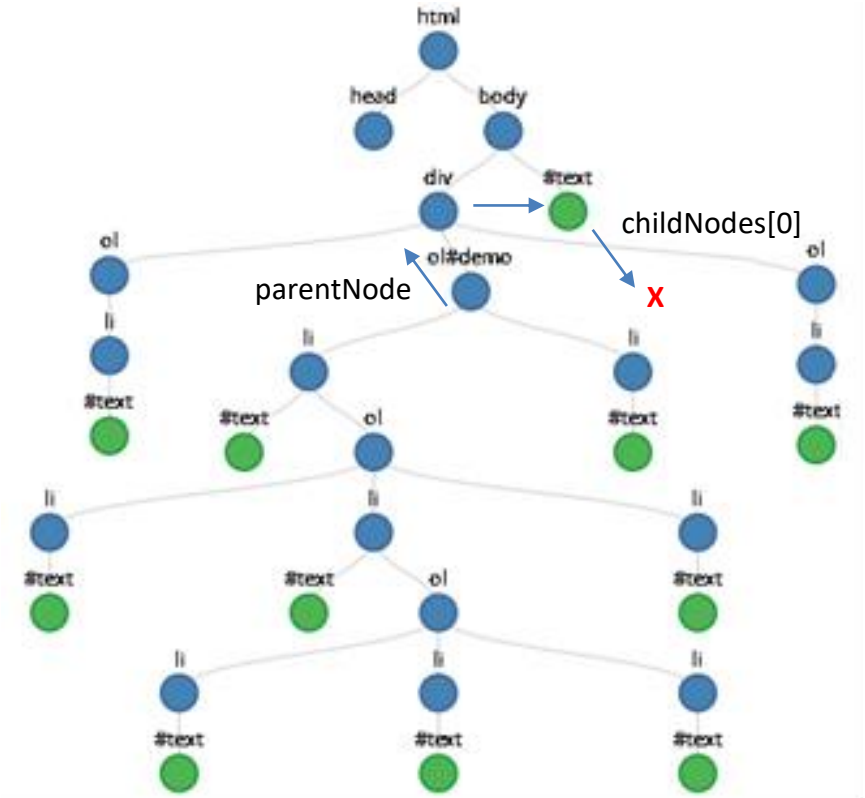
1. First ordered list

1. List 0
    1. List 0,0
    2. List 0,1
        1. 0,1,0
        2. 0,1,1
        3. 0,1,2
    3. List 0,2
2. List 1

1. Third ordered list

Examples for DOM Traversal (b)

b) here=document.getElementById("*demo*");
here.parentNode.nextSibling.childNodes[0].parentNode.
style.color="red";



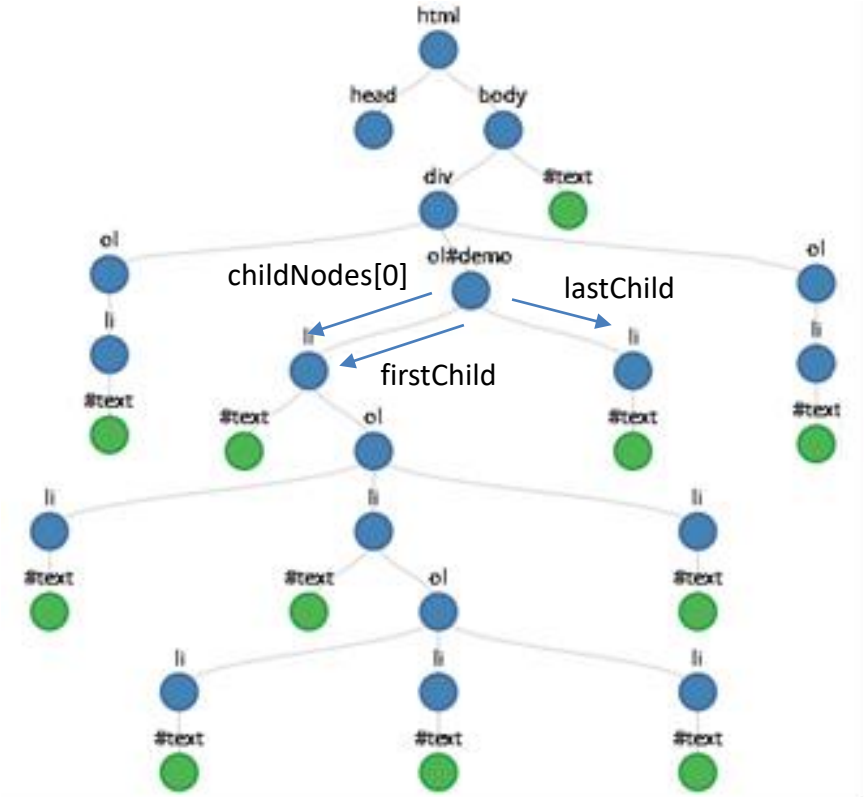
1. First ordered list

1. List 0
    1. List 0,0
    2. List 0,1
        1. 0,1,0
        2. 0,1,1
        3. 0,1,2
    3. List 0,2
2. List 1

1. Third ordered list

Examples for DOM Traversal (c)

c) here=document.getElementById("*demo*");
here.childNodes[0].parentNode.firstChild.parentNode.lastChild.parentNode.style.color="red";



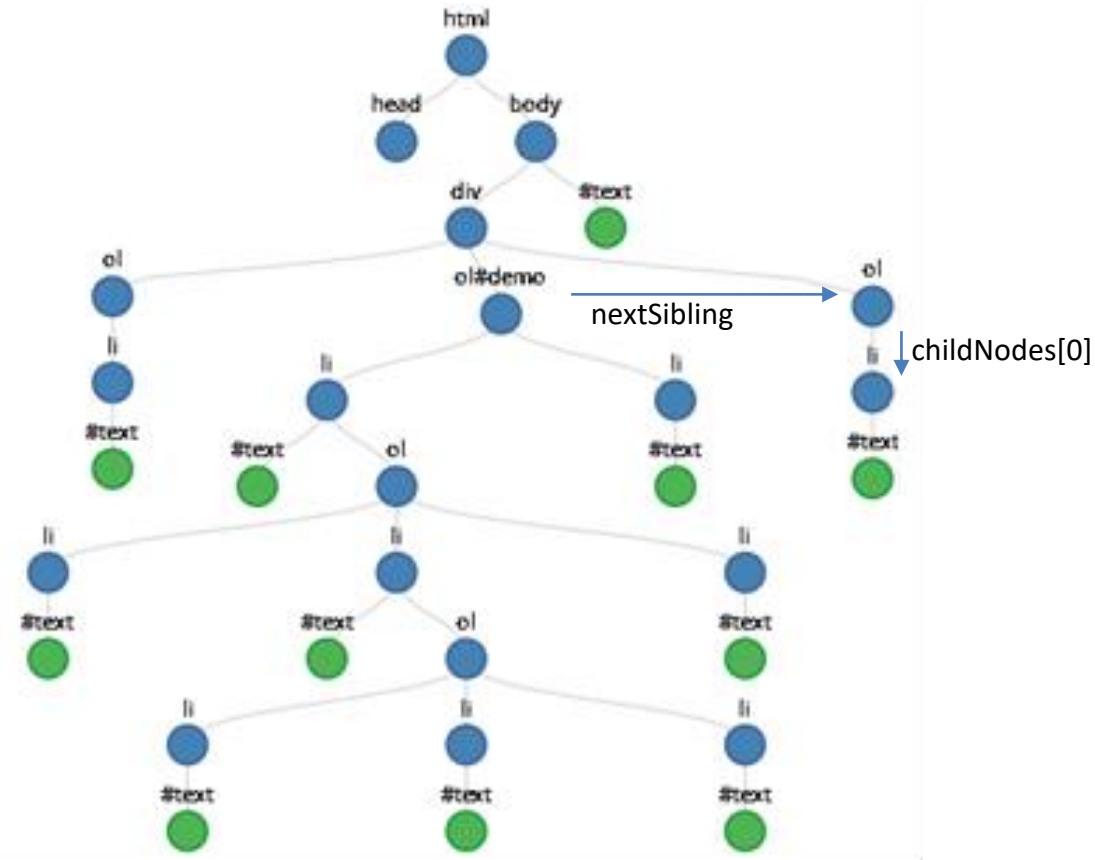
1. First ordered list

1. List 0
    1. List 0,0
    2. List 0,1
        1. 0,1,0
        2. 0,1,1
        3. 0,1,2
    3. List 0,2
2. List 1

1. Third ordered list

Examples for DOM Traversal (d)

d) here=document.getElementById("*demo*");
here.nextSibling.childNodes[0].style.color="red";



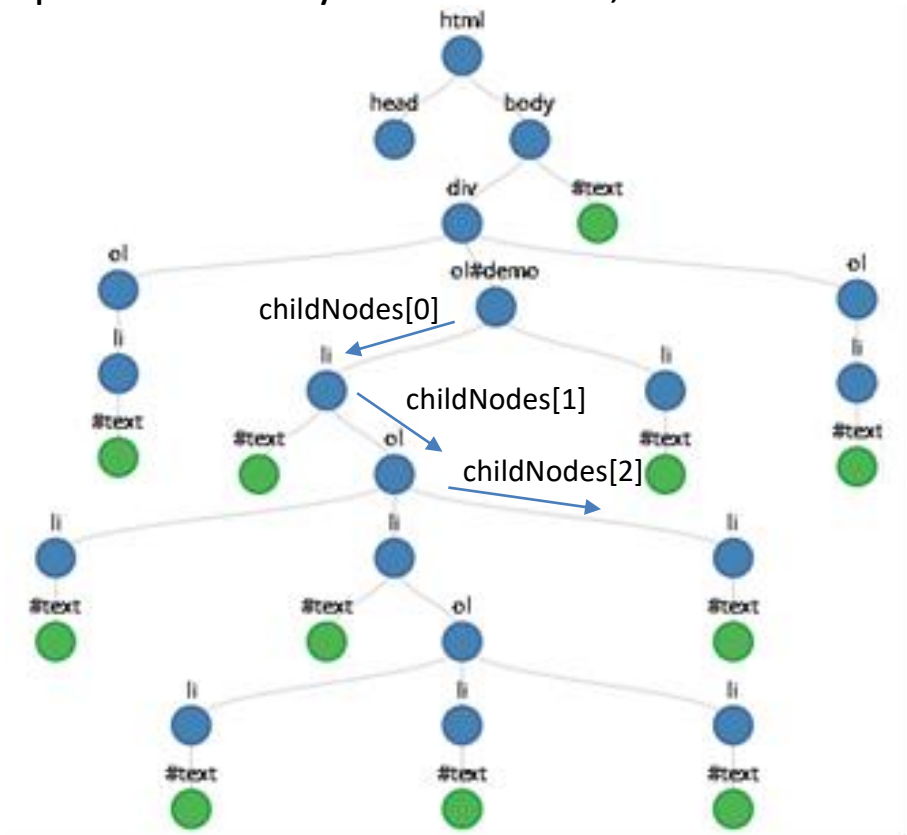
1. First ordered list

1. List 0
    1. List 0,0
    2. List 0,1
        1. 0,1,0
        2. 0,1,1
        3. 0,1,2
    3. List 0,2
2. List 1

1. Third ordered list

Examples for DOM Traversal (e)

e) here=document.getElementById("*demo*");
here.childNodes[0].childNodes[1].childNodes[2].parentNode.parentNode.style.color="red";



1. First ordered list

1. List 0
    1. List 0,0
    2. List 0,1
        1. 0,1,0
        2. 0,1,1
        3. 0,1,2
    3. List 0,2
2. List 1

1. Third ordered list

Some Advanced DOM Operations

- Creating and adding nodes to the DOM
  - HTML example
  - SVG example
- Deleting nodes in the DOM
  - HTML example
  - SVG example
- Old style DOM code: document.all

Creating and Adding Nodes to DOM

1. Create a node

2. Add it to the DOM at an appropriate place

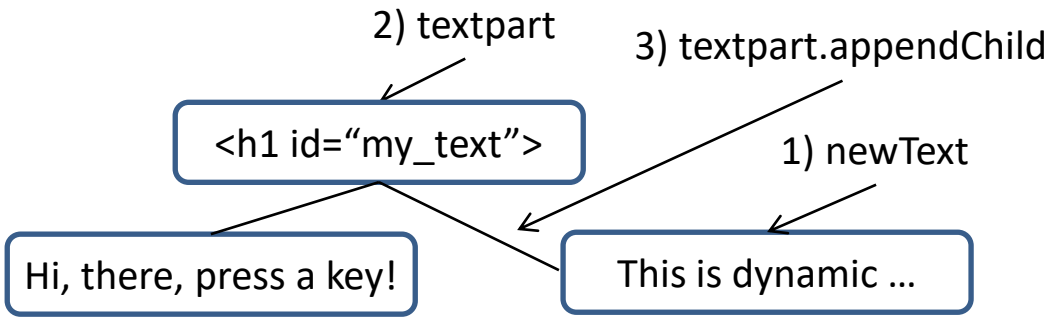
- Right after you created a node (step 1), the node is not actually part of the DOM yet
- You need to attach it to an existing node in the DOM
- For visual languages such as HTML and SVG, you won't actually see the node until it is added to the DOM

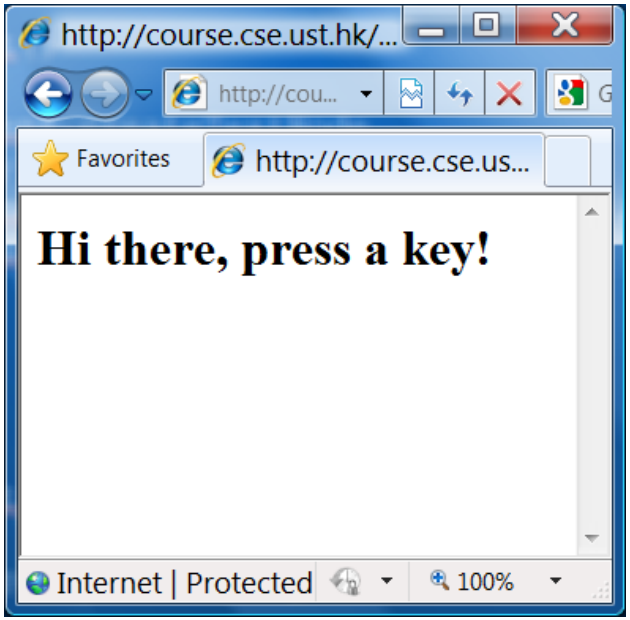
Dynamic HTML Node Creation – Example

```
<html> <head> <script type="text/javascript">
function insert_new_text()    {
   var newText = document.createTextNode("This is dynamically added text!");
   var textpart = document.getElementById("my_text");
   textpart.appendChild(newText) ;    }    </script>    </head>
```

Run Demo

```
<body onkeypress="insert_new_text()">
<h1 id="my_text" >Hi there, press a key! </h1>
</body>
```





Dynamic Node Creation – SVG Example 1/2

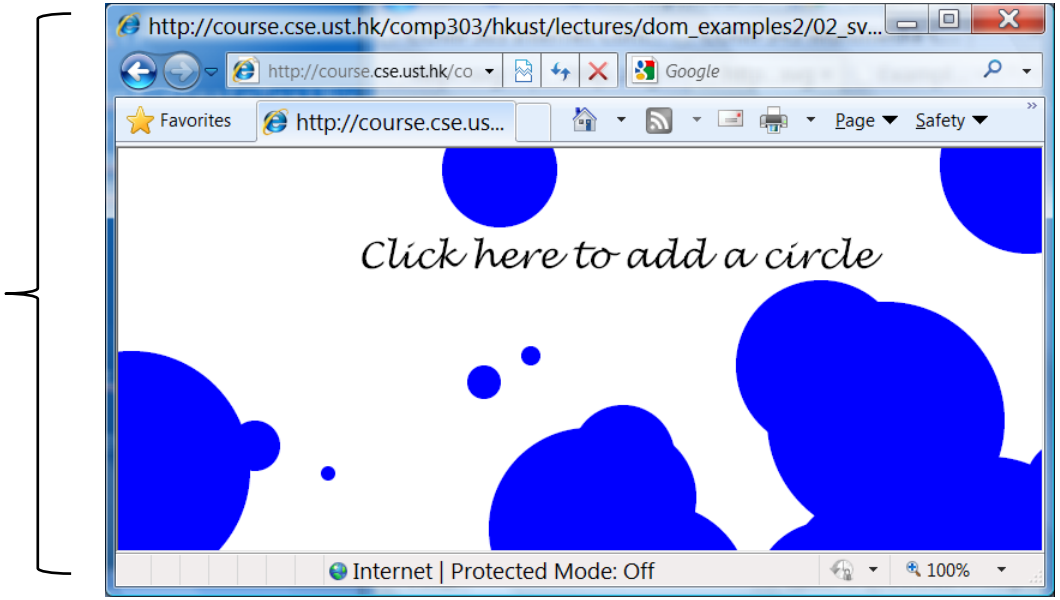
- The example creates a random-size circle at random location within the SVG when the SVG is clicked

```
<svg width="1000" height="800" onclick="insert_a_circle(evt)" >
<text x="200" y="100" style="font-size:30px;font-family:Lucida Handwriting">
    Click here to add a circle
</text>
</svg>
```

Example display after many clicks

Run Demo

Demo on jsfiddle without using SVGRoot



Dynamic Node Creation – SVG Example 2/2

```
<script type="text/javascript">
var SVGDocument = null,   SVGRoot = null;

function insert_a_circle(event)    {
   SVGDocument = event.target.ownerDocument;
   SVGRoot = SVGDocument.documentElement;

   var newnode=SVGDocument.createElementNS(
            "http://www.w3.org/2000/svg","circle");
   var cx=Math.floor(Math.random() * 1000);
   var cy=Math.floor(Math.random() * 800);
   var r=Math.floor(Math.random() * 100);
   newnode.setAttribute('cx', cx);      newnode.setAttribute('cy', cy);
   newnode.setAttribute('r', r);        newnode.setAttribute('fill', "blue");

   SVGRoot.appendChild(newnode);    }    </script>
```

document that has been clicked

root (i.e., document element) of the DOM

Deleting Nodes

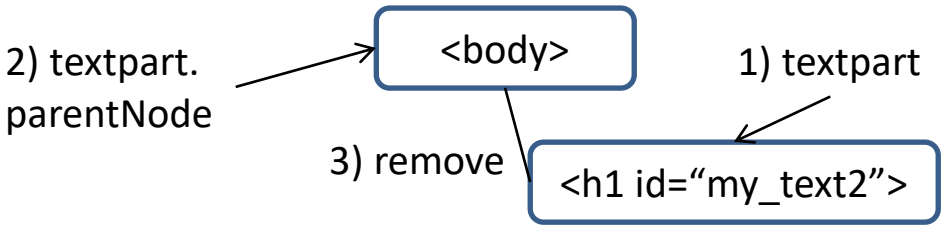
- To delete a node in the DOM, you cannot simply point to a node and say ‘delete this’
- Instead, you have to ask the parent node to delete that child node
- The parent node may have many children, so you have to specify exactly which child you want the parent to delete

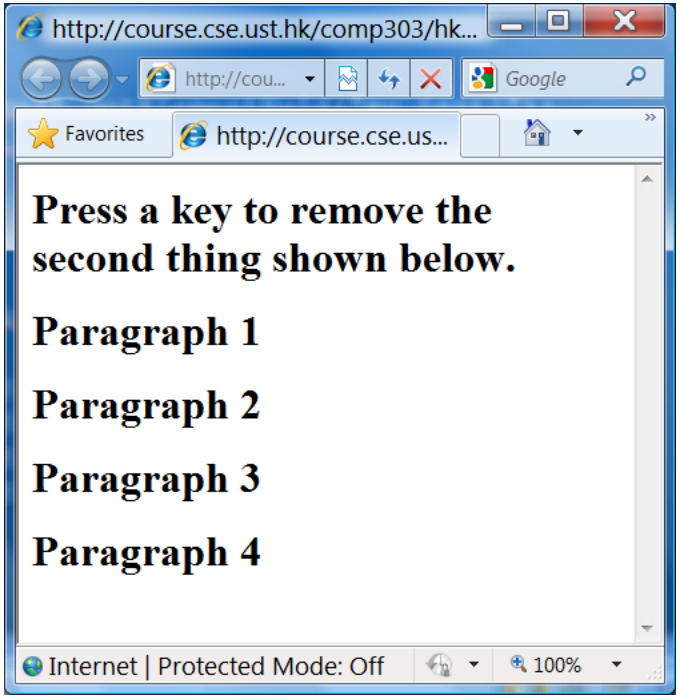
Dynamic Node Deletion – HTML Node

```
function delete_text()    {
   var textpart = document.getElementById("my_text2");
   textpart.parentNode.removeChild(textpart);    }
```

Run Demo

```
<body onkeypress="delete_text() ">
<h1 id="my_text1">Paragraph 1</h1>
<h1 id="my_text2">Paragraph 2</h1>
<h1 id="my_text3">Paragraph 3</h1>
<h1 id="my_text4">Paragraph 4</h1>
</body>
```

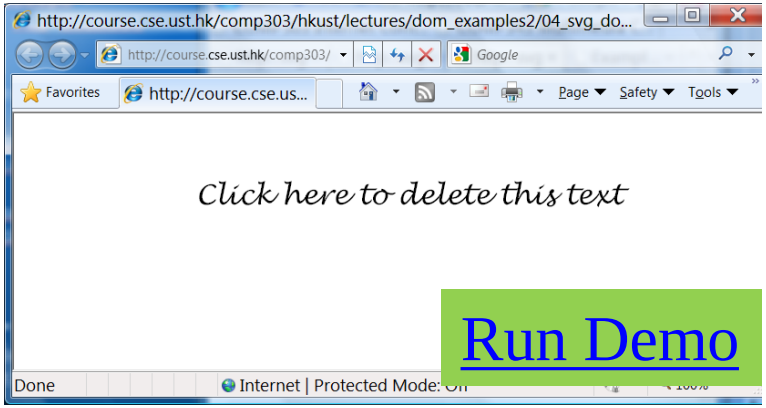




- Always deletes the 2nd paragraph; try to change it to delete the paragraph clicked

Dynamic Node Deletion – SVG Node

```
<svg width="1000" height="800“
onclick="delete_text(evt)">
<script type="text/javascript">
var SVGDocument = null, SVGRoot = null;
var node = null;

function delete_text(event)    {
   SVGDocument = event.target.ownerDocument;

   node = SVGDocument.getElementById("nice_text");
   if (node) node.parentNode.removeChild(node);    }
</script>
<text id="nice_text" x="200" y="100"
  style="font-size:30px;font-family:Lucida Handwriting">
  Click here to delete this text</text>    </svg>
```



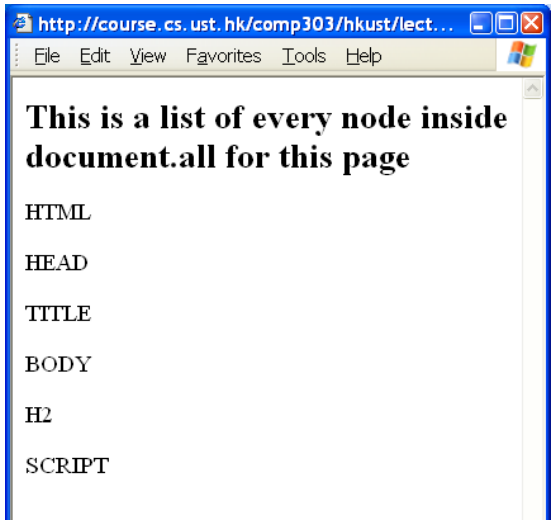
- What happens if node is null?
- How to change the code to delete the text element only if it is clicked (not the entire SVG element)

Finding Elements with querySelectorAll()

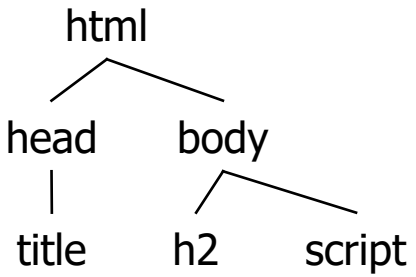
- Another way to access ‘anything’ in the DOM is by using document.all
  - document.querySelectorAll("*") returns a list of all elements
  - You can use any CSS selector in the parameter
- The examples in the next few slides give further insight into how DOM works dynamically

Example 1 : List All Elements

```
<html>  <head><title></title></head>
<body>
<h2>This is a list of all nodes inside querySelectorAll()
for this page</h2>
<h2>Note: jsfiddle addes several tags to the page</h2>

<script language="JavaScript">
var list="";
for (i = 0; i < document.querySelectorAll("*").length; i++){
  list = list + "<p>" +
  document.querySelectorAll("*")[i].tagName + "</p>";
}
document.write( list );
</script>
</body></html>
```



Run Demo



list

HTML HEAD .... SCRIPT

More About querySelectorAll("...")

- Using get.ElementsByTagName("*") to get all of the tags into a collection
- Use querySelectorAll("*") to select all of the child elements of a node:
  - document.querySelectorAll("*") gets all of the child elements under document (i.e., all elements in the document)
  - document.getElementsByTagName("p")[0].querySelectorAll("*") gets all of the child elements of the first paragraph
- querySelector("p") returns the first <p> tag

Run Demo

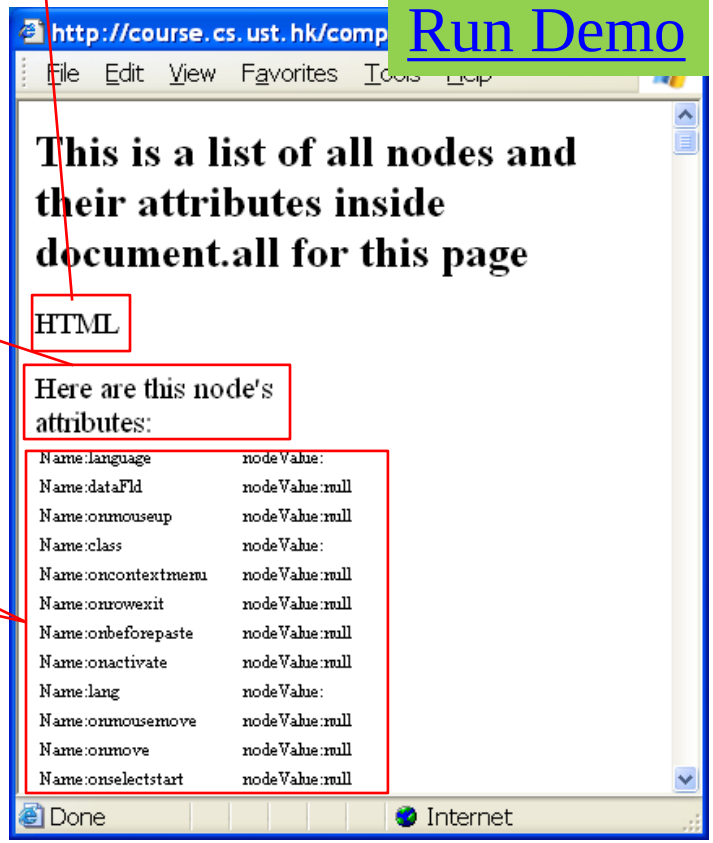
Example 2: List Tag Properties and Values

```
for(i = 0; i < document.querySelectorAll("*").length; i++)  {
   list = list + "<p>" + document.querySelectorAll("*")[i].tagName + "</p>";

   list=list + "<table ><thead>Here are this node's attributes:</thead>";

   for (j=0; j< document.querySelectorAll("*")[i].
            attributes.length; j++)  {
      list = list + "<tr> <td>Name: <b>" +
       document.querySelectorAll("*")[i].attributes[j].
            nodeName +
       "</b></td> <td>nodeValue: <b>" +
       document.querySelectorAll("*")[i].attributes[j].
            nodeValue +
       "</b></td> </tr>";      }
   list=list + "</table>";      }
document.write( list );
```

list

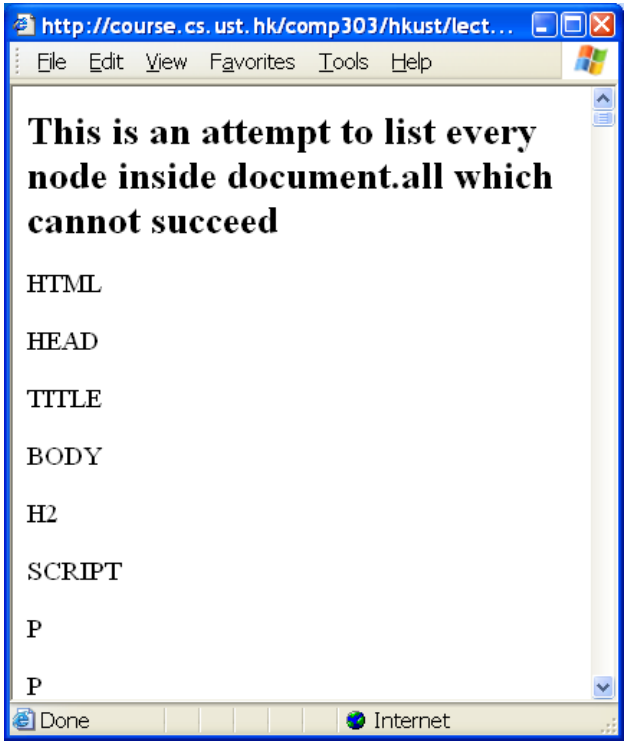
```
...<p>HTML</p><table ...><thead> ...</thead>
<tr><td>Name: Name.language</td>
<td>nodeValue:</td></tr>... ...</table>
```

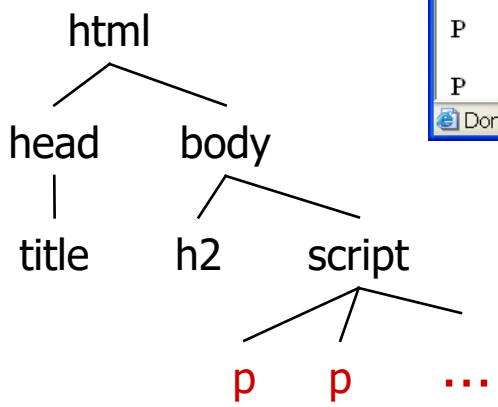
Run Demo



Example 3: Infinite DOM (Fails)

```
<html>  <head></head>
<body>
<h2>This is an attempt to list every  node by
dynamically querying the DOM</h2>

<script language="JavaScript">
for (i = 0; i < document.querySelectorAll("*").length; i++) {
 document.write("<p>" +
   document.querySelectorAll("*")[i].tagName + "</p>");
}
</script>  </body>   </html>
```





Run Demo

Take Home Message

- DOM captures everything on a webpage, including all Element nodes, Text nodes, Attribute nodes, Comment nodes and their root, i.e., Document node
- Three ways of identifying a node and their pros and cons
- Traversing all nodes in a DOM
- Dynamic update to any part of a DOM is supported
  - Insertion and deletion of Element nodes
  - Update to any properties (Attribute nodes), including attaching event handlers to multiple Element nodes
- Beware of “white” text nodes caused by line breaks