中山大學
SUN YAT-SEN UNIVERSITY

Lecture 03. Advanced JavaScript: Object Function Closure & Prototype

SE-386 Software Process Improvement

http://my.ss.sysu.edu.cn/wiki/display/SPSP

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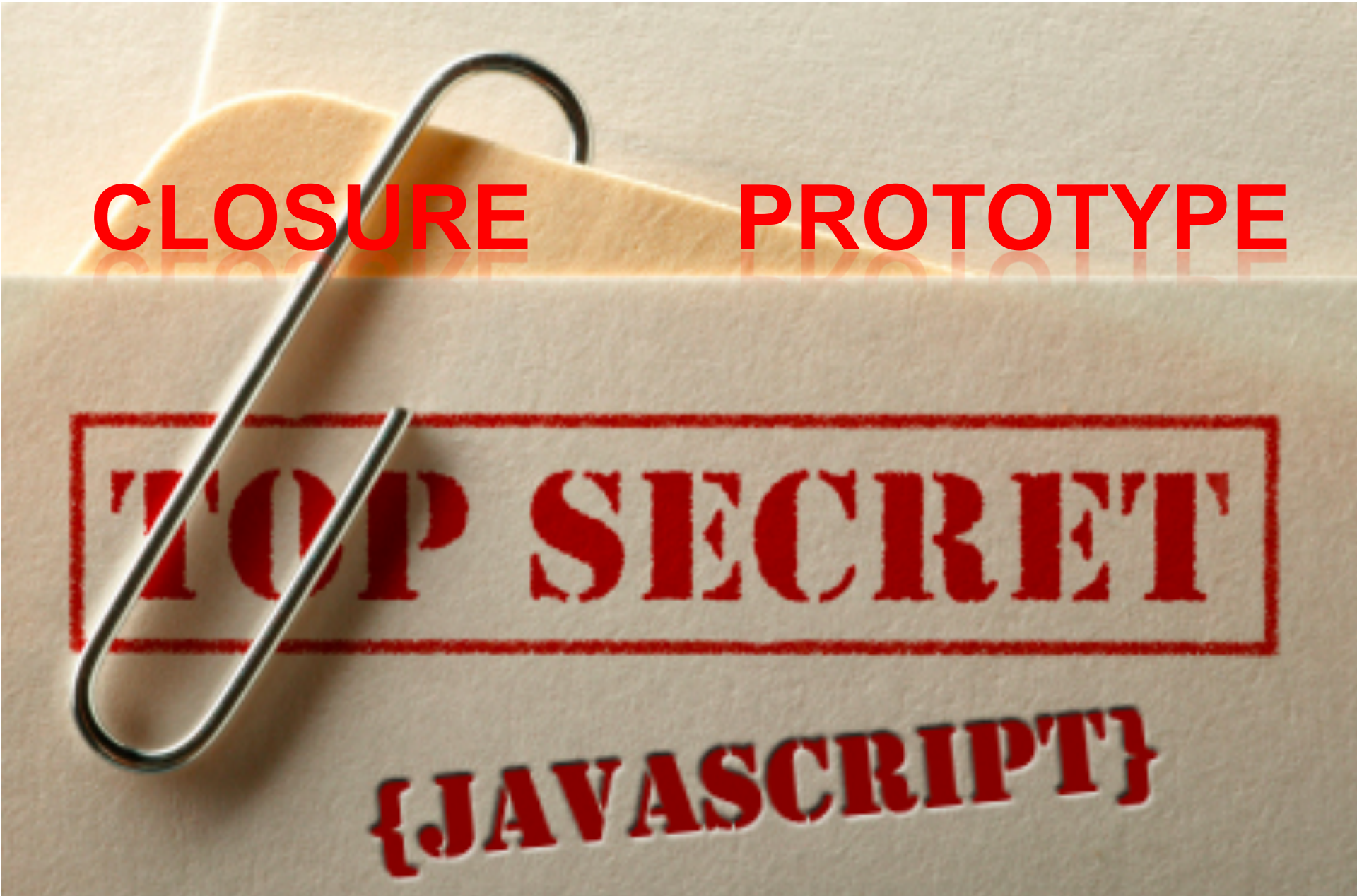
The core tech. of Web

Secrets of JavaScript

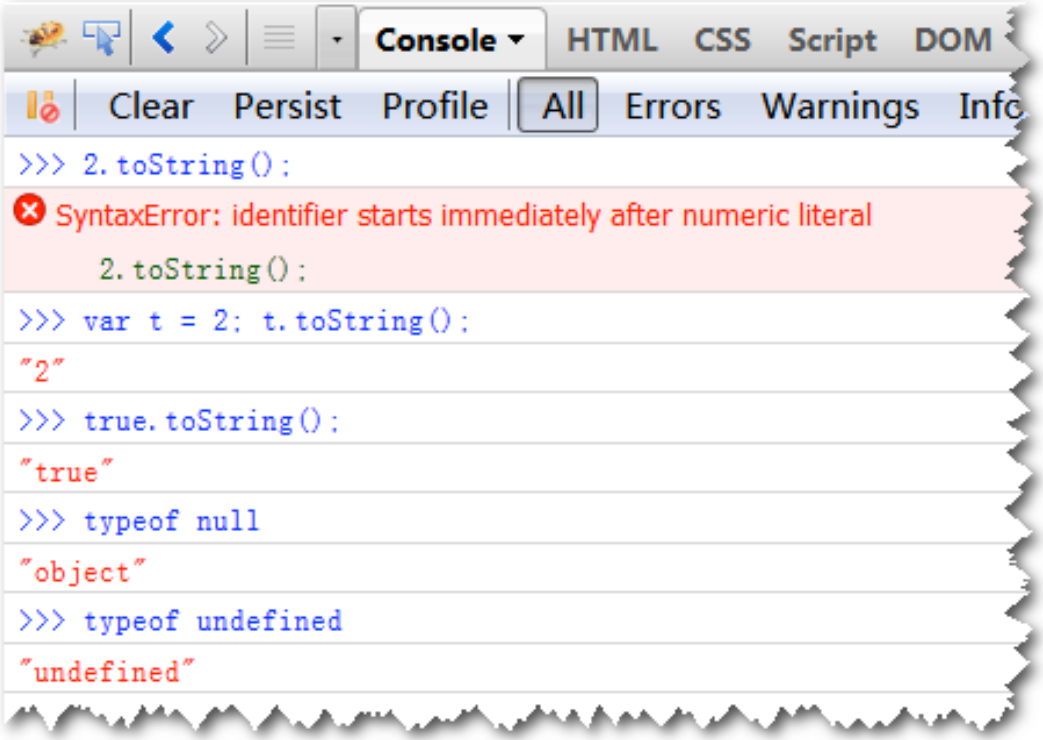


Outline

- **Everything is Object**
- Closure: the Secret of Function
- Top JavaScript secret: Prototype
- Code practice

Everything in JS is an Object

- What is an object
- What is OOP



- 只有数字字面表达（number literal）和undefined不是对象

Everything in JS is an Object

- JavaScript语言中对象就是一个容器，容器包含了一系列属性（properties）。
- 每个属性都是一组名值对，属性名可以是任意字符串，包括空字符串，属性值可以是JavaScript中除undefined任何外合法的值。
- 当属性值为函数时，这个属性也称为对象的方法。
- JavaScript对象的最大特点就是其动态性（动态对象，dynamic object），一个对象可以在创建之后，动态地增加和删除属性和方法。

Object literal

源代码 9-1 对象字面表达（Object Literal）示例

```
var member = {
    name: '张三',
    age: 23,
    'goto': 'United States',
    say: function(){
        return this.name + '前往' + this['goto'];
    }
};

alert(member.age);          // 23
alert(member.say());        // 张三前往United States
```

Object literal

源代码 9-2 属性读取与更新示例

```
var member = {
    age: 23,
    'goto': 'United States',
};

alert(member.age);          // 23
alert(member['age']);       // 23
alert(member['goto']);      // United States
alert(member.goto);         // 语法错误！（某些JavaScript引擎能够执行）
```

源代码 9-3 安全读取和使用属性示例

```
var member = {
    age: 23,
    'goto': 'United States',
};

var name = member.name;                    // undefined
var name = member.name || '未知';          // '未知'
member.address.state                       // 抛出TypeError异常
member.address && member.address.state // undefined
```

Use of properties

源代码 9-4 更新和移除属性示例

```
var member = {
    age: 23,
    'goto': 'United States',
};

member.age = 34;
alert(member.age);        // 34
member.name = '李四';
alert(member.name);       // '李四'
delete member.name;
alert(member.name);       // undefined
```

JavaScript 动态对象（dynamic objects）：传统静态类型、强类型语言，如：C++、Java 等等，对象的类型固定，创建之后就不能改变增加或者删除其属性和方法。JavaScript 和很多动态类型、弱类型语言，如：ruby，python 等等，对象的类型不固定，都可以在对象创建后，灵活地增加和删除属性与方法。

Array literal

- Array is a special kind of object

源代码 9-6 数组字面表达示例

```
var a = ['a', 'b', 'c', 0, {name:'张三'}];
alert(typeof a);  // object
alert(a.length);  // 5
alert(a[4].name); // '张三'
```

JavaScript 的对象在使用中传递的都是引用，没有传值，即复制传递的方式。

源代码 9-5 更新和移除属性示例

```
var peter = {nickname: 'rabbit'};
var littlePeter = peter;
peter.nickname = 'bear';
alert(littlePeter.nickname);        // 'bear'
```

Outline

- Everything is Object
- **Closure: the Secret of Function**
- Top JavaScript secret: Prototype
- Code practice

Function is also an Object

源代码 9-7 函数对象示例

```
var func = function(otherFunc){
    alert('func');
    otherFunc();
    return otherFunc;
};

var func2 = function(){
    alert('func2');
};

func.method = function(){
    alert('method of func');
};

var obj = {
    myFunc : func
};

var arr = [func, func2];

func.method();          // method of func
obj.myFunc(func2);      // func func2
arr[0](arr[1])();       // func func2 func2
```

Scope

源代码 9-9 JavaSript 嵌套作用域示例

```
function outter(){
    var outterName = 'outter name';
    var inner = function(){
        alert(outterName);    // outter name
        var innerName = 'inner name';
    };
    inner();
    alert(innerName); // ReferenceError: innerName is not defined
}

outter();
```

- var 局部；无 var 全局
- 局部为function block scope

Duration

源代码 9-11 JavaScript 词法作用域（lexical scope）示例

```
function outter(){
    var secret = 'secret';
  inner = function(){
    alert(secret);
  };
    inner();
}
outter(); // secret
inner(); // secret
```

词法作用域是 JavaScript 构造闭包（closure）的基础，参考 f)闭包。

arguments, caller, callee

源代码 9-12 arguments 参数示例

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

alert(sum(4, 8, 15, 16, 23, 42)); // 108
```

this problem

源代码 9-15 this 丢失问题示例

```
var peter = {name: 'peter'};
var name = 'global';
var sayHello = function(){
    var helper = function(){
        alert(this.name + ' says hello');
    };
    helper();
};
peter.greeting = sayHello;

peter.greeting(); // global says hello (应该是peter says hello)
```

Closure

- 闭包(closure)指函数和函数所能访问的函数体外部局部变量构成的组合
- 闭包中的函数称为闭包函数,闭包函数能够访问的函数体外部局部变量称为闭包变量
- JavaScript 的scope和duration使得闭包，自然、容易、强大

源代码 9-18 闭包（closure）示例

```
var counter = function(){
    var amount = 0;
    return function(){
        return amount++;
    };
}();

alert(counter()); // 0
alert(counter()); // 1
alert(counter()); // 2
```

```
.....
    <ol>
        <li>第一项</li>
        <li>第二项</li>
        <li>第三项</li>
        <li>第四项</li>
    </ol>
.....
```

---------- 错误的JavaScript ----------

```
window.onload = function(){
  var lis = document.getElementsByTagName('li');
  for (var i = 0; i < lis.length; i++) {
    lis[i].onclick = function(){
            alert(i);
    }
  }
}
```

---------- 正确的JavaScript(使用闭包) ----------

```
window.onload = function(){
  var lis = document.getElementsByTagName('li');
  for (var i = 0; i < lis.length; i++) {
    lis[i].onclick = function(i){
            return function(){
                alert(i);
        };
    }(i);
  }
};
```

that for this

源代码 9-16 使用 that 模式修复 this 丢失问题示例

```
var peter = {name: 'peter'};
var name = 'global';
var sayHello = function(){
    var that = this;
    var helper = function(){
        alert(that.name + ' says hello');
    };
    helper();
};
peter.greeting = sayHello;

peter.greeting(); // peter says hello
```

Functional Programming

源代码 9-22 Memoization 示例

```
------------------------ 原始fibonacci ------------------------
var fibonacci = function(n){
  return n < 2 ? n : fibonacci(n - 1) + fibonacci(n - 2);
};

for (var i = 0; i <= 10; i += 1) {
  document.writeln('// ' + i + ': ' + fibonacci(i));
}   // fibonacci被调用452次
```

Functional Programming

```
-------------------- Memoization fibonacci -------------------
var fibonacci = function(){
  var memo = [0, 1];
  var fib = function(n){
    var result = memo[n];
    if (typeof result !== 'number') {
      result = fib(n - 1) + fib(n - 2);
      memo[n] = result;
    }
    return result;
  };
  return fib;
}();

for (var i = 0; i <= 10; i += 1) {
  document.writeln('// ' + i + ': ' + fibonacci(i));
}   // fibonacci被调用29次
```

Functional Programming

源代码 9-23 Memoization 示例

```
------------------------- memoizer -------------------------
var memoizer = function(memo, fundamental){
  var shell = function(n){
    var result = memo[n];
    if (typeof result !== 'number') {
      result = fundamental(shell, n);
      memo[n] = result;
    }
    return result;
  };
  return shell;
};

-------------------- memoizer fibonacci函数 ------------------
var fibonacci = memoizer([0, 1], function(shell, n){
  return shell(n - 1) + shell(n - 2);
});

----------------------- memoizer阶乘函数 ----------------------
var factorial = memoizer([1, 1], function(shell, n){
  return n * shell(n - 1);
});
```

4 kinds of function invoking

- 普通函数
- 构造子
- 方法(method)调用
- 应用(apply、call)调用

4 kinds of function invoking

```
> var sayHello = function (){
    console.log(this.name + ' says hello.');
  }
<· undefined
>
```

```
> name = 'global'
<· "global"
> sayHello()
  global says hello.
```

函数模式 / 直接调用模式

4 kinds of function invoking

```
> var sayHello = function (){
    console.log(this.name + ' says hello.');
  }
<· undefined
>
```

```
> peter = {name: 'peter'}
<· Object {name: "peter"}
> peter.greeting = sayHello
<· function (){
    console.log(this.name + ' says hello.');
  }
> peter.greeting()
  peter says hello.
```

方法模式 / 方法调用模式

4 kinds of function invoking

```
> var sayHello = function (){
    console.log(this.name + ' says hello.');
  }
<· undefined
>
```

```
> alice = {name: 'alice'}
<· Object {name: "alice"}
> sayHello.apply(alice)
  alice says hello.
<· undefined
> sayHello.call(alice)
  alice says hello.
<· undefined
```

应用模式 / 绑定调用模式

call , apply

源代码 9-17 函数应用（apply、call）模式调用示例

```
var sayHello = function(message, to){
    alert(this.name + ' says ' + message + ' to ' + to);
};
var peter = {name: 'peter'};
var name = 'global';
sayHello.apply(this, ['hello', 'Marry']);  //global says hello to Marry
sayHello.apply(peter, ['hello', 'Marry']);// peter says hello to Marry
sayHello.call(this, 'hello', 'Marry'); // global says hello to Marry
sayHello.call(peter, 'hello', 'Marry');// peter says hello to Marry
```

4 kinds of function invoking

```
> var sayHello = function (){
    console.log(this.name + ' says hello.');
  }
<· undefined
>
```

```
> var Alice = function (){
    return this.name = 'alice';
  }
<· undefined
> alice = new Alice()
<· Alice {name: "alice"}
> alice.name
<· "alice"
```

```
> sayHello.apply(alice)
  alice says hello.
<· undefined
```

构造子模式 / new调用模式

Constructor

源代码 9-13 函数构造子示例

```
var Foo = function(){
    this.name = 'foo';
}

var result = Foo();              // 普通函数
alert(result);                   // undefined
alert(name);                     // foo
var result = new Foo();          // 构造子
alert(result);                   // Object
alert(result.name);              // foo
```

4 kinds of function invoking

表 9-1 4 种调用方式的对比

调用模式	this	无 return 时的返回值
函数模式	顶层对象（在浏览器中执行时为 window）	undefined
方法模式	当前对象（方法从属的对象，即成员操作符“.”的左侧）	undefined
构造子模式	正在构造的对象	this（构造好的对象）
应用模式	第一个参数	undefined

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- **Top JavaScript secret: Prototype**
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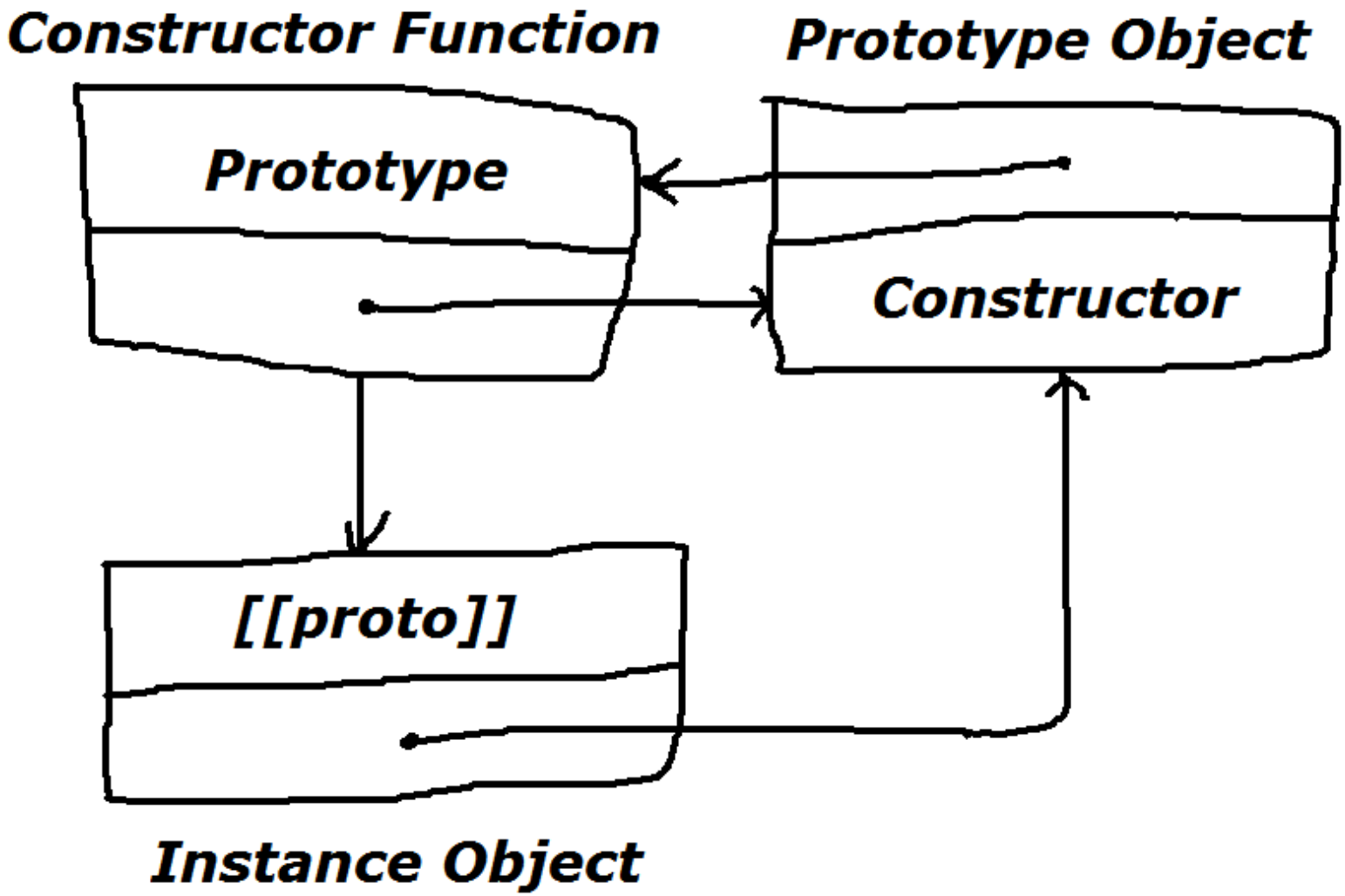
Prototype


Constructor Function
Prototype Object
Prototype
Constructor
[[proto]]
Instance Object

Prototype

Constructor

```
> var Alice = function (){
    return this.name = 'alice';
  }
<· undefined
```

Prototype

```
> Alice.prototype
<· Alice {}
> Alice.prototype.constructor === Alice
<· true
```

```
> alice = new Alice()
<· Alice {name: "alice"}
```

Instance

Prototype

Constructor

```
> var Alice = function (){
    return this.name = 'alice';
  }
<· undefined
```

Prototype

```
> Alice.prototype
<· Alice {}
> Alice.prototype.constructor === Alice
<· true
> alice.__proto__ == Alice.prototype
<· true
```

```
> alice = new Alice()
<· Alice {name: "alice"}
```

Instance

__proto__

Prototype

```
> alice.secret
<· undefined
> Alice.prototype.secret = 'secret'
<· "secret"
> alice.secret
<· "secret"
```

find missing properties from __proto__

```
> bob = new Alice()
<· Alice {name: "alice", secret: "secret"}
> bob.secret
<· "secret"
```

```
> bob.hasOwnProperty('name')
<· true
> bob.hasOwnProperty('secret')
<· false
```

Prototype

```
> Alice.prototype.saySecret = function (){
    return console.log(this.name + "'s secret is " + this.secret);
  }
```

```
> marry = new Alice()
<· ▶ Alice {name: "alice", secret: "secret", saySecret: function}
> marry.saySecret()
  alice's secret is secret
```

```
> alice.saySecret()
  alice's secret is secret
<· undefined
> bob.saySecret()
  alice's secret is secret
<· undefined
```

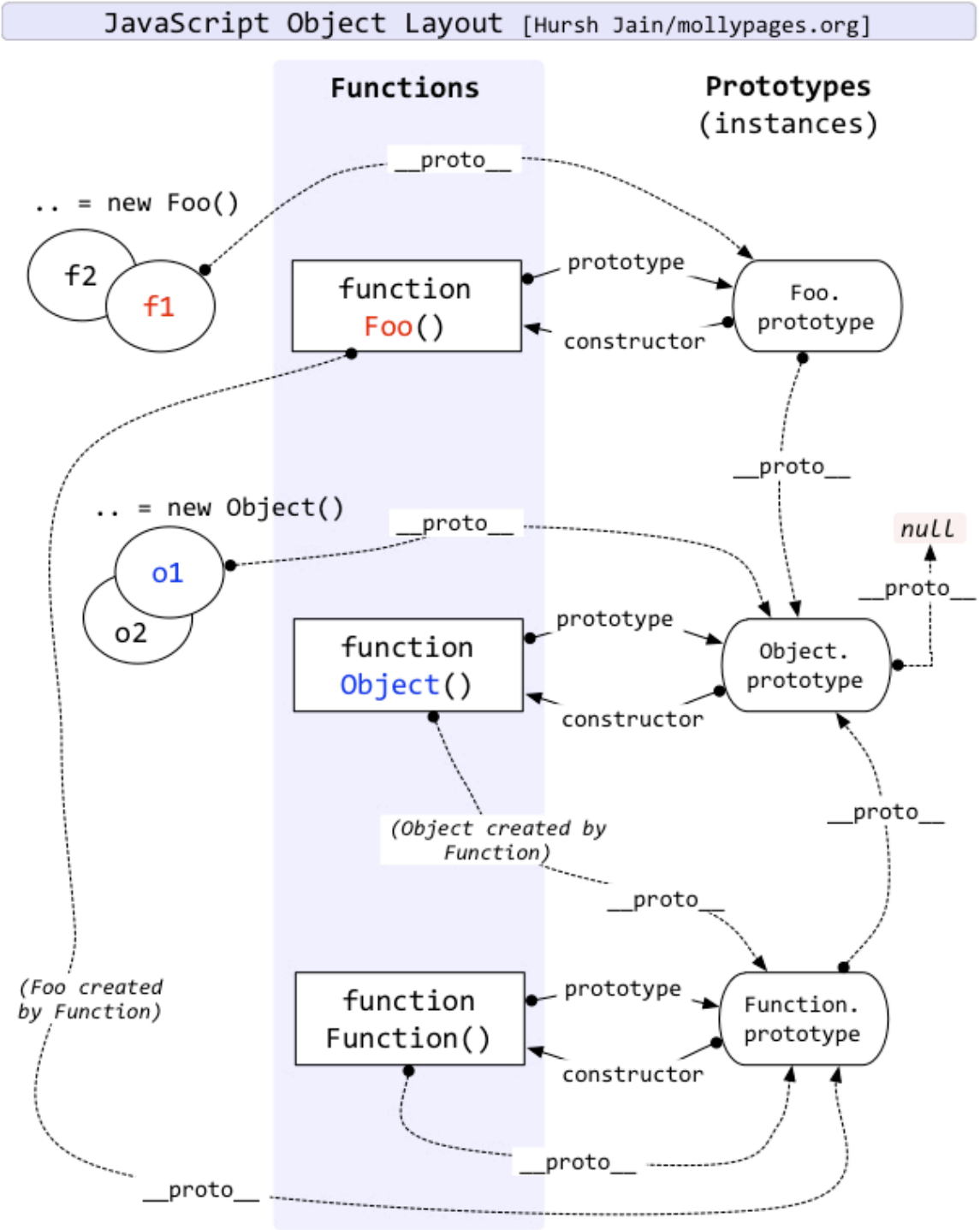
Prototype

```
> Alice
<· function (){
    return this.name = 'alice';
  }
> Alice.prototype
<· ▶ Alice {secret: "secret", saySecret: function}
> Tom = function(){}
<· function (){}
> Tom.prototype = new Alice()
<· ▶ Alice {name: "alice", secret: "secret", saySecret: function}
> tom = new Tom()
> tom.name
<· "alice"
> tom.saySecret()
  alice's secret is secret
```

prototype chain!_

Prototype

- __proto__, 缺属性去那儿找
- __proto__指向构造子的prototype
- 构造子的prototype用constructor反指构造子
- 构造子的prototype也是object，也有自己的构造子
- 形成了__proto__链条



Outline

- Everything is Object
- Closure: the Secret of Function
- Top JavaScript secret: Prototype
- **Code practice**

Singletons

```
var singleton = (function () {
    var privateVariable;
    function privateFunction(x) {
        ...privateVariable...
    }
    return {
        firstMethod: function (a, b) {
            ...privateVariable...
        },
        secondMethod: function (c) {
            ...privateFunction()...
        }
    };
}());
```

A Module Pattern

```
var singleton = (function () {
    var privateVariable;
    function privateFunction(x) {
        ...privateVariable...
    }
    return {
        firstMethod: function (a, b) {
            ...privateVariable...
        },
        secondMethod: function (c) {
            ...privateFunction()...
        }
    };
}());
```

Applications are Singletons

```
MYAPP.MyApplication = (function () {
    var privateVariable;
    function privateFunction(x) {
        ...privateVariable...
    }
    return {
        firstMethod: function (a, b) {
            ...privateVariable...
        },
        secondMethod: function (c) {
            ...privateFunction()...
        }
    };
}());
```

Privileged Method

- A Privileged Method is a function that has access to secret information.
- A Privileged Method has access to private variables and private methods.
- A Privileged Method obtains its secret information through closure.

Module pattern is easily transformed into a powerful constructor pattern.

Power Constructors

1. Make an object.
   - Object literal
   - `new`
   - `Object.create`
   - call another power constructor

Power Constructors

1. Make an object.
   - Object literal, **`new`**, **`Object.create`**, call another power constructor
2. Define some variables and functions.
   - These become private members.

Power Constructors

1. Make an object.
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   - These become private members.
3. Augment the object with privileged methods.

Power Constructors

1. Make an object.
   - Object literal, `new`, `Object.create`, call another power constructor
2. Define some variables and functions.
   - These become private members.
3. Augment the object with privileged methods.
4. Return the object.

Step One

```
function myPowerConstructor(x) {
    var that = otherMaker(x);
}
```

Step Two

```
function myPowerConstructor(x) {
    var that = otherMaker(x);
    var secret = f(x);
}
```

Step Three

```
function myPowerConstructor(x) {
    var that = otherMaker(x);
    var secret = f(x);
    that.priv = function () {
        ... secret x that ...
    };
}
```

Step Four

```
function myPowerConstructor(x) {
    var that = otherMaker(x);
    var secret = f(x);
    that.priv = function () {
        ... secret x that ...
    };
    return that;
}
```

Power Constructor

- Public methods (from the prototype)

```
var that = Object.create(my_base);
```

- Private variables (`var`)
- Private methods (inner functions)
- Privileged methods (`that`...)
- No need to use `new`

```
myObject = power_constructor();
```

Functional Inheritance

- A power constructor calls another constructor, takes the result, augments it, and returns it as though it did all the work.

```
function symbol(s, p) {
    return {
        id: s,
        lbp: p,
        value: s
    };
}

function delim(s) {
    return symbol(s, 0);
}
```

```
function stmt(s, f) {
    var x = delim(s);
    x.identifier = true;
    x.reserved = true;
    x.fud = f;
    return x;
}
function blockstmt(s, f) {
    var x = stmt(s, f);
    x.block = true;
    return x;
}
```

Pseudoclassical Inheritance

```
function Gizmo(id) {
    this.id = id;
}
Gizmo.prototype.toString = function () {
    return "gizmo " + this.id;
};

function Hoozit(id) {
    this.id = id;
}
Hoozit.prototype = new Gizmo();
Hoozit.prototype.test = function (id) {
    return this.id === id;
};
```

Functional Inheritance

```
function gizmo(id) {
    return {
        id: id,
        toString: function () {
            return "gizmo " + this.id;
        }
    };
}

function hoozit(id) {
    var that = gizmo(id);
    that.test = function (testid) {
        return testid === this.id;
    };
    return that;
}
```

Secrets

```
function gizmo(id) {
    return {
        toString: function () {
            return "gizmo " + id;
        }
    };
}

function hoozit(id) {
    var that = gizmo(id);
    that.test = function (testid) {
        return testid === id;
    };
    return that;
}
```

Shared Secrets

```
function gizmo(id, secret) {
    secret = secret || {};
    secret.id = id;
    return {
        toString: function () {
            return "gizmo " + secret.id;
        }
    };
}

function hoozit(id) {
    var secret = {};    /*final*/
    var that = gizmo(id, secret);
    that.test = function (testid) {
        return testid === secret.id;
    };
    return that;
}
```

Super Methods

```
function hoozit(id) {
    var secret = {};
    var that = gizmo(id, secret);
    var super_toString = that.toString;
    that.test = function (testid) {
        return testid === secret.id;
    };
    that.toString = function () {
        return super_toString.apply(that);
    };
    return that;
}
```

Inheritance Patterns

- Prototypal Inheritance works really well with public methods.
- Functional Inheritance works really well with privileged and private and public methods.
- Pseudoclassical Inheritance for elderly programmers who are old and set in their ways.

Thank you!