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Innovative Software Solutions.

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Declaration of Variables

- Simple variable declaration:
  `var name;`
- Variable declaration with value assignment:
  `var name = value;`
- **SSJS only** (Server Side JavaScript): **typed** variable declaration:
  `var name : type = value;`
- **Best Practice:** Declare all variables at the top of a function (like you should in LotusScript, but not in Java, because of the scopes, covered later).

Types of Variables

- “loose typing” doesn't mean **un**typed!
- There are **exactly 6 types** in JavaScript
  - String
  - Number
  - Boolean
  - Object
  - `null`
  - `undefined`

Special Strings

- \ escape character
- \\ one backslash
- \' simple quote
- \" double quote
- \n new line
- \r carriage return
- \t tabulator
- \u Unicode character, e.g. \u042F ⇒ Я

String Object

- Useful methods of the String object
  - toUpperCase(), toLowerCase(): like LotusScript
  - charAt(position): character at given position
  - indexOf(searchString): position of searchString
  - indexOf(searchString, startPos): Position of searchString after startPos
  - lastIndexOf(suchstring): ditto, but backwards
  - substring(start, end): part of string
  - slice(start, end): like substring, but when end is negative, length is added (counts from end)
  - split(separator): splits string into an array

String Concatenation

- `+` and `+=` are fast in all browsers, but IE7 (and older)
- `array.join` is fast in IE7, but slower than `+` or `+=` in all other browsers.
- `string.concat` is mostly slower then simple `+` or `+=`.

String Trimming

- You can trim strings with `for` loops and `charAt` to determine the first and the last non-whitespace char and using `slice` to cut the result out off the string.
- Or you can use regular expressions, e.g.

```
if (!String.prototype.trim) {
    String.prototype.trim = function() {
        return this.replace(/^\s+/, "").
                    replace(/\s+$/, "");
    }
}
```

- What's faster depends on the amount of whitespace at the start and at the end of the string.

Numbers and the Number Object

- **All** numbers are 64-bit floating point (“double”).
- **Rounding differences** through binary-decimal-conversion
- Bit-shifting (<<, >>) possible, but **inefficient**
- `Number.MAX_VALUE` ⇒ `1.7976931348623157e+308`
  `Number.MIN_VALUE` ⇒ `5e-324`
- Number.toString(basis), e.g.
- var a = 100;
- a.toString(16) Ŭ "64"
- a.toString(2) Ŭ "1100100"

Heads up: parseInt and Octal Numbers

- `0x` prefix for hexadecimal numbers, e.g. `0xFF`
- `0` prefix for octal numbers, e.g. `014` (=12)
- Caution using parseInt(), e.g.
  - `parseInt("08")` ⇒ 0,
    parsed until first invalid character and
  - `parseInt(08)` ⇒ Error:
    `08 is not a legal ECMA-262 octal constant`
- Particularly with regard to user input, e.g. month
- **Better**:
  always call with radix as second parameter:
  `parseInt("08", 10)`

Math Object

- Useful constants and methods of the Math object:
  - Math.PI ⇒ 3.141592653589793
  - Math.E ⇒ 2.718281828459045
  - Math.SQRT2 ⇒ 1.4142135623730951
  - Math.LN2 ⇒ 0.6931471805599453
  - Math.LN10 ⇒ 2.302585092994046
  - Math.random() ⇒ 0 <= random number < 1
  - Math.round(), Math.floor(), Math.ceil()
  - Math.sin(), Math.cos(), Math.atan()
  - Math.min(), Math.max()
  - Math.pow(), Math.sqrt()

NaN = Not a Number

- "contagious" in calculations
- Not equal to anything (including NaN)
- Test with `isNaN()`
- `typeof NaN` ⇒ `"number"` 

Infinity

- e.g. 1/0 ⇒ Infinity
- Greater than the largest valid number:
  Infinity > Number.MAX_VALUE
- "contagious" in calculations, but
  - 1/Infinity ⇒ 0
  - Infinity/Infinity ⇒ NaN

Boolean

- ! Logical Not
- && Logical And
- || Logical Or
- **Lazy evaluation:** calculate only, if (still) necessary
- In LotusScript, both sides of And and Or are evaluated, even if not necessary for the result.
- Example:

```
var a = 1;
true || (a = 2);
```

a ⇒ a is still equal 1

“Falsy” Values

- Following values are “**falsy**”:
  - `false`
  - `null` (empty, set intentionally)
  - `undefined` (uninitialized or non-existent)
  - `""` (empty string)
  - `0`
  - `NaN`
- **All** other values are considered `true`, even
  - `"0"`
  - `"false"`

Heads up: Test, if Variable is Defined

- Seen often, but (over-)simplified:

```
if (a) {
    …
}
```

- **Caution:** the code block { … } will be executed, if a is undefined, but also, if it's equal to false, null, "" or 0
- **Better way**:

```
if (typeof a !== "undefined") {
    …
}
```

Comparison Operators

- `==` Equality **with** type conversion (if necessary)
  `!=` Inequality **with** type conversion (if necessary)
- `===` Equality **without** type conversion
  `!==` Inequality **without** type conversion
- Examples
  - `"1" == 1` ⇒ `true`
  - `"1" === 1` ⇒ `false`
- **Best Practice:** Always use `===` and `!==`
- `switch`
  - Comparison **with** type conversion

Ternary Operator

- `a ? b : c`
  - ? is the Ternary Operator
  - Returns b, if a is `true`, else c
- Example:

```
(typeof a !== "undefined") ? a : "Default"
```

Default Operator ||

- `||` is logical Or
- Example
```
var value = arg || "Default value";
```
- Assigns `arg` to `value`, if `arg` is `true` (not falsy), else `"Default value"`
- **Useful for optional parameters** of a function
- **Caution**, if `false`, `null`, `""`, `0` could be valid values!

Guard Operator &&

- && is logical And
- Example:
  `return obj && obj.member;`
- Returns `obj.member`, if `obj` is `true` (not falsy), else `obj`
- **Circumvents possible error** when accessing `undefined.member`
- **Caution**, if `false`, `null`, `""`, `0` could be valid values!

More Operator Magic

- + as unary operator converts strings (and date/time values) into numbers:
  +"1" === 1
- !! converts anything into boolean:
- !!"1" === true

Arrays

- Arrays are objects (inherit from `Object`)
- Their `length` attribute is always the greatest index plus 1
- `length` can also be set.
  - setting a **larger number enlarges** the array by appending `undefined` values
  - setting it to a **smaller number shortens** the array by cutting surplus elements
- Array literals: `["one", "two", "three"]`
- You can use strings like character arrays:
  `var text = "abcd"; text[2]` ⇒ `"c"`

Arrays (cont.)

- Useful methods of the `Array` object:
  - `push` and `pop`, to use an array as a stack
  - `sort`: sorts array
  - `join(separator)`: joins the elements to a string
  - `slice(start, end)`: returns part of array, doesn't change the source array
  - `splice(start, end, additional parameters)`: returns part of array, replaces it by the additional parameters or removes it without leaving a gap

Heads up: delete

- **`delete arr[2]`**
  Deletes the 3rd element, or to be more precise:
  sets the 3rd element **to `undefined`.**

```
var arr = ["one", "two", "three", "four"];
delete arr[2];
arr ⇒ ["one", "two", undefined, "four"]
```

- **`arr.splice(2, 1)`**
  Removes the 3rd element and the **remaining elements move up**

```
var arr = ["one", "two", "three", "four"];
arr.splice(2, 1);
arr ⇒ ["one", "two", "four"]
```

typeof Operator

- Results of **typeof** are sometimes not too useful:

Object of type	Result of typeof
object	"object"
function	"function"
array	"object"
number	"number"
string	"string"
boolean	"boolean"
null	"object"
undefined	"undefined"

- Use **instanceof** on objects (details follow)

for Loops

- ```
  for (init; comparison; increment) {
      ...
  }
  ```
- All three elements can contain **multiple statements,** separated by commas (!), e.g.

```
for (
    var i = 0, result = "";
    i < 100;
    i++, result += i + "\n"
) {...}
```
```

Loops and Conditions

- `for`, `while` and `do-while` loops perform similarly.
- Avoid `for-in` loop whenever possible.
- Reduce the number of iterations and the amount of work done in one iteration when possible.
- Tune `if-else if-else if-...-else` chains by putting the conditions in the "right" order: move most frequently met conditions up to the front.
- Consider using look-up tables: instead of a long `switch` statement, put the results into an array once and access the results by index.

Heads up: with

- Instead of accessing object members through the dot operator (`obj.member`) you can use `with`, especially if you want to access a lot of members of one object:

```
with (obj) {
    member = "value";
}
```

- If `obj` contains an attribute with the name `member`, its value will be set to `"value"` …
- … else a **new global variable** `member` is created and `"value"` is assigned

Heads up: Semicolon Insertion

- When an error occurs, the JavaScript interpreter **inserts an semicolon** at the end of a line and **retries** the execution.
- Example:

```
return
{
    state: "ok"
};
```

- will return **undefined**, because a semicolon will be inserted after the `return` statement.
- This behavior can mask errors.

Error Handling with try – catch – finally

- Just try it... and react on errors
- Example:

```
try {
    // an error could occur in here
} catch (e) { // e is an Error object
    // do something about this error
    alert(e.name + ": " + e.message);
} finally {
    // will be executed regardless of an
    // error, e.g. to free up ressources
}
```

- Only **one** catch-block (not many as in Java)

Error Handling (cont.)

- `throw` creates (fires) a new error
- Examples:

```
throw new Error("Message");
throw {
    name: "Name",
    message: "Message"
}
```

- `window.onerror = myErrorHandler`
  Sets error handling function in the browser, which will be called on every error afterwards
- Thus you can install a global error logging and e.g. use AJAX to send an error log to the server.

Heads up: References

- Variables contain references
- Parameters are passed to functions as references, not values.
- If a parameter is not an object:
  - If the function assigns a new value to it, it's only modified in the function, the calling code still only sees the old value.
- If a parameter is an object:
  - If the function assigns a new object to it, it's only modified in the function. The calling code still has access to the old object (and only to the old one).
  - **Caution:** If the function modifies object members, the **object is changed for the calling code, too!**

Heads up: References (cont.)

```
function test1(paramA) {paramA = "changed";}
a = "original";
test1(a);
a ⇒ "original"

function test2(paramA) {paramA = {"m":"new m"};}
a = {"m": "original m"};
test2(a);
a.m ⇒ "original m"

function test3(paramA) {paramA.m = "changed m";}
a = {"m": "original m"};
test3(a);
a.m ⇒ "changed m"
```

Functions – Data – Objects

- **Functions are first-class objects!**
  - They can have attributes and methods (i.e. inner functions).
- **Functions are data!**
  - They can be stored in variables.
  - They can be passed to and returned by functions.
- This can't be done in LotusScript, nor Java.
- JavaScript is a functional language.

Definition of Functions

- `function f (args) { ... };`
  is an **abbreviation** for
  `var f = function (arg) { ... };`
- **Anonymous** functions
  `function (args) { ... };`
- **Inner** functions

```
function f(args) {
    function g(args) { ... };
    var h = function (args) { ... };
    this.i = function (args) { ... };
}
```

- `new Function(args, body)`
  `f = new Function("a", "b", "return a + b");`

Source Code of a Function

- **Useful: `f.toString()`** returns the definition of function `f`, i.e. **its source code**
- Doesn't work with predefined functions though.
- Examples:

```
function f() {
    alert(new Date());
};
f.toString()
⇒ "function f() { alert(new Date); }"

Object.toString.toString()
⇒ "function toString() { [native code] }"
```

Function Parameters

- Declaration of a function contains the list of the **expected parameters**
- Parameters are local variables of the function

"Unexpected" Function Parameters with arguments

- Access to **all** parameters with arguments, an **array-like construct**
- Example:

```
function sum() {
    var i, result = 0;
    for (i = 0; i < arguments.length; i++) {
        result += arguments[i];
    }
    return result;
}
sum(1, 2, 3, 4, 5) ⇒ 15
```

arguments (cont.)

- arguments has the attribute length, but not the other methods of the Array object.
- **Work around**: Function.prototype.apply()

```
function removeFirstArgument() {
    var slice = Array.prototype.slice;
    return slice.apply(arguments, [1]);
} ;
removeFirstArgument(1, 2, 3, 4)
⇒ [2, 3, 4]
```

- arguments.callee contains a reference to the called function, which can become handy in anonymous functions (“banned” in ECMAScript 5)

Configuration Object

- **Tip**: Use an object as (only) parameter, which contains all needed information.
- **Benefits**:
  - You can always add new “inner parameters” without changing existing code calling this function.
  - You have “named parameters”.
  - Defaults should be used for all parameters not in the value object.

Configuration Object (cont.)

- Example:

```
function showHide(argsList) {
    var node = argsList.node || document;
    var state = argsList.state || "show";
    var term = argsList.term || "true";
    ...
};
showHide({
    node: document.getElementById("blubb"),
    state: "hide";
})
```

Heads up: Function Results

- A function without `return` returns `undefined`.
- A function with `return x` returns x. 
- A constructor (details follow) without `return` returns a reference to the new object.
- **Caution:** A constructor with `return x` returns x, **if x is an object**, else it returns the new object.

Memoization

- Cache results of function calls for later reuse
- Example:

```
function factorial(n) {

    if (!factorial.cache) {
        factorial.cache = {"0": 1, "1": 1};
    }

    if (!factorial.cache.hasOwnProperty(n)) {
        factorial.cache[n] = n * factorial(n-1);
    }

    return factorial.cache[n];
}
```

Function Calls and `this`

- Functions always run in a **context**.
- **`this`** points to the current context.
- An inner function cannot access its outer function's current context.
- **Convention**: `var that = this;`
- There are (at least) 4 ways to call functions:

Function Calls (cont.)

- **1st Functional form** `f(args)`:
  `f` will be executed in the global context.
- **2nd Method form** `obj.f(args)` and `obj["f"](args)`:
  `f` will be executed with `obj` as context.
- **3rd Constructor form** `new f(args)`:
  `f` runs in the context of the newly created, empty object, which will be returned by the function.
- **4th** `f.apply(obj, args)` and `f.call(obj, arg1, arg2, ...)`:
  `f` runs in the context of `obj`.
  `f` doesn't need to be method of `obj`!

Function Calls (cont.)

- **Caution:**
  If you want to call a method of an object, but forget to specify the object, no error will be thrown and the method will be executed in the global context.

Call Chaining

- By returning `this` in (all) methods, you can "chain" method calls to one object and get more concise code, do less typing, and structure your code better.
- Example:

```
var obj = { value: 1,
    increment: function () {
        this.value += 1; return this;
    },
    add: function (v) {
        this.value += v; return this;
    },
    shout: function () {
        alert(this.value); return this;
    }
};
obj.increment().add(3).shout(); // output: 5
```

Anonymous Functions

- Used as parameters for other functions
  - when they are used only for this purpose
  - in the called functions they have a name: the name of the parameter
- Example:
  call-back functions for Ajax calls, for `setTimeout()` or `setInterval()`:

```
setTimeout(
    function() { alert(new Date()); },
    1000
)
```

- For immediate, one-time execution, e.g. for initializing

Anonymous Functions (cont.)

- You can **hide** code with anonymous functions.
- Example:

```
(function () {
    var message = "Bye Bye!";
    window.onunload = function () {
        alert(message);
    };
})(); // define function and execute it
```

- Keeps the global object clean
- Variable `message` is accessible by the anonymous function, but is invisible and inaccessible for other code (Closure!)

Self-Modifying Functions

- Example:

```
f = function() {
    alert("First time");
    return function() {
        alert("Next time");
    };
}();
f();
f.toString()
⇒ "function() { alert("Next time"); }"
```

- 2 Alerts: "First time" and "Next time"
- **Typical usage**: one-time initialization and creation of an appropriate function for a special environment, e.g. the current browser

Currying

- Create a new function with at least one parameter less than an existing one.
- Example:

```
function addGenerator(a) {
    return function(b) {
        return a + b;
    };
};
addOne = addGenerator(1);
addOne(47) ⇒ 48
```

Function Object

- Useful attributes and methods of the `Function` object:
  - `length`: number of expected parameters
  - `caller`: calling function (not standardized)
  - `call(obj, param1, param2, ...)`: executes function in the context of `obj`
  - `apply(obj, paramsArray)`: like `call`, but all function parameters in one array

"eval is evil"

- Performance is **bad**.
- Security: use only on **absolutely trustworthy** argument
- Same considerations apply to `new Function(args, body)`
- and to call `setInterval` and `setTimeout` with strings instead of function literals.

alert()

- Auxiliary “debugger”
- Blocks execution of JavaScript
- **Caution** when using `alert()` in combination with asynchronous Ajax calls

Heads up: Scopes

- **Scope**: Where is a variable visible and accessible?
- There are only two kinds of scopes in JavaScript:
  - **global** scope
  - **function** scope
- In particular, there is no block scope like in Java
- **Caution:** Accessing an undeclared variable doesn't throw an error, but creates a **new, global** variable (think about typos).
- Example:

```
function () {
    a = 1; // without var: a is global!
}
```

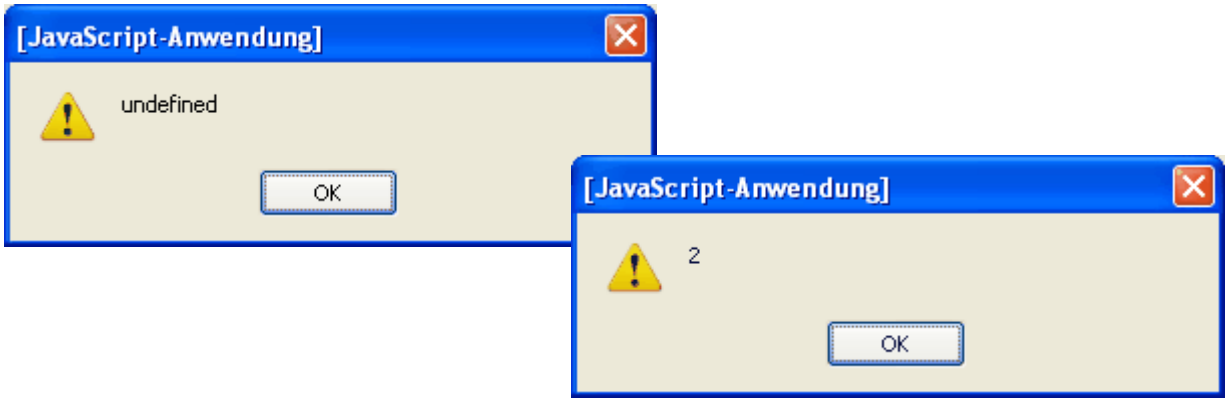
Scopes (cont.)

- Which output do you expect here?

```
var a = 1;
function f() {
    alert(a);
    var a = 2;
    alert(a);
}
f()
```

Scopes (cont.)

- Results in 2 alerts



- 2 phases:
  - local variables are found and memory reserved
  - code is executed and e.g. values assigned

Scopes (cont.)

- JavaScript has a **lexical** scope.
- The context of a function is created, when the function is **defined**, not when it is executed.

Speed of Data Access

- Literal values are fastest to access
- Local variables are second.
- Array items and object members are considerably slower.
- Going up the scope chain is costly.
- This is true for the prototype chain, too.
- **Best Practice:**
  Create **local** variables to cache array items, object members, global variables or those variables "up the chain", especially when handling DOM/BOM objects.

Context

- **Context**: “place” where variables and members “live”
- Each object has it **own context**.
- Plus there is a **global context**.
- Functions have access to the attributes and method of the context, in which they have been defined …
- … and all the way up to the global context.

Context (cont.)

- The global object in browsers is the `window` object!
- Example:
  ```
  a = 1;
  window.a ⇒ 1
  ```
- Global functions like `parseInt` are methods of the global object:
  ```
  parseInt === window.parseInt ⇒ true
  ```

Context (cont.)

- **Lexical context**, i.e. “as written in code”, not as executed
- Example:

```
function outer() {
    var o = 1;
    function inner() {
        alert(o);
    }
}
```

- At the time `inner` is defined, `o` is already known.

Context (cont.)

- Another example:

```
function outer() {
    var o = 1;
    return (function() {
        alert(o);
    })
};
var f = outer();
f() ⇒ 1
delete outer;
f() ⇒ 1 (!)
```

- o is still known, after `outer` has been executed – even **after it has been deleted**, `f` has still access to o!

Closures

- Even after an outer function has been completed, inner functions can access its attributes and functions.
- This feature is called **Closure**.
- **Most unusual concept** of JavaScript for LotusScript and Java developers.
- But Closures are probably the single **most important feature** of the JavaScript language!

Heads up: Reference, not Copy of Value

- f has a reference to o, not a copy of its value at definition time.
- When o is modified after f has been defined, this effects f.
- Decoupling with mediator function: a function, which is defined and immediately executed.

Heads up: Reference, not Copy of Value (cont.)

- Example with an unexpected result:

```
function f() {
    var a = [];
    for (var i = 0; i < 5; i++) {
        a[i] = function() {
            return i;
        }
    }
    return a;
};
var a = f();
a[0]() ⇒ 5 (should be 0)
```

Heads up: Reference, not Copy of Value (cont.)

- Improved example:

```
function f() {
    var a = [];
    for (var i = 0; i < 5; i++) {
        a[i] = (function(x) {
            return function() {
                return x;
            }
        })(i);
    }
    return a;
};
var a = f();
a[0]() ⇒ 0
```

Objects

- Objects are sets of name-value pairs.
- Names are Strings.
- Values can be of any type.
- Like lists in LotusScript
- Correlate to “associative arrays” or “hash maps” in other programming languages

Creation of Objects

- Object literals like {}
  ```
  var object = {};
  ```
- new
  ```
  var object = new Constructor();
  ```
- Object.create(...)
  actually, you probably never need this

Object Literals and Access to Members

- ```
  var obj = {
      firstName: "Thomas",
      "city of birth": "Hannover",
      "123": 123,
      "@$&%": 1,
      doIt: function() {
          alert(this.firstName);
      }
  };
  obj.doIt()
  ```
- `obj.firstName` is `"Thomas"`, `obj["city of birth"]` is `"Hannover"` etc.
- The second kind is **necessary** for reserved words and invalid identifiers.
  ```

Modifying Objects

- ```
  var obj = {
      firstName: "Thomas",
      doIt: function() {
          alert(this.firstName);
      }
  };
  obj.firstName = "Lydia";
  obj.doIt = function() {
      alert("First Name: " + this.firstName);
  };
  obj.doIt()
  ```
- Attributes and **methods** can be changed at run-time.
- This isn't possible in class-based programming languages like LotusScript.
  ```

Constructors

- Functions can be used as constructors (**with new**):

```
function Factory(location) {
    this.location = location;
};
var f = new Factory("Kiel")
```

- A new, empty object is created and `Factory` is executed in its context.
- Default return value is this newly constructed object.
- When a constructor is completed with `return x`, `x` will be returned, (only) if x is an object, else the new object is returned.

Constructors (cont.)

- Objects have an `constructor` attribute, which points to the constructor of the object **at its creation time**.
- Example creates new, similar object:

```
function Factory(totalEmployees) {
    this.totalEmployees = totalEmployees;
};
var f1 = new Factory(100);
var f2 = new f1.constructor(200);
f2 ⇒ Object { totalEmployees = 200 }
```

Constructors (cont.)

- **Convention**: Constructor names should start with an **capital letter**.
- **Caution:**
  If you forget new, the function will still be executed, but in the **global** context instead in the context of the newly created object.

Self-Invoking Constructors

- In order to avoid the problem with the missing new, write your constructors this way:

```
function Car() {
    if (!(this instanceof Car)) {
        return new Car();
    }
    // do the normal construction stuff
}
```

- If Car is executed without new, it runs in the global context, therefore this points the global object, which is not a Car.

instanceof Operator

- instanceof operator compares with constructor:
  f1 instanceof Factory ⇒ true
  f1 instanceof Object ⇒ true
  f1 instanceof String ⇒ false
- instanceof is true for "super-objects", too.

for ... in Loops

- Iterate over all attributes and methods of an object – and its "ancestors" (but not all properties are "enumerable").
- Example:

```
for (prop in obj) {
   alert(prop.toString());
}
```

- **Best Practice:** Use `obj.hasOwnProperty("name")`, which is `true`, only if `obj` has the attribute `name`, to distinguish between "own" and "inherited" properties.

Enhancing Existing Objects

- You can **enhance existing objects** after they have been created …
- … even objects of the JavaScript language, like `Function`, `Object` and `String`!
- Example:

```
String.prototype.trim = function() {
    return this.replace(/^\s+|\s+$/g, "");
}
"'" + "   test   ".trim() + "'" ⇒ "'test'"
```

- Some people consider augmenting built-in prototypes a bad practice.

Enhancing Existing Objects (cont.)

- **Caution:** What if the next version of JavaScript has your addition built-in?
- Or other developers have the same idea?
- At least, you should **check before** you enhance language objects.
- Example:

```
if (!String.prototype.trim) {
    String.prototype.trim = function() {
        return this.replace(/^\s+|\s+$/g, "");
    }
}
```

Public Attributes and Methods

- Principally, all properties, i.e. attributes and methods of an object are **publically visible and usable**.
- Example:

```
function Factory() {
    this.totalGoods = 0;
    this.produce = function() {
        this.totalGoods++;
    };
};
var f = new Factory();
f.totalGoods = 1000;
f.produce();
f.totalGoods ⇒ 1001
```

Private Attributes and Methods

- **Local variables and parameters** of the constructor get **private attributes and methods** of all objects created with function.
- Only inner functions of the constructor can access its local variables and functions, its private properties.
- Example:

```
function Factory(totalEmployees) {
    var totalGoods = 0;
    var produce = function() {
        totalGoods++;
    };
};
var f = new Factory();
f.produce() ⇒ Error
```

Privileged Methods

- Privileged methods are **publically callable** and **can access private properties**.
- Definition in the constructor:
  `this.privilegedFunction = function() {...}`
- They **cannot** be added to the constructor **later**!
- Closures again!

Privileged Methods (cont.)

- Example:

```
function Factory() {
    var totalGoods = 0;
    this.produce = function(count) {
        totalGoods += count;
    };
    this.getTotalGoods = function() {
        return totalGoods;
    }
};
var f = new Factory();
f.produce(5);
f.getTotalGoods() ⇒ 5
```

“Class Attributes”

- In Java, there is a **`static`** modifier for class attributes and methods.
- In JavaScript, there are no classes, but …
- … you can add attributes to the constructor function itself (the Function object), which are usable like class attributes.
- Useful for logging, book keeping (counting created objects), object pools, configuration of an “object factory” etc.

"Class Attributes" (cont.)

- Example:

```
var Factory = function() {
    Factory.totalFactories++;
    var totalGoods = 0;
    this.produce = function(count) {
        totalGoods += count;
    };
    this.getTotalGoods = function() {
        return totalGoods;
    }
};
Factory.totalFactories = 0;
var f1 = new Factory();
var f2 = new Factory();
Factory.totalFactories ⇒ 2
```

Inheritance à la JavaScript

- Each object has a **prototype** attribute, normally `{}`.
- Functions are objects, constructors are functions, therefore constructors have this attribute, too.
- You can **add new properties** to a prototype object or even **replace** it completely.

Inheritance à la JavaScript (cont.)

- Search sequence for properties:
  - current object a
  - `a.constructor.prototype`
  - `a.constructor.prototype.constructor.prototype`
  - etc.
  - at last: `Object`
- **Prototype chain**
- This can be used as "**inheritance**".
- All changes to an object's `prototype` take effect immediately – to the object itself and it "successors" in the prototype chain.

Inheritance à la JavaScript (cont.)

- Properties of an object superimpose properties with the same name up in the chain – they **override "inherited" properties**.
- Methods in a constructor are **copied** into each created object and use up some memory.
- You can add them to the object's `prototype` instead.
- This consumes less memory, but costs some performance (more lookups up the chain).

Prototypical Inheritance

- Example:

```
var Factory = function() {
    this.totalGoods = 0;
};
var f = new Factory();
Factory.prototype.produce =
    function(count) {
        this.totalGoods += count;
    };
f.produce(10);
f.totalGoods ⇒ 10
```

Prototypical Inheritance (cont.)

- This works even **after the object's creation!**
- In the example: Object `f` is created, then `produce` is defined and added to the `Factory`'s `prototype`.
- The function `produce` is not found directly in `f`, but in its prototype chain.
- Instead of
  `Factory.prototype.produce = ...`
  you can write
  `f.constructor.prototype.produce = ...`

Prototypical Inheritance (cont.)

- Another example:

```
var Person = function (name) {
    this.name = name;
};
Person.prototype.getName = function () {
    return this.name;
};
var User = function(name, password) {
    this.name = name;
    this.password = password;
};
User.prototype = new Person();
var me = new User("Thomas", "secret");
alert("User " + me.getName() + " created")
```

Heads up: Replacing the `prototype` Object

- If you **replace the `prototype`** object instead of enhancing the existing one, this only takes effect on **objects created afterwards**.
- Objects has an **internal pointer** to the `prototype` object at the time, they were created. This pointer isn't changed, when you overwrite the `prototype` object.
- In Firefox, this internal attribute is called `__proto__`.
- Besides, after replacing the `prototype` object the `constructor` attribute sometimes points to the wrong object. Therefore you should also **set the `constructor`** after replacing the `prototype` object.

Heads up: Replacing the prototype Object (cont.)

- Example:

```
var Person = function (name) {
    this.name = name;
};
Person.prototype.getName = function () {
    return this.name;
};
var User = function(name, password) {
    this.name = name;
    this.password = password;
};
User.prototype = new Person();
User.prototype.constructor = User;
```

Access the "Super Class" with uber

- There is **no direct access** to the "super class"
- **Convention**: set the **uber attribute** to the prototype of the "super class"
- Example:

```
User.prototype = new Person();
User.prototype.constructor = User;
User.uber = Person.prototype;
```

Simplification

- Simplify this by introducing a helper function:

```
function extend(child, parent) {
    var F = function() {}; // empty function
    F.prototype = parent.prototype;
    Child.prototype = new F();
    Child.prototype.construtor = child;
    Child.uber = parent.prototype;
}
```

- Usage:

```
extend(User, Person);
```

Classical Inheritance in JavaScript

- There are different approaches to “simulate” classical, i.e. class-based inheritance in JavaScript
  - Douglas Crockford
  - Markus Nix
  - Prototype (JavaScript library)
  - many, many more

Classical Inheritance: Crockford's Way

- 3 enhancements of Function
- Method method to simplify additions to Function

```
Function.prototype.method = function (name, func)
{
  this.prototype[name] = func;
  return this; // useful for call chaining
};
```

- Method inherits for inheritance

```
Function.method("inherits", function(parent) {
  this.prototype = new parent();
  return this;
}); // minimalistic version without uber();
```

Classical Inheritance: Crockford's Way (cont.)

- 3 enhancements of Function (cont.)
- Method swiss to **copy properties** from a parent object:

```
Function.method("swiss", function (parent) {
    for (var i = 1; i < arguments.length; i += 1) {
        var name = arguments[i];
        this.prototype[name] = parent.prototype[name];
    };
    return this;
});
```

- With swiss you can simulate multiple-inheritance or interfaces.

Classical Inheritance: Crockford's Way (cont.)

- Example of usage:

```
var Person = function(name){this.name = name};
Person.method("getName", function() {
    return this.name;
});
var User = function(name, password) {
    this.name = name;
    this.password = password;
};
User.inherits(Person);
User.method("getPassword", function() {
    return this.password;
});
var b = new User("Thomas", "secret");
b.getName() ⇒ "Thomas"
```

Parasitic Inheritance

- In a constructor **call another constructor** and return the object, it returns, after enhancing it.
- Example:

```
function ExistingConstructor(a) {...};
function NewConstructor(a, b) {
    var that = new ExistingConstructor(a);
    that.anotherAttribute = 0;
    that.anotherMethod = function (b) {...};
    return that; // instead of this (implicit)
}
var obj = new NewConstructor();
obj
```

Parasitic Inheritance (cont.)

- **Drawback**: Changes and enhancements of `NewConstructor.prototype` **won't be inherited**.
- Example:

```
var obj = new NewConstructor();
NewConstructor.prototype.a = 1;
typeof obj.a ⇒ "undefined"
```

Binding

- With `function.call` and `function.apply` you can borrow methods from other objects (remember use of `function.slice` with the `arguments` object).
- You can use this to permanently bind a method to an object, using a function like this:

```
function bind(o, m) {
    return function () {
        return m.apply(o,
                       [].slice.call(arguments));
    };
}
```

- Usage:

```
var newObj = bind(oldObj, anotherObj.m);
newObj.m();
```

- In ECMAScript 5 there is a `bind` method in `Function`.

Copying Properties

- Instead of inheriting properties in some way, you can simply copy them to another object:

```
function extend(parent, child) {
    var prop;
    child = child || {};
    for (prop in parent) {
        if (parent.hasOwnProperty(prop)) {
            child[prop] = parent[prop];
        }
    }
    return child;
}
```

- Usage:

```
var kid = extend(parent);
// add/overwrite properties of kid here
```

Mix-Ins

- Instead of just copying from one object, you can have the effect of "multiple inheritance" by having more than one source object:

```
function mix() {
  var arg, prop, child = {};
  for (arg=0; arg<arguments.length; arg+=1) {
    for (prop in arguments[arg]) {
      if (arguments[arg].
          hasOwnProperty(prop)) {
        child[prop] = arguments[arg][prop];
      }
    }
  }
  return child;
}
```

Global Variables

Global Variables are evil  and you should avoid using them, wherever possible.

Imagine the problems, if some JavaScript libraries use the same global variables – you'll get unpredictable (undeterministic) results...

Namespaces

- Namespaces help to keep the global context clean.
- Example:

```
var de = {};
de.assono = {};
de.assono.HtmlHelper = {
    appendDiv: function(child, parent) {...};
    ...
}
```

- **Best Practice:** Use the least amount of global variables possible; organize your code inside of namespace objects.

Loading JavaScript

- `<script>` tag in an HTML file: loads (if external) and executes JavaScript
- Loading JavaScript blocks loading of other resources (except some modern browsers).
- Executing JavaScript blocks **everything else** (loading, rendering) in the browser.
- **Best Practice:** Place `<script>` tags at the end of the HTML (where possible), then everything can be loaded and the page rendered beforehand.
- The page “seems” to load faster, users can read it...
- **Best Practice:** Combine many small JavaScript files to less bigger ones: Less requests, less overhead.

Loading JavaScript (cont.)

- `<script>` tag got a new, optional attribute in HTML 4: `defer`
- but it is only implemented in IE 4+ and Firefox 3.5+
- `<script>` tags **programmatically** created and inserted into the DOM **don't block** anything.
- If code is self-executing, you're done, else you have to react, when it's ready.
- In IE use `script.onreadystatechange` and `script.readyState`, else use `script.onload` to install a function to run, when the script is ready.

Helper function loadScript

```
function loadScript(url, callback) {

var script = document.createElement("script");
script.type = "text/javascript";

if (script.readyState) {  // IE
    script.onreadystatechange = function() {
        if (script.readyState == "loaded" ||
            script.readyState == "complete") {
            script.onreadystatechange = null;
            callback();
        }
    };
} else {
…
```

Helper function loadScript (cont.)

```
function loadScript(url, callback){
…
} else {  // other browsers
    script.onload = function(){ callback(); };
}

script.src = url;
var head = document.getElementsByTagName("head");
head[0].appendChild(script);
}
```

- If necessary, you can chain loadScript calls.
- **Very Best Practice:** Load only loadScript directly in your page and use it to get the rest.

Scripting the DOM

- Accessing DOM objects is **slow**!
- Minimize the access to them, use local variables.
- One big modification is better than many small ones.
- Using innerHTML can be faster then using DOM methods, but not considerably faster (and even slower in some WebKit based browsers).
- Prefer the convenient and fast Selectors API methods (`doc.querySelectorAll` and `doc.querySelector`) to `doc.getElementBy…` whenever available (modern browsers).

Scripting the DOM (cont.)

- Reduce the number of repaints, and even more important, the number of reflows.
- Repaint: visible change of DOM, but no change of sizes.
- Reflow: visible change of DOM and the size and positions of the elements have to be recalculated.
- Cache style information.
- Combine or batch changes.
- Take elements out of the DOM tree, manipulate them and put them back.
- Use document fragments to build a DOM sub-tree (`doc.createDocumentFragment`) and add it in one step to the DOM.

Event Delegation

- Uncaught events bubble up the DOM tree.
- For repeating structures like tables or lists it's better to have one event handler for all events than one for each sub-element (e.g. row).
- The original target is stored in the event object.

Event Delegation (cont.)

- Example:

```
table.onclick = function(e) {

e = e || window.event;
var target = e.target || e.srcElement;

// exit, if target is not a row
if (target.nodeName !== 'TR') { return; }

// do something with the target, e.g. change style

// prevent default action and cancel bubbling
if (typeof e.preventDefault === 'function') {
    e.preventDefault();
    e.stopPropagation();
} else {
    e.returnValue = false;
    e.cancelBubble = true;
}
};
```

Keeping the User Interface Responsive

- Execution of JavaScript blocks the UI
- Avoid long running scripts when possible, else split the task up and use timers to schedule the work.
- Example:

```
function processArray(items, process, callback){
    var todo = items.concat(); // clone them
    setTimeout(function(){
        process(todo.shift());

        if (todo.length > 0){
            setTimeout(arguments.callee, 25);
        } else {
            callback(items);
        }
    }, 25);
}
```

Keeping the User Interface Responsive (cont.)

- You can measure the time and continue, until a limit is reached. Then you set up a timer to continue from here on later.
- Example (excerpt in pseudo code):

```
var start = +new Date();
do {
    // do something
} until (+new Date() - start > limit);
if (still something to do) {
    // set up the timer
}
```

- You add overhead, but the UI keeps responsive.
- Use the web workers API (new in ECMAScript 5), when it's available in “your” target browsers.

Tools

- Mozilla **Firefox** with
  - **Firebug**: http://getfirebug.com/
  - Venkman (JavaScript debugger): http://www.hacksrus.com/~ginda/venkman/
- For other browsers (mainly for testing)
  - Firebug Lite: http://getfirebug.com/firebuglite
  - Fiddler: http://www.fiddler2.com/fiddler2/

Books

- Douglas Crockford: “JavaScript: The Good Parts” O'Reilly, Yahoo! Press, 2008, ISBN 978-0-596-51774-8, 176 pages

Douglas' Web site: http://www.crockford.com/

Books (cont.)

- Nicholas C. Zakas: “High Performance JavaScript” O'Reilly, Yahoo! Press, 2010, ISBN 978-0-596-80279-0, 240 pages

Nicholas' Web site: http://www.nczonline.net/

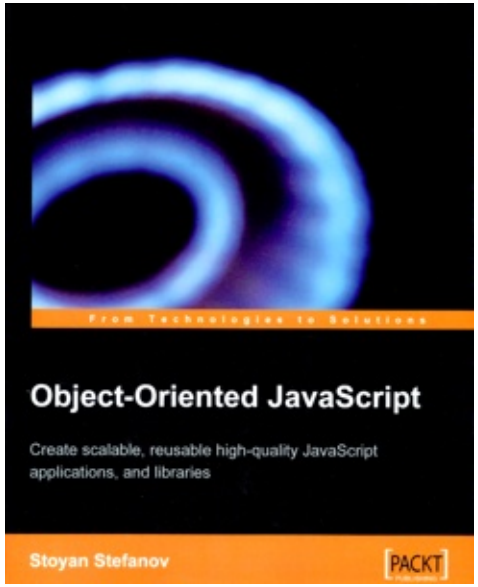
Books (cont.)

- Stoyan Stefanov: “JavaScript Patterns”
  O'Reilly, Yahoo! Press, 2010, ISBN 978-0-596-80675-0, 240 pages

Web site: http://jspatterns.com/

Books (cont.)

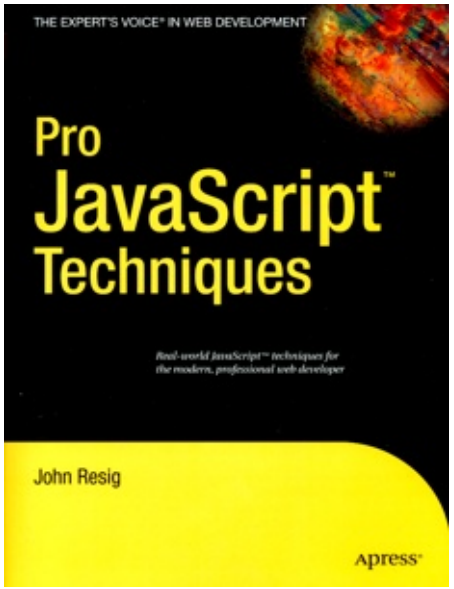
- Stoyan Stefanov: “Object-Oriented JavaScript”
  Packt Publishing, ISBN 978-1-847194-14-5, 337 pages



Stoyan's Web site: http://www.phpied.com/

Books (cont.)

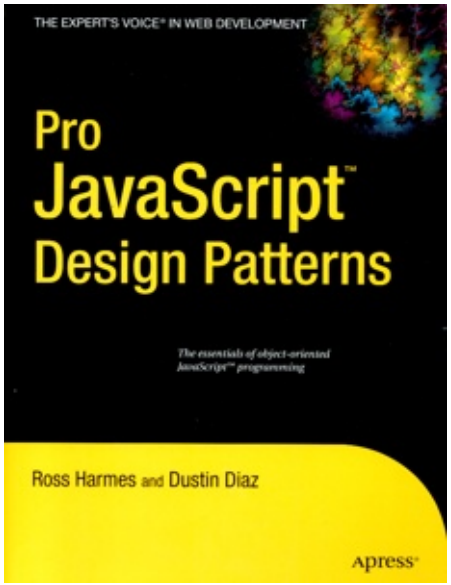
- John Resig: “Pro JavaScript Techniques”
  Apress, ISBN 1-59059-727-3, 359 pages



John's Web site: http://ejohn.org/

Books (cont.)

- Ross Harmes, Dustin Diaz:
  "Pro JavaScript Design Patterns"
  Apress, ISBN 978-1-59059-908-2, 269 pages

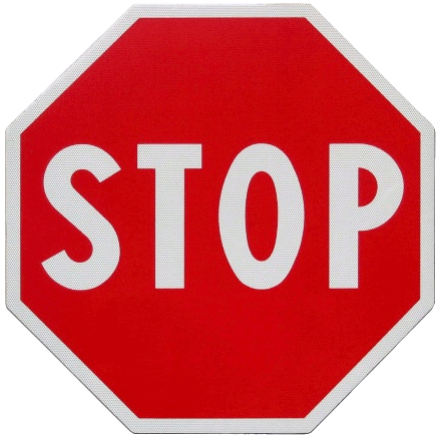


Ross' Web site: http://techfoolery.com/
Dustin's Web site: http://www.dustindiaz.com/

The JavaScript Standard

- Standard ECMA-262
  ECMAScript Language Specification
  http://www.ecma-international.org/publications/standards/Ecma-262.htm

Questions?



Ask questions now — or later:

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