Lecture 5: DOM Manipulation

CPEN322

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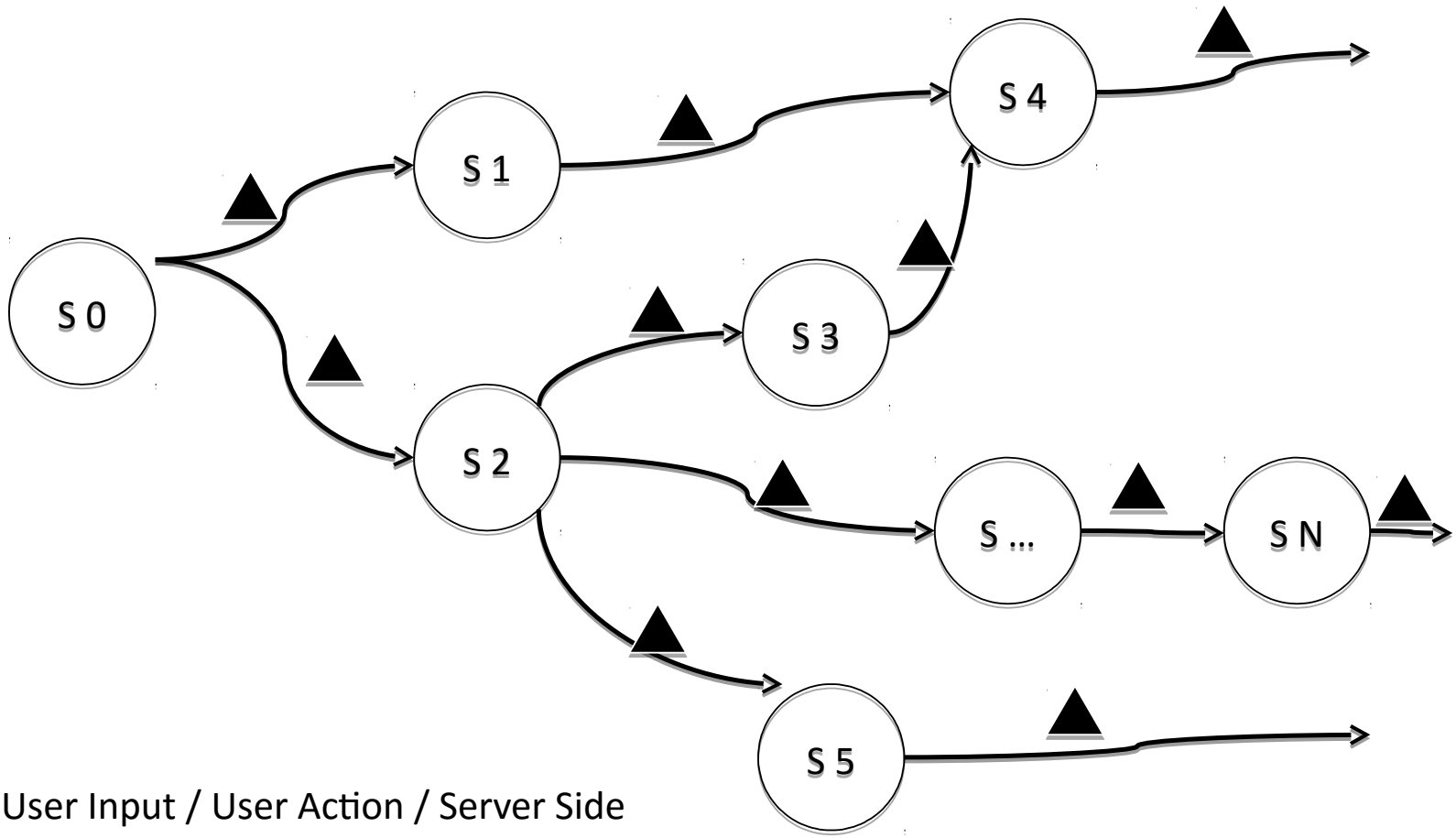
Outline

DOM: Recap

- Hierarchical representation of the contents of a web page – initialized with static HTML
- Can be manipulated from within the JavaScript code (both reading and writing)
- Allows information sharing among multiple components of web application

DOM as an evolving entity

DOM is highly dynamic!



Why Study DOM Interactions?

- Needed for JS code to have any effect on webpage (without reloading the page)
- Uniform API/interface to access DOM from JS
- Does not depend on specific browser platform

NOTE

- We'll be using the native DOM APIs for many of the tasks in this lecture
- Though many of these can be simplified using frameworks such as jQuery, it is important to know what's "under the hood"
- We assume a standards compliant browser !

Selecting DOM elements

Motivation: Selecting Elements

- You can access the DOM from the object window.document and traverse it to any node
- However, this is slow – often you only need to manipulate specific nodes in the DOM
- Further, navigating to nodes this way can be error prone and fragile
  - Will no longer work if DOM structure changes
  - DOM structure changes from one browser to another

Methods to Select DOM Elements

- With a specified id
- With a specified tag name
- With a specified class
- With generalized CSS selector

Method 1: *getElementById*

- Used to retrieve a **single** element from DOM
  - IDs are unique in the DOM (or at least must be)
  - Returns null if no such element is found

Example

```
1  var name = "Section1";
2  var id = document.getElementById(name);
3  if (id == null)
4     throw new Error("No element found: " + name);
```

Method 2: *getElementsByTagName*

- Retrieves multiple elements matching a given tag name ('type') in the DOM
- Returns a *read-only* array-like object (empty if no such elements exist in the document)

Example: Hide all images in the document

```
1  var imgs = document.getElementsByTagName("img");
2  for (var i=0; i<images.length; i++) {
3      imgs[i].display = "none";
4  }
```

Method 3: *getElementsByClassName*

- Can also retrieve elements that belong to a specific CSS class
  - More than one element can belong to a CSS class<

Example

```
1  var warnings = document.getElementsByClassName("
       warning");
2  if (warnings.length > 0) {
3     // do something with the warnings list here
4  }
```

Important point: Live Lists

- Both getElementsByClassName and getElementsByTagName return live lists
  - List can change after it is returned by the function if new elements are added to the document
  - List cannot be changed by JavaScript code adding to it or removing from it directly (list elements can change though)
- Make a copy if you're iterating through the lists (and modifying the list elements). e.g., const copy = Array.from(list)

Selecting elements by CSS selector

- Can also select elements using generalized CSS selectors using querySelectorAll() method
  - Specify a selector query as argument
  - Query results are not "live" (unlike earlier)
  - Can subsume all the other methods
- querySelector() returns the first element matching the CSS query string, null otherwise

CSS selector syntax: Examples (Recap)


```
1  "#nav"              // Any element with id=nav
2
3  "div"             // Any <div> element
4
5  ".warning"          // Any element with "warning" class
6
7  "#log span"           // Any <span> descendant of id="log"
8
9  "#log > span"        // Any span child element of id="log"
10
11 "body>h1:first-child" // first <h1> child of <body>
12
13 "div, #log"         // All div elements, element with id="log"
```

Invocation on DOM subtrees

- All of the above methods can also be invoked on DOM elements not just the document
  - Search is confined to subtree rooted at element
- Example: Assume element with id="log" exists

```
1  var log = document.getElementById("log");
2  var error = log.getElementsByClassName("error");
3  if (error.length ==0) { ... }
```

Class Activity

- Assume the page contains a div element with id id, which contains a series of images (img nodes).
- Write a function that takes two arguments, id and interval. At each interval, the images must be "rotated", i.e., image0 will become image1, image1 will become image2, etc.

Solution


```
1  function changeImages(id, interval) {
2      // Select the parent div by its id
3      const parentDiv = document.getElementById(id);
4      if (!parentDiv) return; // Exit if the div is not found
5
6      // Function to perform the rotation of images
7      function rotateImages() {
8          const images = parentDiv.getElementsByTagName('img');
9          if (images.length > 0) {
10             // Remove the first image and add it to the end
11             parentDiv.appendChild(images[0]);
12         }
13     }
14
15     // Set up the interval to rotate images
16     setInterval(rotateImages, interval);
17 }
```

DOM Traversal

Traversing the DOM

- Since the DOM is just a tree, you can walk it the way you'd do with any other tree
  - Typically using recursion
- Every browser has minor variations in implementing the DOM, so should not be sensitive to such changes
  - Traversing DOM this way can be fragile

Before accessing or manipulating the DOM...

Problem

- When your JS code executes, the page might not have finished loading
  - ⇒The DOM tree might not be fully instantiated / might change!

window.onload or DOMContentLoaded

- Your DOM manipulation code should go inside that function

```
1  // load
2  window.addEventListener('load', function() {
3      console.log('All resources finished loading!');
4  });
5
6  // 'DOMContentLoaded
7  document.addEventListener('DOMContentLoaded', function() {
8   console.log('The DOM is fully loaded and parsed, but not
        necessarily all resources.');
9  });
```

Properties for DOM Traversal

parentNode

Parent node of this one, or null

childNodes

A read only array-like object containing all the (live) child nodes of this one

firstChild, lastChild

The first and lastChild of a node, or null if it has no children

nextSibling, previousSibling

The next and previous siblings of a node (in the order in which they appear in the document)

Other node properties

nodeType: 'kind of node'

- Document nodes: 9
- Element nodes: 1
- Text nodes: 3
- Comment node: 8

nodeValue

Textual content of Text of comment node

nodeName

Tag name of a node, converted to upper-case

Example: Find a Text Node

- We want to find the DOM node that has a certain piece of text, say "text"
- Return true if text is found, false otherwise
- We need to recursively walk the DOM looking for the text in all text nodes

```
1  function search(node, text) {
2      /* ... */
3  };
4
5  var result = search(window.document, "Hello world!");
```

Searching Recursively for a Text Node


```
1  function search(node, text) {
2     var found = false;
3     if (node.nodeType== Node.TEXT_NODE) { \\ 3
4        if (node.nodeValue === text) found = true;
5     } else { // textNodes cannot have children
6        var cn = node.childNodes;
7        if (cn) {
8           for (var i=0; i < cn.length; i++) {
9              found = found || search(cn[i], text);
10          }
11       }
12    }
13    return found;
14 };
15
16 var result = search(window.document, "Hello world!");
```

Class Activity

- Write a function that will traverse the DOM tree rooted at a node with a specific 'id', and checks if any of its sibling nodes and itself in the document is a text node, and if so, concatenates their text content and returns it.
- Can you generalize it so that it works for the entire subtree rooted at the sibling nodes ?

Solution


```
1  function collectTextFromSiblingsAndSubtree(id) {
2    // Find the element by id
3    const startElement = document.getElementById(id);
4    if (!startElement) return ''; // If the element doesn't
         exist, return an empty string
5
6    let textContent = '';
7
8    // Helper function to traverse the subtree
9    function traverseSubtree(node) {
10     // Check if the current node is a text node
11     if (node.nodeType === Node.TEXT_NODE) {
12       textContent += node.nodeValue; // Concatenate the text
             from the text node
13     } else if (node.nodeType === Node.ELEMENT_NODE) {
14       // Recursively check the children of this node
15       Array.from(node.childNodes).forEach(traverseSubtree);
16     }
17   }
18
19   // Include the text from the starting node's subtree
20   traverseSubtree(startElement);
21   return textContent;
22 }
```

Solution (siblings)


```
1  function collectTextFromSiblingsAndSubtree(id) {
2    ...
3    // Include the text from the starting node's subtree
4    traverseSubtree(startElement);
5
6    // Traverse sibling nodes
7    let sibling = startElement.parentNode.firstChild;
8    while (sibling) {
9      if (sibling !== startElement) { // Skip the starting
           node
10       traverseSubtree(sibling); // Use the helper function
           on the sibling's subtree
11     }
12     sibling = sibling.nextSibling; // Move to the next
           sibling
13   }
14
15   return textContent;
16 }
17
18 // Example usage
19 const textResult = collectTextFromSiblingsAndSubtree('
       yourElementId');
20 console.log(textResult);
```

Modifying DOM Elements

Modifying DOM elements

- DOM elements are also JavaScript Objects (in most browsers) and consequently can have their properties read and written to
  - Can extend DOM elements by modifying their prototype objects
  - Can add fields to the elements for keeping track of state (E.g., visited node during traversals)
  - Can modify HTML attributes of the node such as width etc. – changes reflected in browser display

Element Interface

- It is bad practice to modify the Node object directly, so instead JavaScript exposes an Element interface. Objects that implement the Element interface can be modified
- Hierarchy of Element objects e.g., HTMLTextElement, HTMLDivElement
- Element object derives from Node object and has access to its properties

Example: Changing visible elements of a node

- Assume that you want to change the URL of an image object in the DOM with id="myimage" after a 5 second delay to "newImage.jpg"

```
1  var myImage = document.getElementById("myimage");
2  setTimeout( function() {
3      myImage.src ="newImage.jpg";
4  }, 5000 );
```

Example: Extending DOM element's prototype

- Let's add a new print method to Node that prints the text to console if it's a text/comment node
  - This may break some frameworks, so proceed with caution !

```
1  Element.prototype.print = function() {
2      if (this.nodeType==3 || this.nodeType==8)
3              console.log( this.nodeText );
4  }
```

Example: Adding new attributes to DOM elements

- You can also add new attributes to DOM nodes, but these will not be rendered by the web browser (unless they're HTML attributes)
  - Caution: may break frameworks such as jQuery !

```
1  var e = document.getElementById("myelement");
2  e.accessed = true;
3  // accessed is a non-standard HTML attribute
```

Accessing the raw HTML of a node

- You can retrieve the raw HTML of a DOM node using it's innerHTML property
  - Can modify it from within JavaScript code, though this is considered bad practice and is deprecated

```
1  // HTML: <p id="myP">I am a paragraph.</p>
2  // JS code:
3  var e = document.getElementById("myP");
4  console.log( e.innerHTML );
5  e.innerHTML = "Don't do this !";
```

Class Activity

- Add a field to each DOM element of type div that keeps track of how many times the div is accessed through the document.getElementById method, and make sure to initialize the value of this field for all div's in the document to 0 when the document is initially loaded.

Solution


```
1  document.addEventListener('DOMContentLoaded', function() {
2    // Initialize the access count property for each div
3    const divs = document.getElementsByTagName('div');
4    for (let i = 0; i < divs.length; i++) {
5      divs[i].accessCount = 0;
6    }
7
8    // Create a wrapper function for `document.getElementById`
9    const originalGetElementById = document.getElementById.
         bind(document);
10   document.getElementById = function(id) {
11     const elem = originalGetElementById(id);
12     if (elem && elem.tagName === 'DIV') {
13       elem.accessCount = (elem.accessCount || 0) + 1;
14     }
15     return elem;
16   };
17 });
```

Adding and removing nodes

Creating New and Copying Existing DOM Nodes

Creating New DOM Nodes

- Using either document.createElement("element") OR document.createTextNode("text content")

```
1  var newNode = document.createTextNode("hello");
2  var elNode = document.createElement("h1");
```

Copying Existing DOM Nodes: use *cloneNode*

- Single argument can be true or false
  - True: deep copy (recursively copy all descendants)
- new node can be inserted into a different document

```
1  var existingNode = document.getElementByid("my");
2  var newNode = existingNode.cloneNode( true );
```

Inserting Nodes

appendChild

Adds a new node as a child of the node it is invoked on. node becomes *lastChild*

insertBefore

Similar, except that it inserts the node before the one that is specified as the second argument (*lastChild* if it's null)

```
1  var s = document.getElementByID("my");
2  s.appendChild(newNode);
3  s.insertBefore(newNode, s.firstChild);
```

Removing and replacing nodes

Removing a node *n*: *removeChild*

```
1  n.parentNode.removeChild(n);
```

Replacing a node *n* with a new node: *replaceChild*

```
1  n.parentNode.replaceChild(
2      document.createTextNode("[redacted]"),
3      n);
```

Example to put it all together


```
1  // function to replace a node n by making it a child of a
       new "div" element with id = "id"
2  function newdiv(n, id) {
3      var div = document.createElement("div");
4      div.id = id;
5      n.parentNode.replaceChild(div, n);
6      div.appendChild(n);
7  };
```

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