

Lecture 4: JavaScript in the Web Browser

CPEN322 - Building Modern Web Applications - Winter 2021-1

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Outline



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- 1 Browsers and the Web Application Model
- 2 Window Object
- 3 Event Handling in Modern Browsers
- 4 Event Propagation in the DOM

Browser as an OS!



- Anyful meaningful interaction requires access to browser API.



- update DOM

- AJAX Messages

- schedule future events - event handle, etc.

- Modern Browsers are equivalent to an OS for web applications

- Provide core services such as access to the display (DOM, location bar), and permanent state (cookies, local storage, history)
- Schedule event handlers for different tasks and control the global ordering of events - Scheduler.
- Allow network messages to be sent and received from the server

↳ Messaging API

- Not Chromium.

- Web app runs on browser OS.

Modern Web Application



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- Applications running on web browsers that use the browser's facilities
 - Update the browser's DOM or shared location bar
 - Schedule events in the future and register event handlers for various parts of the web application
 - Send and receive asynchronous AJAX messages from the web server
- Web applications run on top of the browser OS !

Browser Sandbox



- However, web applications are restricted in their behaviour for security reasons
 - Some bugs can bypass, should enforce.
 - Cannot write persistent state to the host file system (use cookies or browser local storage)
 - Cannot write to parts of the DOM tree that come from other domains (Same Origin Policy - SOP)
 - Cannot read cookies belonging to other domains (SOP)
 - Only allowed to communicate with their domain

→ Do not trust other domains

Same Origin Policy (SOP)

- Restricts which parts of the web application can be read/written by JavaScript code
 - separate server.
 - e.g. Ad cannot modify web content.
- Origin = (URL, domain, portNumber)
- NOTE: Origin of the script is not important. What is important is the origin on the document in which script is embedded

JavaScript Two Phase Execution Model



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Phase 1

- All code within the `<script></script>` tag is executed when they're loaded in the order of loading (unless the script tag is async or deferred) → top down to exec.
- Some scripts may choose to defer execution or execute asynchronously. These are executed at the end of phase 1

- Typically in header of webapp.

- Others: embed code in HTML

call to snippets / function in same files
embed in URL.

JavaScript Two Phase Execution Model



Phase 1

- All code within the `<script></script>` tag is executed when they're loaded in the order of loading (unless the script tag is `async` or `deferred`)
- Some scripts may choose to defer execution or execute asynchronously. These are executed at the end of phase 1

Phase 2

- Waits for events to be triggered and executes handlers corresponding to the events in order of event execution (single-threaded model) → No context switch of code.
- Events can be of four kinds:
 - Load event: After page has finished loading (phase 1)
 - User events: Mouse clicks, mouse moves, form entry
 - Timer events: Timeouts, Interval
 - Networking: Async messages response arrives

cannot force
give up.

- code must
be reactive
and give up
CPU.

Window Object



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Window object



- Global object that provides a gateway for almost all features of the web application
- Passed to standalone JS functions, and can be accessed by any function within the webpage
- Example Features
 - DOM: Through the `window.document` property
 - URL bar: Through `window.location` property
 - Navigator: Browser features, user agent etc.

window.alert, confirm and prompt



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- Alert: Simple way to popup a dialog box on the current window with an OK button
- POP UP - Avoid if possible
- Can display an arbitrary string as message
- Prompt: Asks the user to enter a string and returns it
- Confirm: Displays a message and waits for user to click OK or Cancel, and returns a boolean

Example

```
1  do { Confirmation  
2    var name = prompt("What is your name?");  
3    var correct = confirm("You entered: " + name);  
4  } while (! correct);  
5  // This is bad security practice - don't do this !  
6  alert("Hello " + name); ← Not sanitizing input
```

setTimeout and setInterval



- **setTimeout** is used to schedule a future event asynchronously **once** after a specified no of milliseconds (can be set to 0)
 - Can specify arguments to event handler
 - Can be cancelled using the **clearTimeout** method
- **setInterval** has the same functionality as **setTimeout**, except that the event fires repeatedly until **clearInterval** is invoked

Example of setTimeout

```
1 var timeoutHandler = function(message) {  
2     return function() {  
3         alert(message);  
4     };  
5 };  
6  
7 var ret = setTimeout(timeoutHandler("Hello"),100);  
8 // [...]  
9 if (flag) clearTimeout(ret);
```

→ global obj.

← returns function

↑ closure.

setTimeout and setInterval



- **setTimeout** is used to schedule a future event asynchronously **once** after a specified no of milliseconds (can be set to 0)
 - Can specify arguments to event handler
 - Can be cancelled using the **clearTimeout** method
- **setInterval** has the same functionality as **setTimeout**, except that the event fires repeatedly until **clearInterval** is invoked

- if busy, set interval gives action

Example of setInterval

```
1 var intervalHandler = function(message) {  
2     var i = 0;  
3     return function() {  
4         alert(message + ' ' + i);  
5         i += 1;  
6     }  
7 };  
8 var ret = setInterval(intervalHandler("invocation"  
9     ),1000); // [...]  
9 if (flag) clearInterval(ret);
```

Class Activity



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- Create a new function that invokes another function **func** a specified number of times **noTimes**, asynchronously, each time after **time** ms.
- The function should pass as an argument to **func** the number of times it called **func** so far.

HINT

You can do it through **setTimeout** or **setInterval**

```
1  function invokeTime( func , noTimes , time ) {  
2      // ...  
3  }  
4  var setup = function () {  
5      invokeTimes( function(i) { alert("hello " + i); }, 10,  
6                  1000 );  
7  }  
8  setup();
```

Event Handling in Modern Browsers



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Event Handling



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- JavaScript code is event-driven, which means that you need to register event callbacks
- Events are of five types in JavaScript
 - Mouse Events (e.g., **mousedown**, **mousemove**, etc)
 - Window Events (**load**, **DOMContentLoaded**, etc)
 - Form events (**submit**, **reset**, **changed** etc)
 - Key events (**keydown**, **keyup**, **keypress** etc)
 - DOM events (part of DOM3 specification)

A cautionary note on event handling



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- There are many browser incompatibilities regarding the types of events implemented, and the way to register event handlers (e.g., IE prior to v9 is different from almost all other browsers)
- This is complicated by the fact that the DOM3 spec itself is a moving target for over 10 years
- In this class, we will follow DOM2 spec. and assume that the browser is standard compliant
 - Focus on set of events that are common (except IE)

Registering Event Handlers



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- Two ways of registering event handlers
 - Old method (DOM 1.0): Directly add a **onclick** or **onload** property to the DOM object/window
 - Disadvantage: Allows only one event handler to be specified. New handlers must remember to chain the old handler, and can potentially 'swallow' the handler
 - New method (DOM 2.0): Allows multiple event handlers to be added to the DOM object/window

E.g. click on elem.
- if also want mouse,
w/o affect of onclick handler,
chain handlers.

Registering Event handlers: DOM 1.0



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- Use `on<event>` as the handler for `<event>`
 - No caps anywhere. Eg., `onload`, `onmousemove`

```
1 element.onclick = function(event) {  
2     this.style.backgroundColor = "#ffffff";  
3     return true;  
4 }
```

- 1 `this` is bound to the DOM element on which the `onclick` handler is defined – can access its properties thro' `this.prop`
- 2 `return` value of false tells browser not to perform the default value associated with the property (true otherwise)

Chaining event handlers in DOM 1.0 method (This is deprecated now !)



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- If you want to have multiple event handlers in the above method, you need to remember to chain the earlier handlers and call them

```
1 var old = element.onclick;  
2 element.onclick = function(event) {  
3     this.style.backgroundColor = "#ffffff";  
4     if (old) return old(event);  
5     return true;  
6 }
```

Registering Event handlers: DOM 2.0



- The DOM 1.0 method is clunky and can be buggy. Also, difficult to remove event handlers
- DOM 2 event handlers
 - `addEventListener` for adding a event handler
 - `removeEventListener` for removing event handlers
 - `stopPropagation` and `stopImmediatePropagation` for stopping the propagation of an event (later)

addEventListener



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- Used to add an Event handler to an element. Does NOT overwrite previous handlers
 - Arg1: Event type for which the handler is active
 - Arg2: Function to be invoked when event occurs
 - Arg3: Whether to invoke in the 'capture' phase of event propagation (more later) - false typically

Example

```
1 var b = document.getElementById("mybutton");  
2 b.addEventListener("click", function() {  
3     alert("hello");  
4 }, false);
```

↑ fx to be invoked on event.
event name/type

↑ to be explained

- can just chain events.

More on *addEventListener*



- Does not overwrite previous handlers, even those set using **onclick**, **onmouseover** etc.
- Can be used to register multiple event handlers – invoked in order of registration (handlers set through DOM 1.0 model have precedence)

Example

ref to button

```
1 var b = document.getElementById("mybutton");  
2 b.addEventListener("click", function() {  
3     alert("hello");  
4 }, false);  
5 b.addEventListener("click", function() {  
6     alert("world");  
7 }, false);
```

removeEventListener



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- Used to remove the event handler set by `addEventListener` functions, with the same arguments
 - No error even if the function was not set as event handler

Example

```
1 var handleClick = function() {  
2     alert("clicked");  
3 };  
4 var b = document.getElementById("mybutton")  
5 b.addEventListener("click", handleClick ,  
6     false);  
6 b.removeEventListener("click", handleClick ,  
    false);
```

- if you remove non-existing, no error.

Event Handler Context



e.g. button -
- 'this' is set to 'this'

- Invoked in the context of the element in which it is set (**this** is bound to the target)
- Single argument that takes the **event** object as a parameter – different events have different properties, with info about the event itself → Captures everything abt event [optional]
- Return value is discarded – not important
- Can access variables in the scope in which it is defined, as any other JS function
 - Can support closures within Event Handlers

Class Activity



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- Write a handler for the `click` property of the button in the example earlier that displays a message (`str1 + str2`) using the `alert` feature
- `str1` is determined at runtime when setting the event handler for the button `b`, and should not be stored in the global context
- `str2` is determined based on the event target at the time of its invocation e.g., `event.target`. This may be different from the button `b` (later why).

Event Propagation in the DOM



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Event Propagation

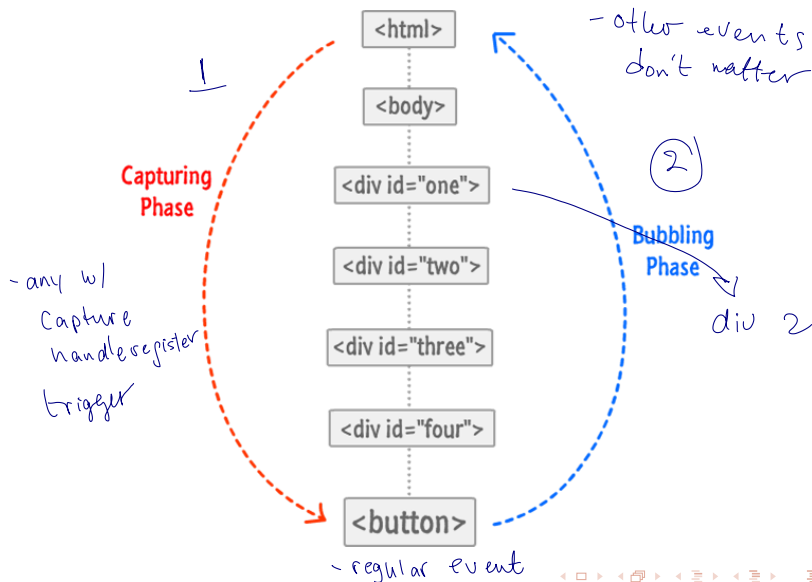


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- Events triggered on an element propagate through the DOM tree in 2 consecutive phases
 - Capture phase: Event is triggered on the topmost element of the DOM and propagates down to the event target element
 - Bubble phase: Event starts from the event target element and 'bubbles up' the DOM tree to the top
- Events may therefore trigger handlers on elements different from their targets



Capture and Bubble Phases



Event Propagation Setup



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- To associate an event handler with the capture phase of event propagation, set the third parameter of `addEventListener` to `true`

Example

```
1 var div1 = getElementById("one");  
2 div1.addEventListener("click", handler, true);
```

- The default way of triggering event handlers is during the bubble phase (3rd argument is false)

false - bubble handler
true - event handler.

Capture and Bubble Phases



```
1 var div1 = getElementById("one");  
2 div1.addEventListener("click", handler1, true);  
3 var div2 = getElementById("two");  
4 div2.addEventListener("click", handler2, true);
```

Capture Phase

- Assume that the **div** element 'two' is clicked.
- **handler1** is invoked before **handler2** as both are registered during the capture phase.

Bubble Phase

- Assume that the **div** element 'two' is clicked.
- **handler2** is invoked before **handler1** as they are both registered during the bubble phase.

Stopping Event Propagation



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- In the prior example, suppose **handler1** and **handler2** are registered in the capture phase

Stopping Event Propagation

```
1 var handler1 = function( clickEvent ) {  
2     clickEvent.stopPropagation();  
3 }
```

- Then **handler2** will never be invoked as the event will not be sent to **div2** in the capture phase

capture {
1
2

stopPropagation, preventDefault and stopImmediatePropagation



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- An event handler can stop the propagation of an event through the capture/bubble phase using the **event.stopPropagation** function
 - Other handlers registered on the element are still invoked however
- To prevent other handlers on the element from being invoked and its propagation, use **event.stopImmediatePropagation**
- To prevent the browser's default action, call the method **event.preventDefault**

→ other handlers in same element

Not recommended.

Class Activity



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- Consider the sample code given in the Github. In what order are the messages in the event handler functions displayed ?
- If you wanted to stop the event propagation in the bubble phase beyond `div3`, how will you do it ?

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