The JavaScript Programming Language

Douglas Crockford

Overview

- History
- Language
- Advanced Features
- Platforms
- Standards
- Style

The World's Most Misunderstood Programming Language

Sources of Misunderstanding

- The Name
- Mispositioning
- Design Errors
- Bad Implementations
- The Browser
- Bad Books
- Substandard Standard
- JavaScript is a Functional Language

History

- 1992

  Oak, Gosling at Sun & FirstPerson

- 1995

  HotJava

  LiveScript, Eich at Netscape

- 1996

  JScript at Microsoft

- 1998

  ECMAScript

Not a Web Toy

- It is a real language
- Small, but sophisticated
- It is not a subset of Java

Key Ideas

- Load and go delivery
- Loose typing
- Objects as general containers
- Prototypal inheritance
- Lambda
- Linkage though global variables

Values

- Numbers
- Strings
- Booleans
- Objects
- **null**
- **undefined**

Numbers

- Only one number type

  No integers

- 64-bit floating point
- IEEE-754 (aka “**Double**”)
- Does not map well to common understanding of arithmetic:
- **0.1 + 0.2 = 0.30000000000000004**

NaN

- Special number: Not a Number
- Result of undefined or erroneous operations
- Toxic: any arithmetic operation with **NaN** as an input will have **NaN** as a result
- **NaN** is not equal to anything, including **NaN**

Number function

```
Number(value)
```

- Converts the value into a number.
- It produces **NaN** if it has a problem.
- Similar to **+** prefix operator.

parseInt function

```
parseInt(value, 10)
```

- Converts the value into a number.
- It stops at the first non-digit character.
- The radix (**10**) should be required.

```
parseInt("08") === 0
parseInt("08", 10) === 8
```

Math

- Math object is modeled on Java's Math class.
- It contains

abs	absolute value
floor	integer
log	logarithm
max	maximum
pow	raise to a power
random	random number
round	nearest integer
sin	sine
sqrt	square root

Strings

- Sequence of 0 or more 16-bit characters
  - UCS-2, not quite UTF-16
  - No awareness of surrogate pairs
- No separate character type
  - Characters are represented as strings with a length of 1
- Strings are immutable
- Similar strings are equal (==)
- String literals can use single or double quotes

String **length**

- string.**length**

- The **length** property determines the number of 16-bit characters in a string.

String function

```
String(value)
```

- Converts value to a string

String Methods

- **charAt**
- **concat**
- **indexOf**
- **lastIndexOf**
- **match**
- **replace**
- **search**
- **slice**
- **split**
- **substring**
- **toLowerCase**
- **toUpperCase**

Booleans

- **true**
- **false**

Boolean function

```
Boolean(value)
```

- returns **true** if value is truthy
- returns **false** if value is falsy
- Similar to **!!** prefix operator

null

- A value that isn't anything

undefined

- A value that isn't even that
- The default value for variables and parameters
- The value of missing members in objects

Falsy values

- **false**
- **null**
- **undefined**
- **""** (empty string)
- **0**
- **NaN**

- **All other values (including all objects) are truthy.**

"0" "false"

Everything Else Is Objects

Dynamic Objects

- Unification of Object and Hashtable
- **new Object()** produces an empty container of name/value pairs
- A name can be any string, a value can be any value except **undefined**
- members can be accessed with dot notation or subscript notation
- No hash nature is visible (no hash codes or rehash methods)

Loosely Typed

- Any of these types can be stored in an variable, or passed as a parameter to any function

- The language is not "untyped"

C

- JavaScript is syntactically a C family language

- It differs from C mainly in its type system, which allows functions to be values

Identifiers

- Starts with a letter or _ or **$**
- Followed by zero or more letters, digits, _ or **$**

- By convention, all variables, parameters, members, and function names start with lower case
- Except for constructors which start with upper case

- Initial _ should be reserved for implementations
- **$** should be reserved for machines.

Reserved Words

abstract
boolean **break** byte
case catch char class const **continue**
debugger **default delete do** double
else enum export extends
false final **finally** float **for function**
goto
if implements import **in instanceof** int
interface
long
native **new null**
package private protected public
return
short static super **switch** synchronized
this throw throws transient **true try typeof**
var volatile **void**
while with

Comments

```
// slashslash line comment

/*
    slashstar
    block
    comment
*/
```

Operators

- Arithmetic

  + - * / %

- Comparison

  == != < > <= >=

- Logical

  && || !

- Bitwise

  & | ^ >> >>> <<

  Ternary

  ?:

+

- Addition and concatenation
- If both operands are numbers,

```
  then
    add them
  else
    convert them both to strings
    concatenate them
```

'$' + 3 + 4 = '$34'

+

- Unary operator can convert strings to numbers

```
+"42" = 42
```

- Also

```
Number("42") = 42
```

- Also

```
parseInt("42", 10) = 42
```

```
+"3" + (+"4") = 7
```

/

- Division of two integers can produce a non-integer result

```
10 / 3 = 3.3333333333333335
```

== !=

- Equal and not equal
- These operators can do type coercion
- It is better to use === and !==, which do not do type coercion.

&&

- The guard operator, aka *logical and*
- If first operand is truthy

  then result is second operand

  else result is first operand
- It can be used to avoid null references

```
if (a) {
  return a.member;
} else {
  return a;
}
```

- can be written as

```
return a && a.member;
```

||

- The default operator, aka *logical or*
- If first operand is truthy

    then result is first operand

    else result is second operand
- It can be used to fill in default values.

```
var last = input || nr_items;
```

- (If **input** is truthy, then **last** is input, otherwise set **last** to **nr_items**.)

!

- Prefix *logical not* operator.
- If the operand is truthy, the result is **false**. Otherwise, the result is **true**.
- **!!** produces booleans.

Bitwise

```
& | ^ >> >>> <<
```

- The bitwise operators convert the operand to a 32-bit signed integer, and turn the result back into 64-bit floating point.

Statements

- *expression*
- **if**
- **switch**
- **while**
- **do**
- **for**
- **break**
- **continue**
- **return**
- **try/throw**

Break statement

- Statements can have labels.
- Break statements can refer to those labels.

```
loop: for (;;) {
  ...
    if (...) {
      break loop;
    }
  ...
}
```

For statement

- Iterate through all of the elements of an array:

```
for (var i = 0; i < array.length; i += 1) {

    // within the loop,
    // i is the index of the current member
    // array[i] is the current element

}
```

For statement

- Iterate through all of the members of an object:

```
for (var name in object) {
    if (object.hasOwnProperty(name)) {

      // within the loop,
      // name is the key of current member
      // object[name] is the current value

    }
}
```

Switch statement

- Multiway branch

- The switch value does not need to a number. It can be a string.

- The case values can be expressions.

Switch statement

```
switch (expression) {
case ';':
case ',':
case '.':
    punctuation();
    break;
default:
    noneOfTheAbove();
}
```

Throw statement

```
throw new Error(reason);

throw {
    name: exceptionName,
    message: reason
};
```

Try statement

```
try {
    ...
} catch (e) {
    switch (e.name) {
    case 'Error':
        ...
        break;
    default:
        throw e;
    }
}
```

Try Statement

- The JavaScript implementation can produce these exception names:

```
'Error'
'EvalError'
'RangeError'
'SyntaxError'
'TypeError'
'URIError'
```

With statement

- Intended as a short-hand
- Ambiguous
- Error-prone
- Don't use it

```
with (o) {
    foo = null;
}
```

❑ o.foo = null;

❑ foo = null;

Function statement

```
function name(parameters) {
  statements;
}
```

Var statement

- Defines variables within a function.
- Types are not specified.
- Initial values are optional.

```
var name;
var nrErrors = 0;
var a, b, c;
```

Scope

- In JavaScript, {blocks} do not have scope.

- Only functions have scope.

- Vars defined in a function are not visible outside of the function.

Return statement

return *expression*;

- or

return;

- If there is no *expression*, then the return value is **undefined**.
- Except for constructors, whose default return value is **this**.

Objects

- Everything else is objects

- Objects can contain data and methods

- Objects can inherit from other objects.

Collections

- An object is an unordered collection of name/value pairs
- Names are strings
- Values are any type, including other objects
- Good for representing records and trees
- Every object is a little database

Object Literals

- Object literals are wrapped in **{ }**
- Names can be names or strings
- Values can be expressions
- : separates names and values
- , separates pairs
- Object literals can be used anywhere a value can appear

Object Literals

```
var myObject = {name: "Jack B. Nimble",
'goto': 'Jail', grade: 'A', level: 3};
```

"name"	"Jack B. Nimble"
"goto"	"Jail"
"grade"	"A"
"level"	3

```
var theName = myObject.name;
var destination = myObject['goto'];
```

Maker Function

```
function maker(name, where, grade, level) {
    var it = {};
    it.name = name;
    it['goto'] = where;
    it.grade = grade;
    it.level = level;
    return it;
}

myObject = maker("Jack B. Nimble",
    'Jail', 'A', 3);
```

Object Literals

```
var myObject = {name: "Jack B. Nimble",
'goto': 'Jail', grade: 'A', format:
{type: 'rect', width: 1920, height: 1080,
interlace: false, framerate: 24}};
```

Object Literals

```
var myObject = {
    name: "Jack B. Nimble",
    'goto': 'Jail',
    grade: 'A',
    format: {
        type: 'rect',
        width: 1920,
        height: 1080,
        interlace: false,
        framerate: 24
    }
};
```

Object Literals

```
myFunction({
    type: 'rect',
    width: 1920,
    height: 1080
});
throw {
    name: 'error',
    message: 'out of bounds'
};
```

Object Literals

```
function SuperDiv(width, height,
  left, top, zIndex, position,
  color, visibility, html,
  cssClass)

function SuperDiv(spec)
```

Object Augmentation

- New members can be added to any object by simple assignment

- There is no need to define a new class

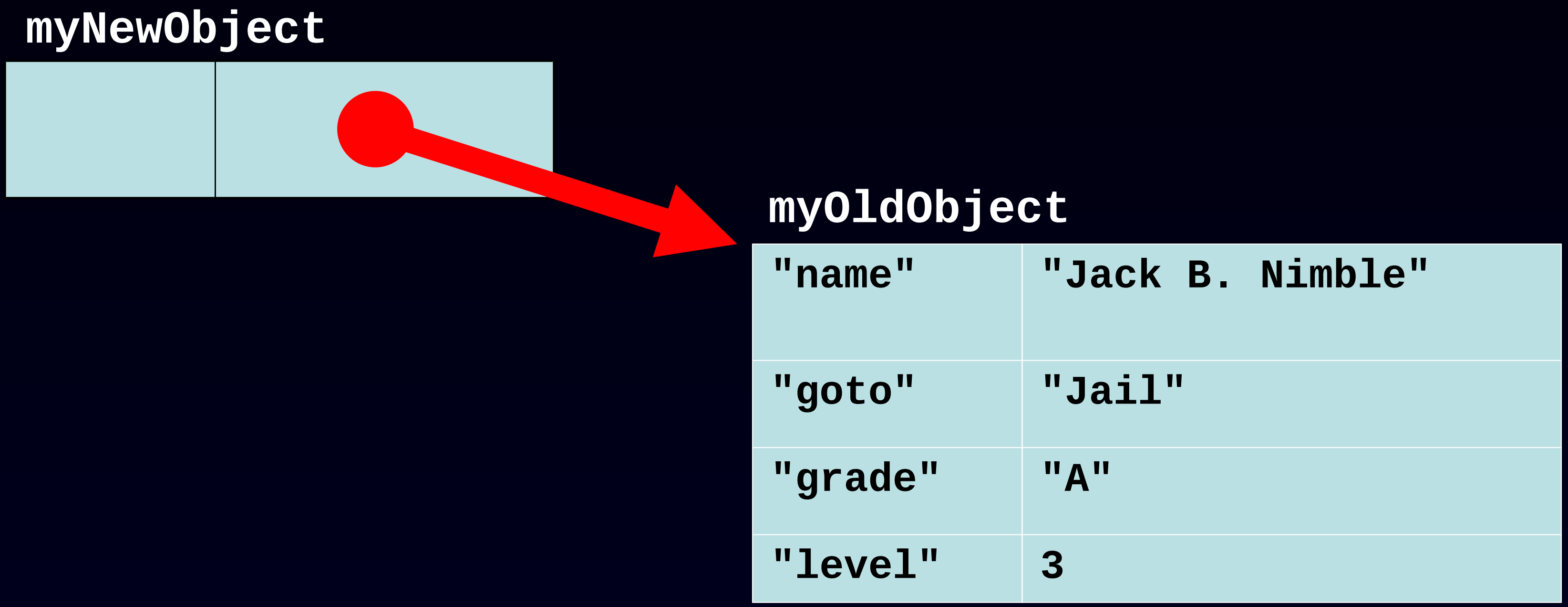
```
myObject.format.colorModel =
    'YCgCb';

myObject[name] = value;
```

Linkage

- Objects can be created with a secret link to another object.
- If an attempt to access a name fails, the secret linked object will be used.
- The secret link is not used when storing. New members are only added to the primary object.
- The **object(**o**)** function makes a new empty object with a link to object o.

Linkage

```
var myNewObject = object(myOldObject);
```



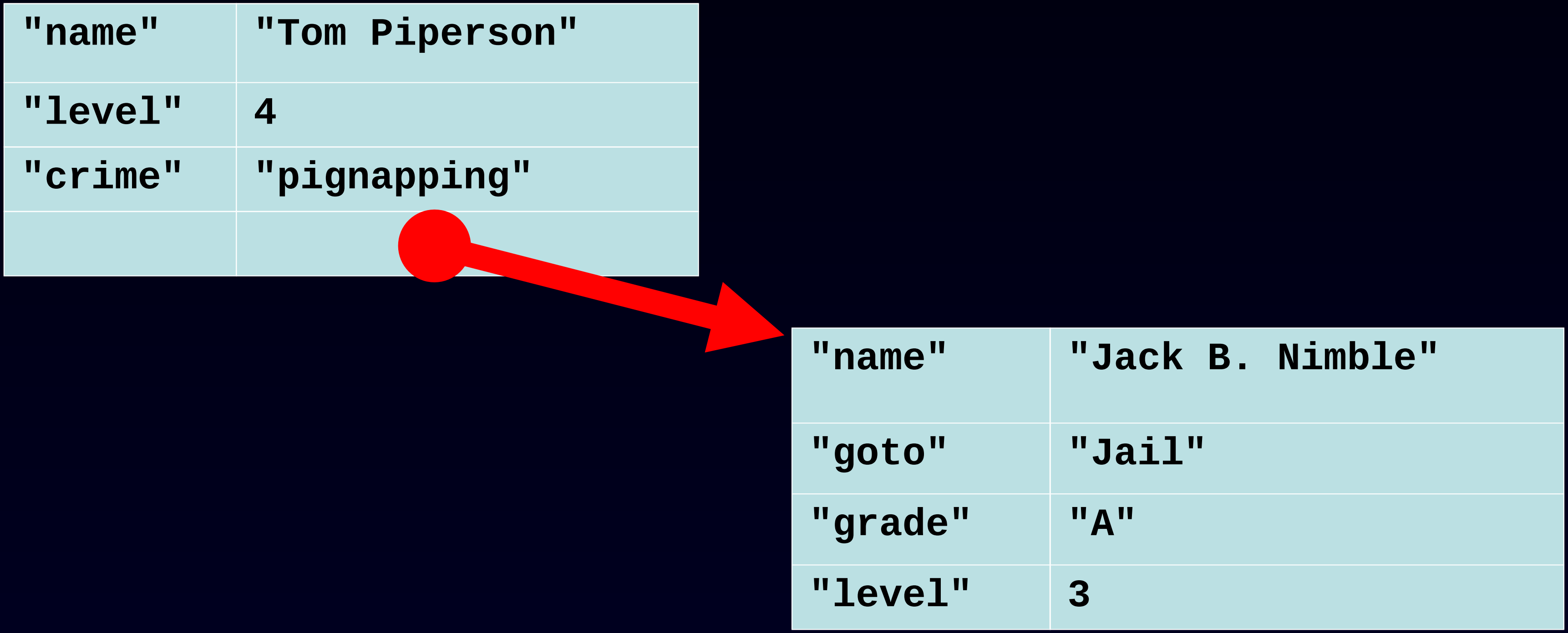
myNewObject

myOldObject

"name"	"Jack B. Nimble"
"goto"	"Jail"
"grade"	"A"
"level"	3

Linkage

```
myNewObject.name = "Tom Piperson";
myNewObject.level += 1;
myNewObject.crime = 'pignapping';
```



"name"	"Tom Piperson"
"level"	4
"crime"	"pignapping"

"name"	"Jack B. Nimble"
"goto"	"Jail"
"grade"	"A"
"level"	3

Inheritance

- Linkage provides simple inheritance.
- An object can inherit from an older object.

Prototypal Inheritance

- Some languages have classes, methods,   constructors, and modules. JavaScript's functions do the work of all of those.
- Instead of Classical Inheritance, JavaScript has Prototypal Inheritance.
- It accomplishes the same things, but differently.
- It offers greater expressive power.
- But it's different.

Prototypal Inheritance

- Instead of organizing objects into rigid classes, new objects can be made that are similar to existing objects, and then customized.
- Object customization is a lot less work than making a class, and less overhead, too.
- One of the keys is the **object(o)** function.
- The other key is functions.

Object Methods

- All objects are linked directly or indirectly to **Object.prototype**
- All objects inherit some basic methods.
- None of them are very useful.
- **hasOwnProperty(**name**)**

  Is the name a true member of this object?
- No **copy** method.
- No **equals** method.

Object Construction

- Make a new empty object
- All three of these expressions have exactly the same result:

```
new Object()

{}

object(Object.prototype)
```

- **{}** is the preferred form.

Reference

- Objects can be passed as arguments to functions, and can be returned by functions
  - Objects are passed by reference.
  - Objects are not passed by value.

- The === operator compares object references, not values
  - **true** only if both operands are the same object

Delete

- Members can be removed from an object with the **delete** operator

```
delete myObject[name];
```

Arrays

- **Array** inherits from **Object**.
- Indexes are converted to strings and used as names for retrieving values.
- Very efficient for sparse arrays.
- Not very efficient in most other cases.
- One advantage: No need to provide a length or type when creating an array.

length

- Arrays, unlike objects, have a special **length** member.
- It is always 1 larger than the highest integer subscript.
- It allows use of the traditional **for** statement.

```
for (i = 0; i < a.length; i += 1) {
    ...
}
```

- Do not use **for**..**in** with arrays

Array Literals

- An array literal uses **[]**
- It can contain any number of expressions, separated by commas

```
myList = ['oats', 'peas', 'beans'];
```

- New items can be appended

```
myList[myList.length] = 'barley';
```

- The dot notation should not be used with arrays.
- **[]** is preferred to **new Array()**.

Array Methods

- **concat**
- **join**
- **pop**
- **push**
- **slice**
- **sort**
- **splice**

Deleting Elements

```
delete array[number]
```

- Removes the element, but leaves a hole in the numbering.

```
array.splice(number, 1)
```

- Removes the element and renumbers all the following elements.

Deleting Elements

```
myArray = ['a', 'b', 'c', 'd'];

delete myArray[1];

// ['a', undefined, 'c', 'd']

myArray.splice(1, 1);

// ['a', 'c', 'd']
```

Arrays v Objects

- Use objects when the names are arbitrary strings.

- Use arrays when the names are sequential integers.

- Don't get confused by the term Associative Array.

Distinguishing Arrays

```
value.constructor === Array
```

```
value instanceof Array
```

Neither of these work when the value comes from a different frame.

Arrays and Inheritance

- Don’t use arrays as prototypes.

  The object produced this way does not have array nature. It will inherit the array's values and methods, but not its **length**.

- You can augment an individual array.

  Assign a method to it.

  This works because arrays are objects.

- You can augment all arrays.

  Assign methods to **Array.prototype**

Functions

- Functions are first-class objects

1. Functions can be passed, returned, and stored just like any other value

2. Functions inherit from **Object** and can store name/value pairs.

Function operator

- The function operator takes an optional name, a parameter list, and a block of statements, and returns a function object.

```
function name(parameters) {
    statements
}
```

- A function can appear anywhere that an expression can appear.

lambda

- What JavaScript calls **function**, other languages call **lambda**.
- It is a source of enormous expressive power.
- Unlike most power-constructs, it is secure.

Function statement

- The function statement is just a short-hand for a **var** statement with a function value.

```
function foo() {}
```

expands to

```
var foo = function foo() {};
```

Inner functions

- Functions do not all have to be defined at the top level (or left edge).

- Functions can be defined inside of other functions.

Scope

- An inner function has access to the variables and parameters of functions that it is contained within.
- This is known as Static Scoping or Lexical Scoping.

Closure

- The scope that an inner function enjoys continues even after the parent functions have returned.
- This is called *closure*.

Example

```
function fade(id) {
    var dom = document.getElementById(id),
        level = 1;
    function step () {
        var h = level.toString(16);
        dom.style.backgroundColor =
            '#FFFF' + h + h;
        if (level < 15) {
            level += 1;
            setTimeout(step, 100);
        }
    }
    setTimeout(step, 100);
}
```

Function Objects

- Functions are objects, so they can contain name/value pairs.

- This can serve the same purpose as **static** members in other languages.

Method

- Since functions are values, functions can be stored in objects.

- A function in an object is called a *method*.

Invocation

- If a function is called with too many arguments, the extra arguments are ignored.

- If a function is called with too few arguments, the missing values will be **undefined**.

- There is no implicit type checking on the arguments.

Invocation

- There are four ways to call a function:
  - Function form
    - *functionObject*(*arguments*)
  - Method form
    - *thisObject*.*methodName*(*arguments*)
    - *thisObject*["*methodName*"](*arguments*)
  - Constructor form
    - **new** *functionObject*(*arguments*)
  - Apply form
    - *functionObject*.**apply**(*thisObject*, [*arguments*])

Method form

thisObject.*methodName*(*arguments*)

- When a function is called in the method form, **this** is set to *thisObject*, the object containing the function.
- This allows methods to have a reference to the object of interest.

Function form

*functionObject***(***arguments***)**

- When a function is called in the function form, **this** is set to the global object.

  That is not very useful.

  It makes it harder to write helper functions within a method because the helper function does not get access to the outer **this**.

```
var that = this;
```

Constructor form

new *functionObject*(*arguments*)

- When a function is called with the **new** operator, a new object is created and assigned to **this**.

- If there is not an explicit return value, then **this** will be returned.

this

- **this** is an extra parameter. Its value depends on the calling form.
- **this** gives methods access to their objects.
- **this** is bound at invocation time.

Invocation form	**this**
function	the global object
method	the object
constructor	the new object

arguments

- When a function is invoked, in addition to its parameters, it also gets a special parameter called **arguments**.

- It contains all of the arguments from the invocation.

- It is an array-like object.

- **arguments.length** is the number of arguments passed.

Example

```
function sum() {
    var i,
        n = arguments.length,
        total = 0;
    for (i = 0; i < n; i += 1) {
        total += arguments[i];
    }
    return total;
}
```

Augmenting Built-in Types

- **Object.prototype**
- **Array.prototype**
- **Function.prototype**
- **Number.prototype**
- **String.prototype**
- **Boolean.prototype**

trim

```
String.prototype.trim = function () {
    return this.replace(
        /^\s*(\S*(\s+\S+)*)\s*$/, "$1");
};
```

supplant

```
var template = '<table border="{border}">' +
    '<tr><th>Last</th><td>{last}</td></tr>' +
    '<tr><th>First</th><td>{first}</td></tr>' +
    '</table>';

var data = {
    first: "Carl",
    last: "Hollywood",
    border: 2
};

mydiv.innerHTML = template.supplant(data);
```

supplant

```
String.prototype.supplant = function (o) {
    return this.replace(/{([^{}]*)}/g,
        function (a, b) {
            var r = o[b];
            return typeof r === 'string' ?
                r : a;
        }
    );
};
```

typeof

- The **typeof** prefix operator returns a string identifying the type of a value.

type	**typeof**
object	**'object'**
function	**'function'**
array	**'object'**
number	**'number'**
string	**'string'**
boolean	**'boolean'**
null	**'object'**
undefined	**'undefined'**

eval

```
eval(string)
```

- The **eval** function compiles and executes a string and returns the result.
- It is what the browser uses to convert strings into actions.
- It is the most misused feature of the language.

Function function

new Function(*parameters*, *body***)**

- The **Function** constructor takes zero or more parameter name strings, and a body string, and uses the JavaScript compiler to produce a function object.
- It should only be used to compile fresh source from a server.
- It is closely related to **eval**.

Built-in Type Wrappers

- Java has **int** and **Integer**, two incompatible types which can both carry the same value with differing levels of efficiency and convenience.

- JavaScript copied this pattern to no advantage. Avoid it.
- Avoid **new Boolean()**
- Avoid **new String()**
- Avoid **new Number()**

Confession

```
function object(o) {
  function F() {}
  F.prototype = o;
  return new F();
}
```

Augmentation

- We can directly modify individual objects to give them just the characteristics we want.

- We can do this without having to create classes.

- We can then use our new object as the prototype for lots of new objects, each of which can also be augmented.

Working with the Grain

- Classical patterns are less effective than prototypal patterns or parasitic patterns.

- Formal classes are not needed for reuse or extension.

(global) Object

- The object that dares not speak its name.

- It is the container for all global variables and all built-in objects.

- Sometimes **this** points to it.

```
var global = this;
```

- On browsers, **window** is the global object.

Global variables are evil

- Functions within an application can clobber each other.
- Cooperating applications can clobber each other.
- Use of the global namespace must be minimized.

Implied Global

- Any var which is not properly declared is assumed to be global by default.
- This makes it easy for people who do not know or care about encapsulation to be productive, but it makes applications less reliable.
- JSLint is a tool which helps identify implied globals and other weaknesses.

http://www.JSLint.com

Namespace

- Every object is a separate namespace.
- Use an object to organize your variables and functions.
- The **YAHOO** Object.

```
<head>
<script>
YAHOO={};
</script>
```

- **http://twiki.corp.yahoo.com/view/Devel/TheYAHOOObject**

Encapsulate

- Function scope can create an encapsulation.

- Use an anonymous function to wrap your application.

Example

```
YAHOO.Trivia = function () {
    // define your common vars here
    // define your common functions here
    return {
        getNextPoser: function (cat, diff) {
            ...
        },
        showPoser: function () {
            ...
        }
    };
} ();
```

Thinking about type

- Trading type-safety for dynamism.
- JavaScript has no cast operator.
- Reflection is really easy, and usually unnecessary.
- Why inheritance?
  - Automatic casting
  - Code reuse
- Trading brittleness for flexibility.

Date

The **Date** function is based on Java's Date class.

It was not Y2K ready.

RegExp

- Regular expression pattern matcher
- Patterns are enclosed in slashes
- Example: a pattern that matches regular expressions

```
/\/(\\[^\x00-\x1f]|\[(\\[^\x00-\x1f]|
[^\x00-\x1f\\\/])*\]|[^\x00-\x1f\\\/\[])+\/[gim]*/
```

- Bizarre notation, difficult to read.

Threads

- The language definition is neutral on threads
- Some language processors (like SpiderMonkey) provide thread support
- Most application environments (like browsers) do not provide it
- Threads are evil

Platforms

- Browsers
- WSH and Dashboard
- Yahoo!Widgets
- DreamWeaver and Photoshop
- Embedded

ActionScript

- Empty strings are truthy
- keywords are case insensitive
- No Unicode support
- No **RegExp**
- No **try**
- No statement labels
- **||** and **&&** return booleans
- separate operators for strings and numbers

E4X

- Extensions to ECMAScript for XML
- Proposed by BEA
- Allows **<XML>** literals
- Not compatible with ECMAScript Third Edition
- Not widely accepted yet
- Not in IE7

ECMAScript Fourth Edition

- A very large set of new features are being considered.
- Mozilla and Opera are committed.
- It is not clear that Microsoft will adopt it.
- No word from Safari yet.

Style

- Programming style isn't about personal taste.
- It is about rigor in expression.
- It is about clearness in presentation.
- It is about product adaptability and longevity.
- Good rules help us to keep the quality of our programs high.

Style and JavaScript

- Style is critically important for JavaScript.

- The dynamic nature of the language is considered by some to be "too soft". Discipline is necessary for balance.

- Most of the world's body of JavaScript programs is crap.

Code Conventions for the JavaScript Programming Language

http://javascript.crockford.com/code.html

Semicolon insertion

- When the compiler sees an error, it attempts to replace a nearby linefeed with a semicolon and try again.
- This should alarm you.
- It can mask errors.
- Always use the full, correct forms, including semicolons.

Line Ending

- Break a line after a punctuator:
  **, . ; : { } ([= < > ? !
  + - * / % ~ ^ | & == != <= >= += -=
  *= /= %= ^= |= &= << >> || && === !
  == <<= >>= >>> >>>=**

- Do not break after a name, string, number, or **)] ++ --**

- Defense against copy/paste errors.

Comma

- Avoid tricky expressions using the comma operators.

- Do not use extra commas in array literals.

- Good: **[1, 2, 3]**
- Bad: **[1, 2, 3,]**

Required Blocks

- Good:

```
if (a) {
    b();
}
```

- Bad:

```
if (a) b();
```

Forbidden Blocks

- Blocks do not have scope in JavaScript.

- Blocks should only be used with structured statements

  function

  if

  switch

  while

  for

  do

  try

Variables

- Define all variables at the beginning of the function.

- JavaScript does not have block scope, so their is no advantage in declaring variables at the place of their first use.

Expression Statements

- Any expression can be used as a statement. That can mask errors.

- Only assignment expressions and invocation expressions should be used as statements.

- Good:

```
foo();
```

- Bad:

```
foo && foo();
```

switch Statement

- Avoid using fallthrough.

- Each clause should explicitly **break** or **return** or **throw**.

Assignment Expressions

- Do not use assignment expressions in the condition parts of **if**, **while**, or **for**.

- It is more likely that

```
if (a = b) { ... }
```

- was intended to be

```
if (a == b) { ... }
```

- Avoid tricky expressions.

== and !=

- Be aware that == and != do type coercion.
- Bad

```
if (a == null) { ... }
```

- Good:

```
if (a === null) { ... }

if (!a) { ... }
```

Labels

- Use labels only on these statements:

  do

  for

  switch

  while

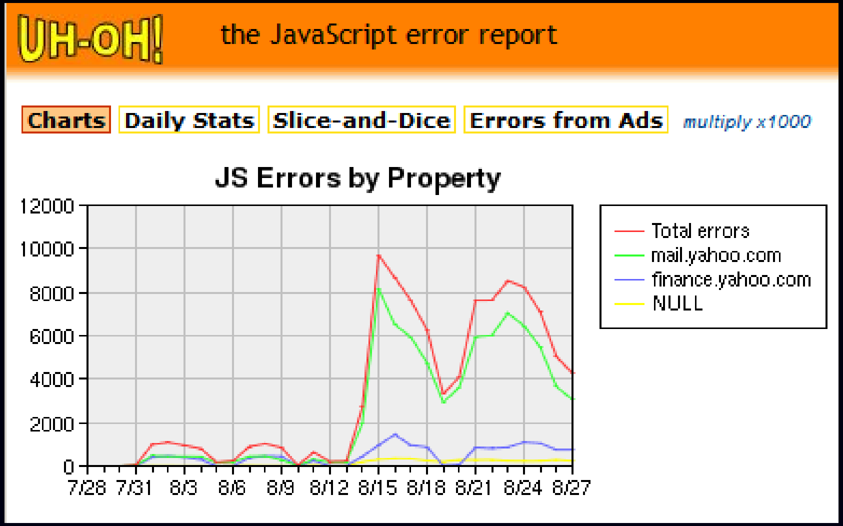
- Never use **javascript:** as a label.

JSLint

- JSLint can help improve the robustness and portability of your programs.
- It enforces style rules.
- It can spot some errors that are very difficult to find in debugging.
- It can help eliminate implied globals.
- Currently available on the web and as a Konfabulator widget.
- Soon, in text editors and Eclipse.

http://www.JSLint.com/

UHOH!



- Universal Header Onerror Handler
- Inserted into 0.1% of pages
- Reports on JavaScript errors
- **http://uhoh.corp.yahoo.com/**

Key Ideas

- Load and go delivery
- Loose typing
- Objects as general containers
- Prototypal inheritance
- Lambda
- Linkage though global variables

The JavaScript Programming Language

Douglas Crockford

crock@yahoo-inc.com

produce.yahoo.com/crock/javascript.ppt