JavaScript

The Basics

Introduction

- JavaScript is a scripting language most often used for client-side web development.

- JavaScript is an implementation of the ECMAScript standard.
  - The ECMAScript only defines the syntax/characteristics of the language and a basic set of commonly used objects such as Number, Date, Regular Expression, etc.

- The JavaScript supported in the browsers typically support additional objects.
  - e.g., Window, Frame, Form, DOM object, etc.

JavaScript / JScript

- Different brands or/and different versions of browsers may support different implementation of JavaScript.
  - They are not fully compatible

- JScript is the Microsoft version of JavaScript.

What can we do with JavaScript?

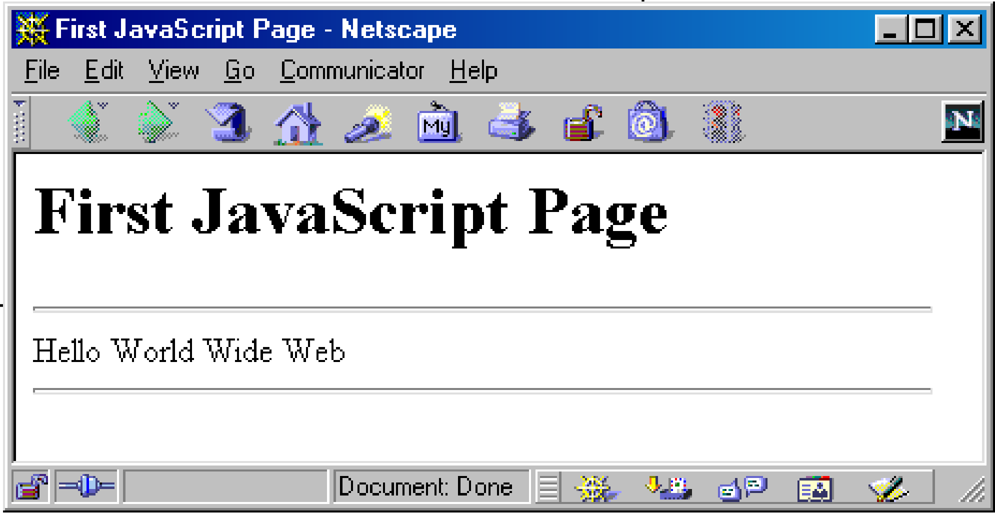
- To create interactive user interface in a web page (e.g., menu, pop-up alert, windows, etc.)

- Manipulating web content dynamically
  - Change the content and style of an element
  - Replace images on a page without page reload
  - Hide/Show contents

- Generate HTML contents on the fly
- Form validation
- AJAX (e.g. Google complete)
- etc.

A Simple Script

```
<html>
<head><title>First JavaScript
   Page</title></head>
<body>
<h1>First JavaScript Page</h1>
<script type="text/javascript">
  document.write("<hr>");
  document.write("Hello World Wide Web");
  document.write("<hr>");
</script>
</body>
</html>
```


First JavaScript Page - Netscape
File Edit View Go Communicator Help
Document: Done

First JavaScript Page

Hello World Wide Web

Embedding JavaScript

```
<html>
<head><title>First JavaScript Program</title></head>
<body>
<script type="text/javascript"
        src="your_source_file.js"></script>
</body>
</html>
```

Inside your_source_file.js

```
document.write("<hr>");
document.write("Hello World Wide Web");
document.write("<hr>");
```

- Use the **src** attribute to include JavaScript codes from an external file.
- The included code is inserted in place.

Embedding JavaScript

- The scripts inside an HTML document is interpreted in the order they appear in the document.
  - Scripts in a function is interpreted when the function is called.

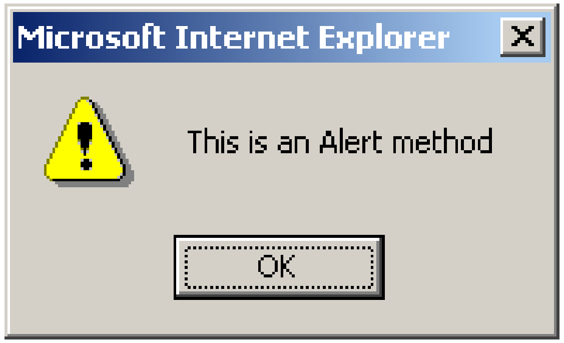
- So where you place the <script> tag matters.

Hiding JavaScript from Incompatible Browsers

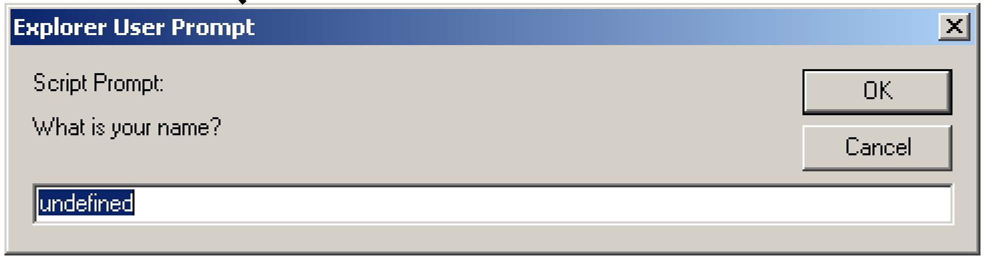
```
<script type="text/javascript">
<!-
  document.writeln("Hello, WWW");
// -->
</script>
<noscript>
  Your browser does not support JavaScript.
</noscript>
```

alert(), confirm(), and prompt()

```
<script type="text/javascript">
alert("This is an Alert method");
confirm("Are you OK?");
prompt("What is your name?");
prompt("How old are you?","20");
</script>
```


Microsoft Internet Explorer

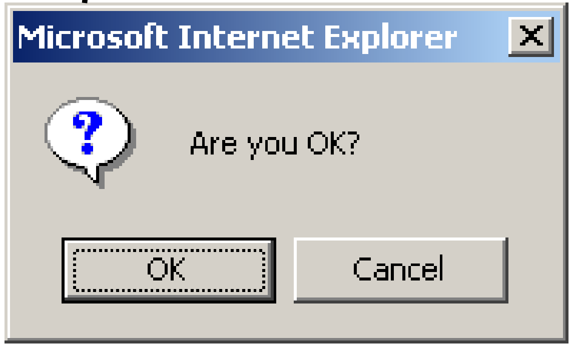
This is an Alert method


Explorer User Prompt

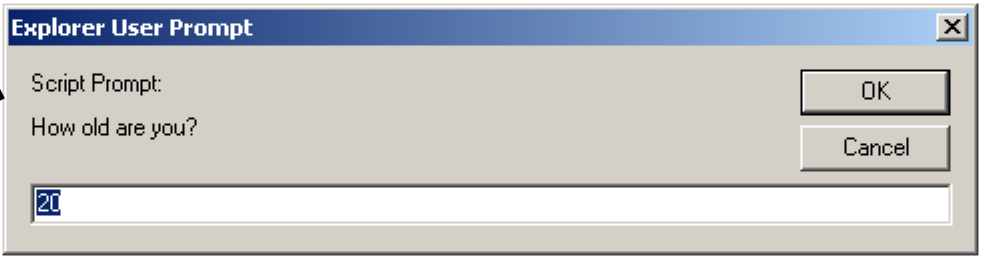
Script Prompt:

What is your name?

undefined


Microsoft Internet Explorer

Are you OK?


Explorer User Prompt

Script Prompt:

How old are you?

20

alert() and **confirm()**

```
alert("Text to be displayed");
```

- Display a message in a dialog box.
- The dialog box will block the browser.

```
var answer = confirm("Are you sure?");
```

- Display a message in a dialog box with two buttons: "OK" or "Cancel".
- **confirm()** returns **true** if the user click "OK". Otherwise it returns **false**.

prompt()

```
prompt("What is your student id number?");
prompt("What is your name?”, "No name");
```

- Display a message and allow the user to enter a value
- The second argument is the "default value" to be displayed in the input textfield.
- Without the default value, "undefined" is shown in the input textfield.

- If the user click the "OK" button, **prompt()** returns the value in the input textfield as a string.
- If the user click the "Cancel" button, **prompt()** returns null.

Identifier

- Same as Java/C++ except that it allows an additional character – '$'.

- Contains only 'A' – 'Z', 'a' – 'z', '0' – '9', '_', '$'
- First character cannot be a digit
- Case-sensitive
- Cannot be reserved words or keywords

Variable and Variable Declaration

```
<head><script type="text/javascript">
  // We are in the default scope – the "window" object.
  x = 3;        // same as "window.x = 3"
  var y = 4;    // same as "y = 4" or "window.y = 4"

  {  // Introduce a block to creat a local scope
     x = 0;           // Same as "window.x = 0"
     var y = 1;       // This is a local variable y
  }

  alert("x=" + x + ", y=" + y);  // Print x=0, y=4

</script></head>
```

- Local variable is declared using the keyword 'var'.
- Dynamic binding – a variable can hold any type of value
- If a variable is used without being declared, the variable is created automatically.
  - If you misspell a variable name, program will still run (but works incorrectly)

Data Types

- Primitive data types
  - Number: integer & floating-point numbers
  - Boolean: true or false
  - String: a sequence of alphanumeric characters

- Composite data types (or Complex data types)
  - Object: a named collection of data
  - Array: a sequence of values (an array is actually a predefined object)

- Special data types
  - Null: the only value is "null" – to represent nothing.
  - Undefined: the only value is "undefined" – to represent the value of an unintialized variable

Strings

- A string variable can store a sequence of alphanumeric characters, spaces and special characters.

- Each character is represented using 16 bit
  - You can store Chinese characters in a string.

- A string can be enclosed by a pair of single quotes (') or double quote (").

- Use escaped character sequence to represent special character (e.g.: \", \n, \t)

typeof operator

```
var x = "hello", y;
alert("Variable x value is " + typeof x );
alert("Variable y value is " + typeof y );
alert("Variable x value is " + typeof z );
```

- An unary operator that tells the type of its operand.
  - Returns a string which can be "number", "string", "boolean", "object", "function", "undefined", and "null"

  - An array is internally represented as an object.

Object

- An object is a collection of properties.
- Properties can be variables (Fields) or Functions (Methods)
- There is no "Class" in JavaScript.

Array

- An array is represented by the **Array** object. To create an array of N elements, you can write

```
var myArray = new Array(N);
```

- Index of array runs from 0 to N-1.
- Can store values of different types
- Property "**length**" tells the # of elements in the array.
- Consists of various methods to manipulate its elements. e.g., **reverse()**, **push()**, **concat()**, etc

Array Examples

```
var Car = new Array(3);
Car[0] = "Ford";
Car[1] = "Toyota";
Car[2] = "Honda";

// Create an array of three elements with initial
// values
var Car2 = new Array("Ford", "Toyota", "Honda");

// Create an array of three elements with initial
// values
var Car3 = ["Ford", "Toyota", "Honda"];
```

```
// An array of 3 elements, each element is undefined
var tmp1 = new Array(3);

// An array of 3 elements with initial values
var tmp2 = new Array(10, 100, -3);

// An array of 3 elements with initial values
// of different types
var tmp3 = new Array(1, "a", true);

// Makes tmp3 an array of 10 elements
tmp3.length = 10; // tmp[3] to tmp[9] are undefined.

// Makes tmp3 an array of 100 elements
tmp3[99] = "Something";
// tmp[3] to tmp[98] are undefined.
```

Null & Undefined

- An undefined value is represented by the keyword "**undefined**".
  - It represents the value of an uninitialized variable

- The keyword "**null**" is used to represent “nothing”
  - Declare and define a variable as “null” if you want the variable to hold nothing.
  - Avoid leaving a variable undefined.

Type Conversion (To Boolean)

- The following values are treated as false
  - null
  - undefined
  - +0, -0, NaN (numbers)
  - "" (empty string)

Type Conversion

- Converting a value to a number

```
var numberVar = someVariable – 0;
```

- Converting a value to a string

```
var stringVar = someVariable + "";
```

- Converting a value to a boolean

```
var boolVar = !!someVariable;
```

Operators

- Arithmetic operators
  - +, -, *, /, %
- Post/pre increment/decrement
  - ++, --
- Comparison operators
  - ==, !=, >, >=, <, <=
  - ===, !== (Strictly equals and strictly not equals)
    - i.e., Type and value of operand must match / must not match

== VS ===

```
// Type conversion is performed before comparison
var v1 = ("5" == 5);    // true

// No implicit type conversion.
// True if only if both types and values are equal
var v2 = ("5" === 5);   // false

var v3 = (5 === 5.0); // true

var v4 = (true == 1); // true (true is converted to 1)

var v5 = (true == 2); // false (true is converted to 1)

var v6 = (true == "1") // true
```

Logical Operators

- **!** – Logical NOT
- **&&** – Logical AND
  - **OP1 && OP2**
  - If OP1 is true, expression evaluates to the value of OP2.

    Otherwise the expression evaluates to the value of OP1.
  - Results may not be a boolean value.
- **||** – Logical OR
  - **OP1 || OP2**
  - If OP1 is true, expression evaluates to the value of OP1. Otherwise the expression evaluates to the value of OP2.

```
var tmp1 = null && 1000;        // tmp1 is null

var tmp2 = 1000 && 500;         // tmp2 is 500

var tmp3 = false || 500;        // tmp3 is 500

var tmp4 = "" || null;          // tmp4 is null

var tmp5 = 1000 || false;       // tmp5 is 1000


// If foo is null, undefined, false, zero, NaN,
// or an empty string, then set foo to 100.
foo = foo || 100;
```

Operators (continue)

- String concatenation operator
  - **+**
  - If one of the operand is a string, the other operand is automatically converted to its equivalent string value.

- Assignment operators
  - **=, +=, -=, *=, /=, %=**

- Bitwise operators
  - **&, |, ^, >>, <<, >>>**

Conditional Statements

- “if” statement
- “if … else” statement
- "? :" ternary conditional statement
- “switch” statement

- The syntax of these statements are similar to those found in C and Java.

Looping Statement

- “for” Loops
- “for/in” Loops
- “while” Loops
- “do … while” Loops
- “break” statement
- “continue” statement

- All except "for/in" loop statements have the same syntax as those found in C and Java.

“for/in” statement

```
for (var variable in object) {
   statements;
}
```

- To iterate through all the properties in "object".
- "**variable**" takes the name of each property in "object"
- Can be used to iterate all the elements in an Array object.

```
var keys = "", values = "";
var mylist = new Array("Chinese", "English", "Jap");
mylist.newField1 = "Something";

for (var key in booklist) {
  keys += key + " ";
  values += booklist[counter] + " ";
}

// keys becomes "0 1 2 newField1"
// values becomes "Chinese English Jap Something"
```

```
var obj = new Object();  // Creating an object

// Adding three properties to obj
obj.prop1 = 123;
obj.prop2 = "456";
obj["prop3"] = true;    // same as obj.prop3 = true

var keys = "", values = "";
for (var p in obj) {
  keys += p + " ";
  values += obj[p] + " ";
}

alert(keys);
// Show "prop1 prop2 pro3 "

alert(values);
// Show "123 456 true "
```

Example: Using for … in loop with object

Functions (Return Values)

```
// A function can return value of any type using the
// keyword "return".

// The same function can possibly return values
// of different types
function foo (p1) {
      if (typeof(p1) == "number")
            return 0;   // Return a number
      else
      if (typeof(p1) == "string")
            return "zero"; // Return a string

      // If no value being explicitly returned
      // "undefined" is returned.
}

foo(1);                 // returns 0
foo("abc");             // returns "zero"
foo();                  // returns undefined
```

Variable Arguments

```
// "arguments" is a local variable (an array) available
// in every function
// You can either access the arguments through parameters
// or through the "arguments" array.
function sum ()
{
  var s = 0;
  for (var i = 0; i < arguments.length; i++)
      s += arguments[i];
  return s;
}


sum(1, 2, 3);              // returns 6
sum(1, 2, 3, 4, 5);        // returns 15
sum(1, 2, "3", 4, 5);      // returns ?
```

Built-In Functions

- **eval(expr)**
  - evaluates an expression or statement
    - eval("3 + 4"); // Returns 7 (Number)
    - eval("alert('Hello')"); // Calls the function alert('Hello')

- **isFinite(x)**
  - Determines if a number is finite

- **isNaN(x)**
  - Determines whether a value is “Not a Number”

Built-In Functions

- **parseInt(s)**
- **parseInt(s, radix)**
  - Converts string literals to integers
  - Parses up to any character that is not part of a valid integer
    - parseInt("3 chances") // returns 3
    - parseInt("   5 alive") // returns 5
    - parseInt("How are you") // returns NaN
    - parseInt("17", 8) // returns 15

- **parseFloat(s)**
  - Finds a floating-point value at the beginning of a string.
    - parseFloat("3e-1 xyz") // returns 0.3
    - parseFloat("13.5 abc") // returns 13.5

Creating Objects

- JavaScript is not an OOP language.
- "prototype" is the closest thing to "class" in JavaScript.

- Next few slides show several ways to create objects

- It is also possible to emulate "inheritance" in JavasScript.
  - See **JavaScript and Object Oriented Programming (OOP)** (http://www.javascriptkit.com/javatutors/oopjs.shtml)

Creating objects using **new Object()**

```
var person = new Object();

// Assign fields to object "person"
person.firstName = "John";
person.lastName = "Doe";

// Assign a method to object "person"
person.sayHi = function() {
  alert("Hi! " + this.firstName + " " + this.lastName);
}

person.sayHi();  // Call the method in "person"
```

Creating objects using Literal Notation

```
var person = {
  // Declare fields
  // (Note: Use comma to separate fields)
  firstName : "John",
  lastName : "Doe",

  // Assign a method to object "person"
  sayHi : function() {
    alert("Hi! " + this.firstName + " " +
          this.lastName);
  }
}

person.sayHi();  // Call the method in "person"
```

Creating objects using Literal Notation
(Nested notation is possible)

```
var triangle = {
  // Declare fields (each as an object of two fields)
  p1 : { x : 0, y : 3 },
  p2 : { x : 1, y : 4 },
  p3 : { x : 2, y : 5 }
}

alert(triangle.p1.y);   // Show 3
```

Object Constructor and prototyping

```
function Person(fname, lname) {
  // Define and initialize fields
  this.firstName = fname;
  this.lastName = lname;

  // Define a method
  this.sayHi = function() {
    alert("Hi! " + this.firstName + " " +
          this.lastName);
  }
}

var p1 = new Person("John", "Doe");
var p2 = new Person("Jane", "Dow");

p1.sayHi();  // Show "Hi! John Doe"
p2.sayHi();  // Show "Hi! Jane Dow"
```

Adding methods to objects using prototype

```
// Suppose we have defined the constructor "Person"
// (as in the previous slide).

var p1 = new Person("John", "Doe");
var p2 = new Person("Jane", "Dow");

// Aattaching a new method to all instances of Person
Person.prototype.sayHello = function() {
  alert("Hello! " + this.firstName + " " +
                    this.lastName);
}

// We can also introduce new fields via "prototype"

p1.sayHello();  // Show "Hello! John Doe"
p2.sayHello();  // Show "Hello! Jane Dow"
```

Events

- An event occurs as a result of some activity
  - e.g.:
    - A user clicks on a link in a page
    - Page finished loaded
    - Mouse cursor enter an area
    - A preset amount of time elapses
    - A form is being submitted

Event Handlers

- Event Handler – a segment of codes (usually a function) to be executed when an event occurs

- We can specify event handlers as attributes in the HTML tags.

- The attribute names typically take the form "**onXXX**" where **XXX** is the event name.
  - e.g.:

```
<a href="…" onClick="alert('Bye')">Other
Website</a>
```

Event Handlers

Event Handlers	**Triggered when**
onChange	The value of the text field, textarea, or a drop down list is modified
onClick	A link, an image or a form element is clicked once
onDblClick	The element is double-clicked
onMouseDown	The user presses the mouse button
onLoad	A document or an image is loaded
onSubmit	A user submits a form
onReset	The form is reset
onUnLoad	The user closes a document or a frame
onResize	A form is resized by the user

For a complete list, see http://www.w3schools.com/htmldom/dom_obj_event.asp

onClick Event Handler Example

```
<html>
<head>
<title>onClick Event Handler Example</title>
<script type="text/javascript">
function warnUser() {
      return confirm("Are you a student?”);
}
</script>
</head>
<body>
<a href="ref.html" onClick="return warnUser()">
<!--
  If onClick event handler returns false, the link
  is not followed.
-->
Students access only</a>
</body>
</html>
```

onLoad Event Handler Example

```
<html><head>
<title>onLoad and onUnload Event Handler Example</title>
</head>
<body
   onLoad="alert('Welcome to this page')"
   onUnload="alert('Thanks for visiting this page')"
>
Load and UnLoad event test.
</body>
</html>
```

onMouseOver & **onMouseOut** Event Handler

```
<html>
<head>
<title>onMouseOver / onMouseOut Event Handler Demo</title>
</head>
<body>
<a href="http://www.cuhk.edu.hk"
   onMouseOver="window.status='CUHK Home'; return true;"
   onMouseOut="status=''"
>CUHK</a>
</body>
</html>
```

- When the mouse cursor is over the link, the browser displays the text "CUHK Home" instead of the URL.
- The "return true;" of `onMouseOver` forces browser not to display the URL.
- window.status and window.defaultStatus are disabled in Firefox.

`onSubmit` Event Handler Example

```
<html><head>
<title>onSubmit Event Handler Example</title>
<script type="text/javascript">
  function validate() {
    // If everything is ok, return true
    // Otherwise return false
  }
</script>
</head>
<body>
<form action="MessageBoard" method="POST"
 onSubmit="return validate();"
>
…
</form></body></html>
```

- If **`onSubmit`** event handler returns false, data is not submitted.
- If **`onReset`** event handler returns false, form is not reset

Build-In JavaScript Objects

Object	Description
Array	Creates new array objects
Boolean	Creates new Boolean objects
Date	Retrieves and manipulates dates and times
Error	Returns run-time error information
Function	Creates new function objects
Math	Contains methods and properties for performing mathematical calculations
Number	Contains methods and properties for manipulating numbers.
String	Contains methods and properties for manipulating text strings

- See online references for complete list of available methods in these objects: http://javascript-reference.info/

String Object (Some useful methods)

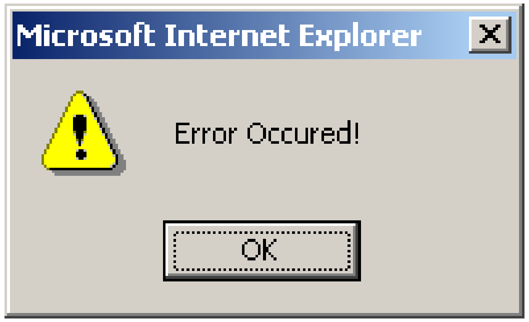
- length
  - A string property that tells the number of character in the string
- charAt(idx)
  - Returns the character at location "idx"
- toUpperCase(), toLowerCase()
  - Returns the same string with all uppercase/lowercase letters
- substring(beginIdx)
  - Returns a substring started at location "beginIdx"
- substring(beginIdx, endIdx)
  - Returns a substring started at "beginIdx" until "endIdx" (but not including "endIdx"
- indexOf(str)
  - Returns the position where "str" first occurs in the string

Error and Exception Handling in JavaScript

- Javascript makes no distinction between Error and Exception (Unlike Java)
- Handling Exceptions
  - The onError event handler
    - A method associated with the window object.
    - It is called whenever an exception occurs
  - The try … catch … finally block
    - Similar to Java try … catch … finally block
    - For handling exceptions in a code segment
  - Use throw statement to throw an exception
    - You can throw value of any type
  - The Error object
    - Default object for representing an exception
    - Each Error object has a name and message properties

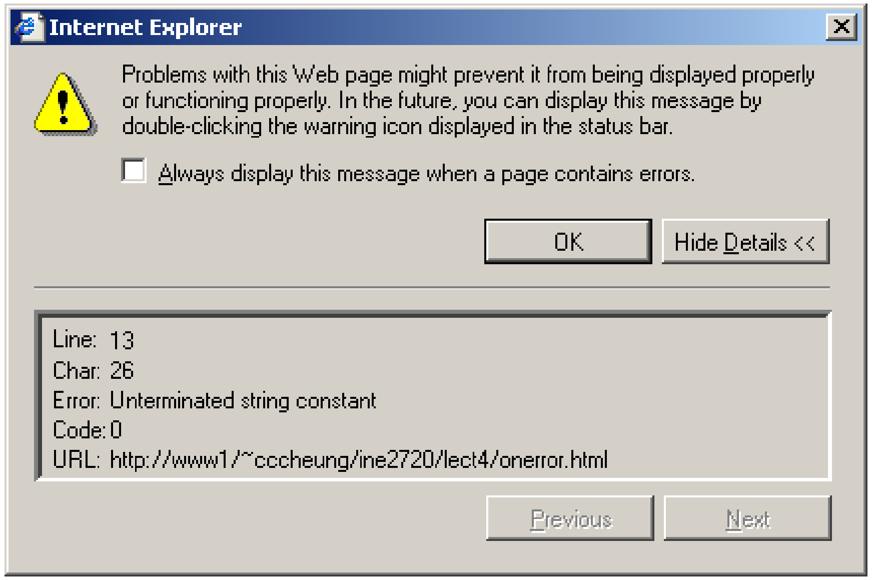
How to use “onError” event handler?

```
<html>
<head>
<title>onerror event handler example</title>
<script type="text/javascript">
function errorHandler(){
  alert("Error Ourred!");
}
// JavaScript is casesensitive
// Don't write onerror!
window.onError = errorHandler;
</script>
</head>
<body>
<script type="text/javascript">
  document.write("Hello there;
</script>
</body>
</html>
```



Microsoft Internet Explorer

Error Occured!



Internet Explorer

Problems with this Web page might prevent it from being displayed properly or functioning properly. In the future, you can display this message by double-clicking the warning icon displayed in the status bar.

☐ Always display this message when a page contains errors.

```
Line: 13
Char: 26
Error: Unterminated string constant
Code: 0
URL: http://www1/~cccheung/ine2720/lect4/onerror.html
```

try … catch … finally

```
try {
  // Contains normal codes that might throw an exception.

  // If an exception is thrown, immediately go to
  //   catch block.

} catch ( errorVariable ) {
  // Codes here get executed if an exception is thrown
  //   in the try block.

  // The errorVariable is an Error object.

} finally {
  // Executed after the catch or try block finish

  // Codes in finally block are always executed
}
// One or both of catch and finally blocks must accompany the try
block.
```

try … catch … finally example

```
<script type="text/javascript">
try{
  document.write("Try block begins<br>");
  // create a syntax error
  eval ("10 + * 5");

} catch( errVar ) {
  document.write("Exception caught<br>");
  // errVar is an Error object
  // All Error objects have a name and message properties
  document.write("Error name: " + errVar.name + "<br>");
  document.write("Error message: " + errVar.message +
                "<br>");
} finally {
  document.write("Finally block reached!");
}
</script>
```

Throwing Exception

```
<script type="text/javascript">
try{
  var num = prompt("Enter a number (1-2):", "1");
  // You can throw exception of any type
  if (num == "1")
    throw "Some Error Message";
  else
  if (num == "2")
    throw 123;
  else
    throw new Error ("Invalid input");
} catch( err ) {
  alert(typeof(errMsg) + "\n" + err);
  // instanceof operator checks if err is an Error object
  if (err instanceof Error)
    alert("Error Message: " + err.message);
}
</script>
```