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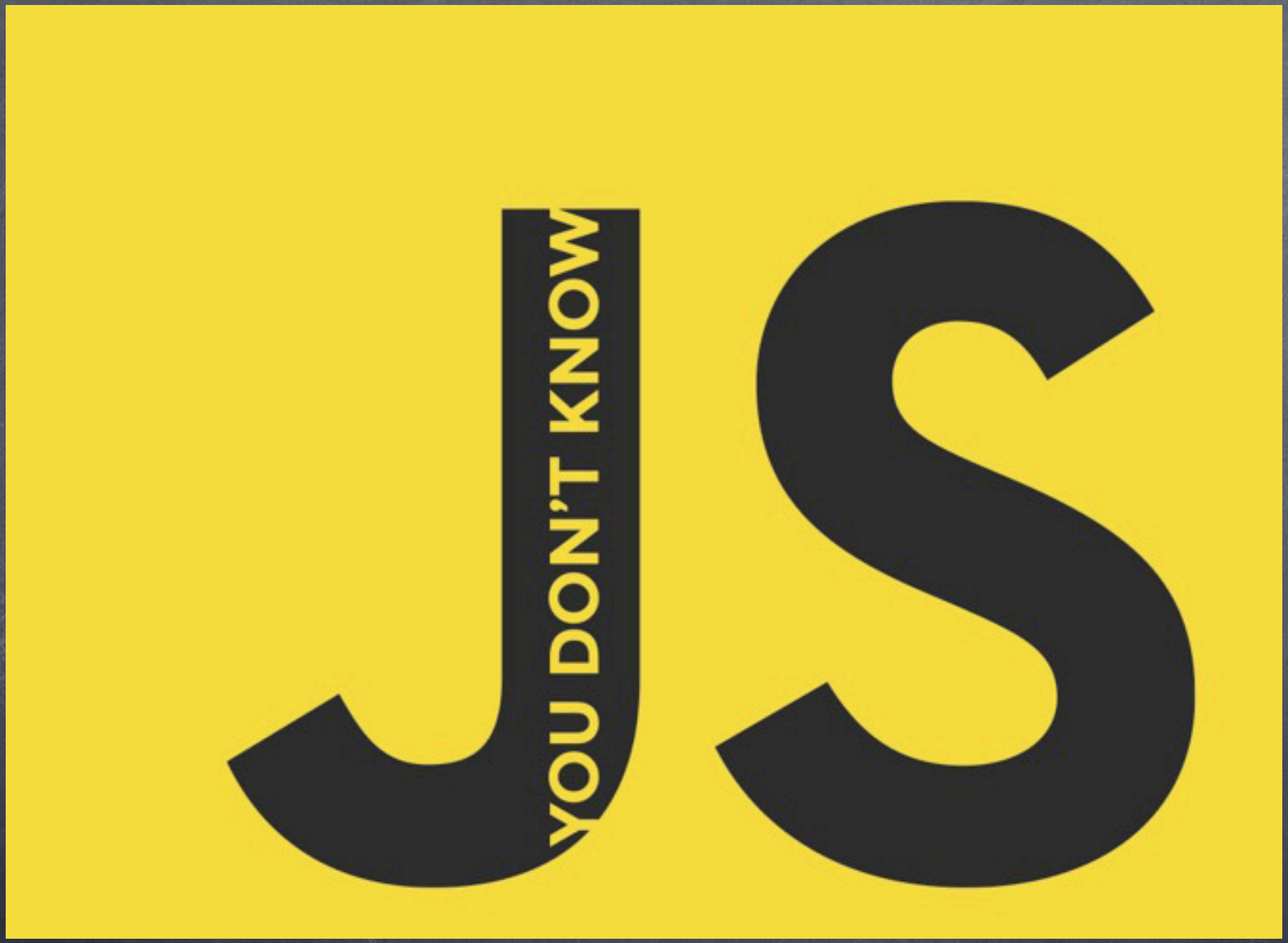
@getify
http://getify.me

- LABjs
- grips
- asynquence



http://YouDontKnowJS.com

Agenda

Scope, Closures

- Nested Scope
- Hoisting
- Closure

Scope: where to look for things

JavaScript has
function scope only*

```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5  }
6
7  function baz(foo) {
8      foo = "bam";
9      bam = "yay";
10 }
```

Scope

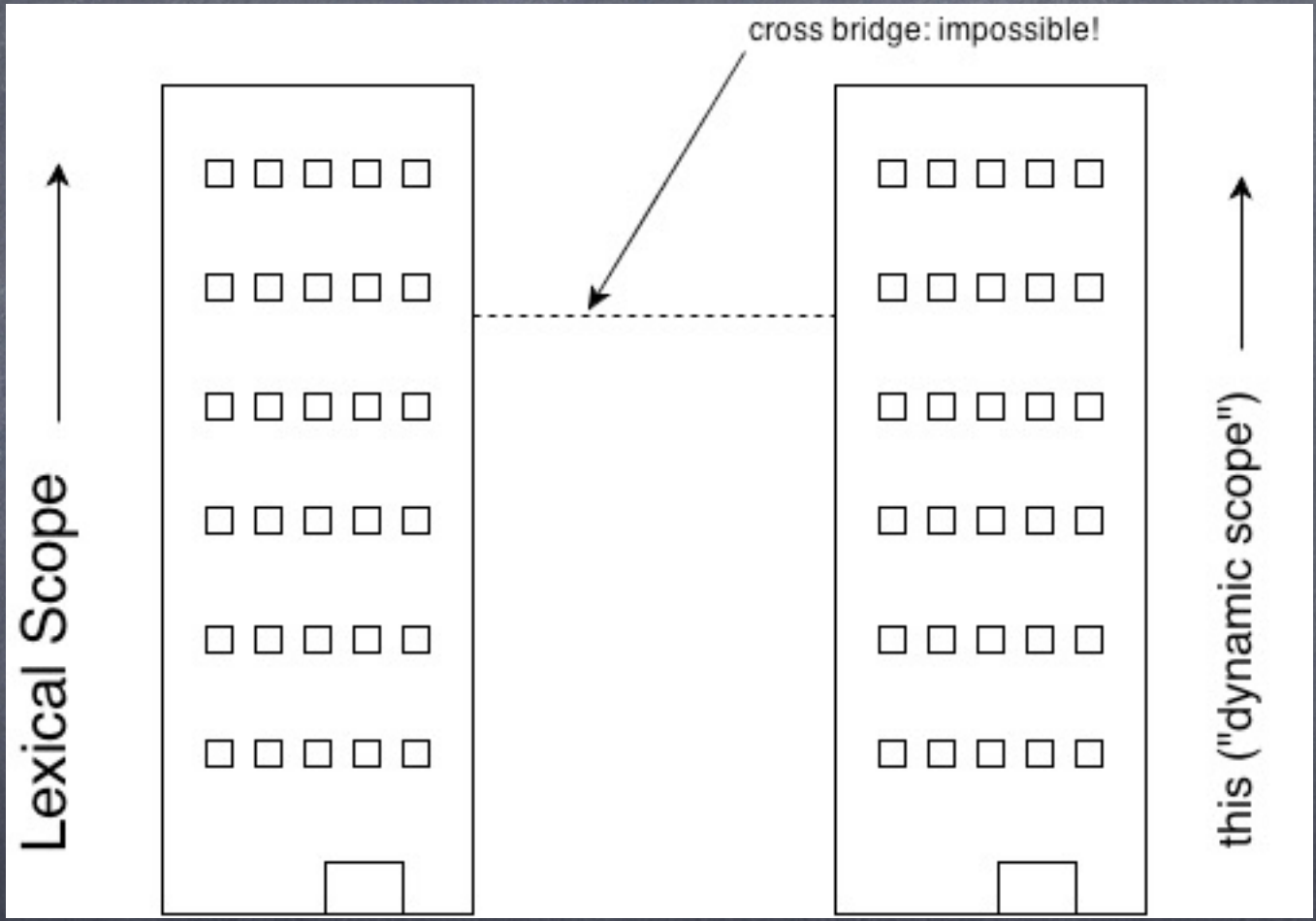
```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5
6      function baz(foo) {
7          foo = "bam";
8          bam = "yay";
9      }
10     baz();
11 }
12
13 bar();
14 foo;          // ???
15 bam;          // ???
16 baz();        // ???
```

Code Me

Scope

```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5
6      function baz(foo) {
7          foo = "bam";
8          bam = "yay";
9      }
10     baz();
11 }
12
13 bar();
14 foo;          // "bar"
15 bam;          // "yay"
16 baz();        // Error!
```

Scope



Scope

```
1  var foo = function bar() {
2      var foo = "baz";
3
4      function baz(foo) {
5          foo = bar;
6          foo;     // function...
7      }
8      baz();
9  };
10
11 foo();
12 bar();        // Error!
```

Scope: function scope?

Code Me

```
1  var foo;
2
3  try {
4      foo.length;
5  }
6  catch (err) {
7      console.log(err); // TypeError
8  }
9
10 console.log(err); // ReferenceError
```

Scope: block scope?

Code Me

lexical scope

dynamic scope

Scope

```
1 function foo() {
2     var bar = "bar";
3
4     function baz() {
5         console.log(bar); // lexical!
6     }
7     baz();
8 }
9 foo();
```

Scope: lexical

```
1 var bar = "bar";
2
3 function foo(str) {
4     eval(str);  // cheating!
5     console.log(bar); // 42
6 }
7
8 foo("var bar = 42;");
```

Scope: WAT!?

```
var obj = {
    a: 2,
    b: 3,
    c: 4
};

obj.a = obj.b + obj.c;
obj.c = obj.b - obj.a;

with (obj) {
    a = b + c;
    c = b - a;
    d = 3; // <-- Look!
}

obj.d; // undefined
d; // 3 -- oops!
```

Scope: WAT!?

IIFE

```
1  var foo = "foo";
2
3  (function(){
4
5      var foo = "foo2";
6      console.log(foo);    // "foo2"
7
8  })();
9
10 console.log(foo);    // "foo"
```

http://benalman.com/news/2010/11/immediately-invoked-function-expression/

Function Scope

Code Me

```
1  var foo = "foo";
2
3  (function(bar){
4
5      var foo = bar;
6      console.log(foo);    // "foo"
7
8  })(foo);
9
10 console.log(foo);    // "foo"
```

Function Scope

Block Scope

let (ES6+)

Block Scope

```
1 function foo() {
2     var bar = "bar";
3     for (let i=0; i<bar.length; i++) {
4         console.log(bar.charAt(i));
5     }
6     console.log(i); // ReferenceError
7 }
8
9 foo();
```

Block Scope: let

```
1  function foo(bar) {
2      if (bar) {
3          let baz = bar;
4          if (baz) {
5              let bam = baz;
6          }
7          console.log(bam); // Error
8      }
9      console.log(baz); // Error
10 }
11
12 foo("bar");
```

Block Scope: let

```
1 function foo(bar) {
2     let (baz = bar) {
3         console.log(baz); // "bar"
4     }
5     console.log(baz); // Error
6 }
7
8 foo("bar");
```

Block Scope: let

```
1 function foo(bar) {
2     /*let*/ { let baz = bar;
3         console.log(baz); // "bar"
4     }
5     console.log(baz); // Error
6 }
7
8 foo("bar");
```

https://gist.github.com/getify/5285514

Block Scope: let

dynamic scope

```
1  // theoretical dynamic scoping
2  function foo() {
3      console.log(bar); // dynamic!
4  }
5
6  function baz() {
7      var bar = "bar";
8      foo();
9  }
10
11 baz();
```

Scope: dynamic!?!?

Quiz

1. What type of scoping rule(s) does JavaScript have? Exceptions?
2. What are the different ways you can create a new scope?
3. What's the difference between undeclared and undefined?

Scope: hoisting

```
1 a;                // ???
2 b;                // ???
3 var a = b;
4 var b = 2;
5 b;                // 2
6 a;                // ???
```

Scope: hoisting

Code Me

```
var a;
var b;
a;                  // ???
b;                  // ???
a = b;
b = 2;
b;                  // 2
a;                  // ???
```

Scope: hoisting

```
1  var a = b();
2  var c = d();
3  a;                    // ???
4  c;                    // ???
5
6  function b() {
7      return c;
8  }
9
10 var d = function() {
11     return b();
12 };
```

Scope: hoisting

```
1  function b() {
2      return c;
3  }
4  var a;
5  var c;
6  var d;
7  a = b();
8  c = d();
9  a;                  // ???
10 c;                  // ???
11 d = function() {
12     return b();
13 };
```

Scope: hoisting

```
1  a(1);          // ???
2
3  function a(foo) {
4      if (foo > 20) return foo;
5      return b(foo+2);
6  }
7  function b(foo) {
8      return c(foo) + 1;
9  }
10 function c(foo) {
11     return a(foo*2);
12 }
```

Hoisting: recursion

```
1 function foo(bar) {
2     if (bar) {
3         console.log(baz); // ReferenceError
4         let baz = bar;
5     }
6 }
7
8 foo("bar");
```

Hoisting: let gotcha

Closure

Closure is when a function "remembers" its lexical scope even when the function is executed outside that lexical scope.

```
1  function foo() {
2      var bar = "bar";
3
4      function baz() {
5          console.log(bar);
6      }
7
8      bam(baz);
9  }
10
11 function bam(baz) {
12     baz();          // "bar"
13 }
14
15 foo();
```

Closure

Code Me

```
1  function foo() {
2      var bar = "bar";
3
4      return function() {
5          console.log(bar);
6      };
7  }
8
9  function bam() {
10     foo()();                    // "bar"
11 }
12
13 bam();
```

Closure

```
1 function foo() {
2     var bar = "bar";
3
4     setTimeout(function() {
5         console.log(bar);
6     },1000);
7 }
8
9 foo();
```

Closure

```
1 function foo() {
2     var bar = "bar";
3
4     $("#btn").click(function(evt) {
5         console.log(bar);
6     });
7 }
8
9 foo();
```

Closure

```
1  function foo() {
2      var bar = 0;
3
4      setTimeout(function(){
5          console.log(bar++);
6      },100);
7      setTimeout(function(){
8          console.log(bar++);
9      },200);
10 }
11
12 foo();  // 0 1
```

Closure: shared scope

Code Me

```
1  function foo() {
2      var bar = 0;
3
4      setTimeout(function(){
5          var baz = 1;
6          console.log(bar++);
7
8          setTimeout(function(){
9              console.log(bar+baz);
10         },200);
11     },100);
12 }
13
14 foo();   // 0 2
```

Closure: nested scope

```
1 for (var i=1; i<=5; i++) {
2     setTimeout(function(){
3         console.log("i: " + i);
4     },i*1000);
5 }
```

Closure: loops

Code Me

```
1 for (var i=1; i<=5; i++) {
2     (function(i){
3         setTimeout(function(){
4             console.log("i: " + i);
5         },i*1000);
6     })(i);
7 }
```

Closure: loops

Code Me

```
1 for (let i=1; i<5; i++) {
2     setTimeout(function(){
3         console.log("i: " + i);
4     },i*1000);
5 }
```

Closure: loops + block scope

```
1 var foo = (function(){
2
3     var o = { bar: "bar" };
4
5     return { obj: o };
6
7 })();
8
9 console.log(foo.obj.bar);    // "bar"
```

Closure?

```
1  var foo = (function(){
2
3      var o = { bar: "bar" };
4
5      return {
6          bar: function(){
7              console.log(o.bar);
8          }
9      };
10
11 })();
12
13 foo.bar();        // "bar"
```

Closure: classic module pattern

Code Me

```
1  var foo = (function(){
2      var publicAPI = {
3          bar: function(){
4              publicAPI.baz();
5          },
6          baz: function(){
7              console.log("baz");
8          }
9      };
10     return publicAPI;
11 })();
12
13 foo.bar();        // "baz"
```

Closure: modified module pattern

Code Me

```
1  define("foo",function(){
2
3      var o = { bar: "bar" };
4
5      return {
6          bar: function(){
7              console.log(o.bar);
8          }
9      };
10
11 });
```

Closure: modern module pattern

foo.js:

```
1 var o = { bar: "bar" };
2
3 export function bar() {
4     return o.bar;
5 }
```

```
1 import { bar } from "foo";
2
3 bar();        // "bar"
4
5 import * as foo from "foo";
6
7 foo.bar();    // "bar"
```

Closure: ES6+ module pattern

Quiz

1. What is a closure and how is it created?
2. How long does its scope stay around?
3. Why doesn't a function callback inside a loop behave as expected? How do we fix it?
4. How do you use a closure to create an encapsulated module? What's the benefits of that approach?

(exercise #1: 20min)

http://dmitrysoshnikov.com/ecmascript/javascript-the-core/

Agenda

Object-Orienting

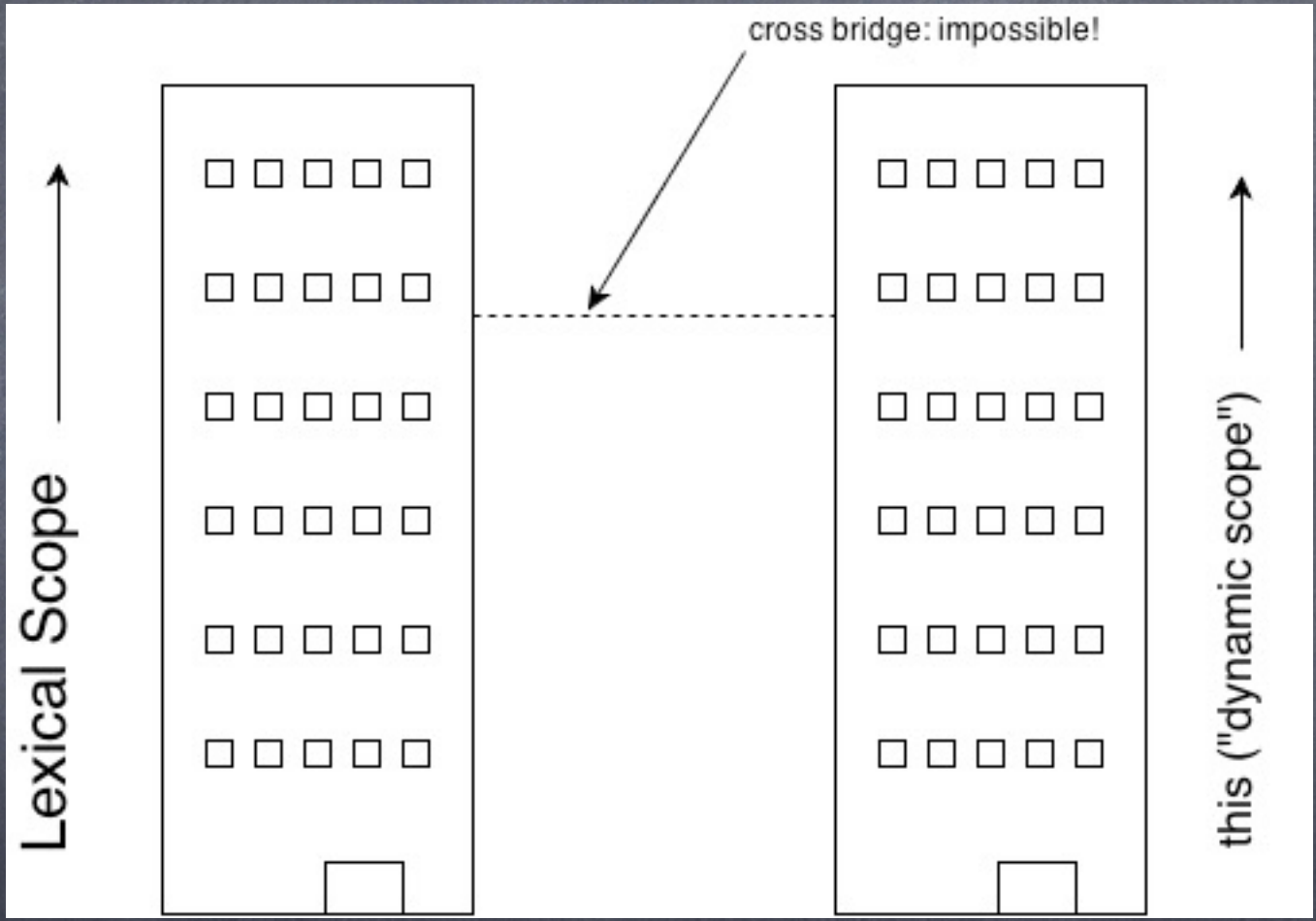
- this
- prototype
- "Inheritance" vs. "Behavior Delegation"
  (OO vs. OLOO)

this

Every function, **while executing**, has a reference to its current execution context, called this.

Remember lexical scope vs. dynamic scope?

JavaScript's version of "dynamic scope" is this.



Scope

```
1  function foo() {
2      console.log(this.bar);
3  }
4
5  var bar = "bar1";
6  var o2 = { bar: "bar2", foo: foo };
7  var o3 = { bar: "bar3", foo: foo };
8
9  foo();                    // "bar1"
10 o2.foo();                 // "bar2"
11 o3.foo();                 // "bar3"
```

this: implicit & default binding

Code Me

```
1 function foo() {
2     console.log(this.bar);
3 }
4
5 var bar = "bar1";
6 var obj = { bar: "bar2" };
7
8 foo();                    // "bar1"
9 foo.call(obj);            // "bar2"
```

this: explicit binding

Code Me

```
1  function foo() {
2      console.log(this.bar);
3  }
4
5  var obj = { bar: "bar" };
6  var obj2 = { bar: "bar2" };
7
8  var orig = foo;
9  foo = function(){ orig.call(obj); };
10
11 foo();            // "bar"
12 foo.call(obj2); // ???
```

this: hard binding

Code Me

https://developer.mozilla.org/en-US/docs/JavaScript/Reference/Global_Objects/Function/bind

```
1 function foo(baz,bam) {
2     console.log(this.bar + " " + baz +
3         " " + bam);
4 }
5
6 var obj = { bar: "bar" };
7 foo = foo.bind(obj,"baz");  // ES5 only!
8
9 foo("bam");                 // "bar baz bam"
```

this: hard binding

Code Me

```
1 function foo() {
2     this.baz = "baz";
3     console.log(this.bar + " " + baz);
4 }
5
6 var bar = "bar";
7 var baz = new foo();    // ???
```

this: new

Code Me

```
1  function something() {
2      this.hello = "hello";
3      console.log(this.hello,this.who);
4  }
5
6  var who = "global", foobar, bazbam,
7      obj1 = { who: "obj1", something: something },
8      obj2 = { who: "obj2" };
9
10 something(); // "hello"  "global"
11 console.log(hello); // "hello"          <-- OOPS!!!
12
13 obj1.something(); // "hello"  "obj1"
14 console.log(obj1.hello); // "hello"
15
16 obj1.something.call(obj2); // "hello"  "obj2"
17 console.log(obj2.hello); // "hello"
18
19 foobar = something.bind(obj2);
20 foobar(); // "hello"  "obj2"
21 foobar.call(obj1); // "hello"  "obj2"  <-- STILL "obj2"
22
23 bazbam = new something(); // "hello"  undefined
24 console.log(bazbam.hello); // "hello"
25
26 bazbam = new obj1.something(); // "hello"  undefined
27 bazbam = new foobar(); // "hello"  undefined  <-- LOOK, not "obj2"
```

this: order of precedence

Code Me

1. Was the function called with `new`?
2. Was the function called with `call` or `apply` specifying an explicit this?
3. Was the function called via a containing/owning object (context)?
4. DEFAULT: global object (except strict mode)

this: determination

Quiz

1. What determines which object a function's this points to? What's the default?
2. How do you "borrow" a function by implicit assignment of this?
3. How do you explicitly bind this?
4. How can you force a specific this for a function? Why do that? Why not?
5. How do you create a new this?

prototype

Every single “object” is built by a constructor call

prototype

A constructor makes an object "~~based on~~" its own prototype

A constructor makes an object linked to its own prototype

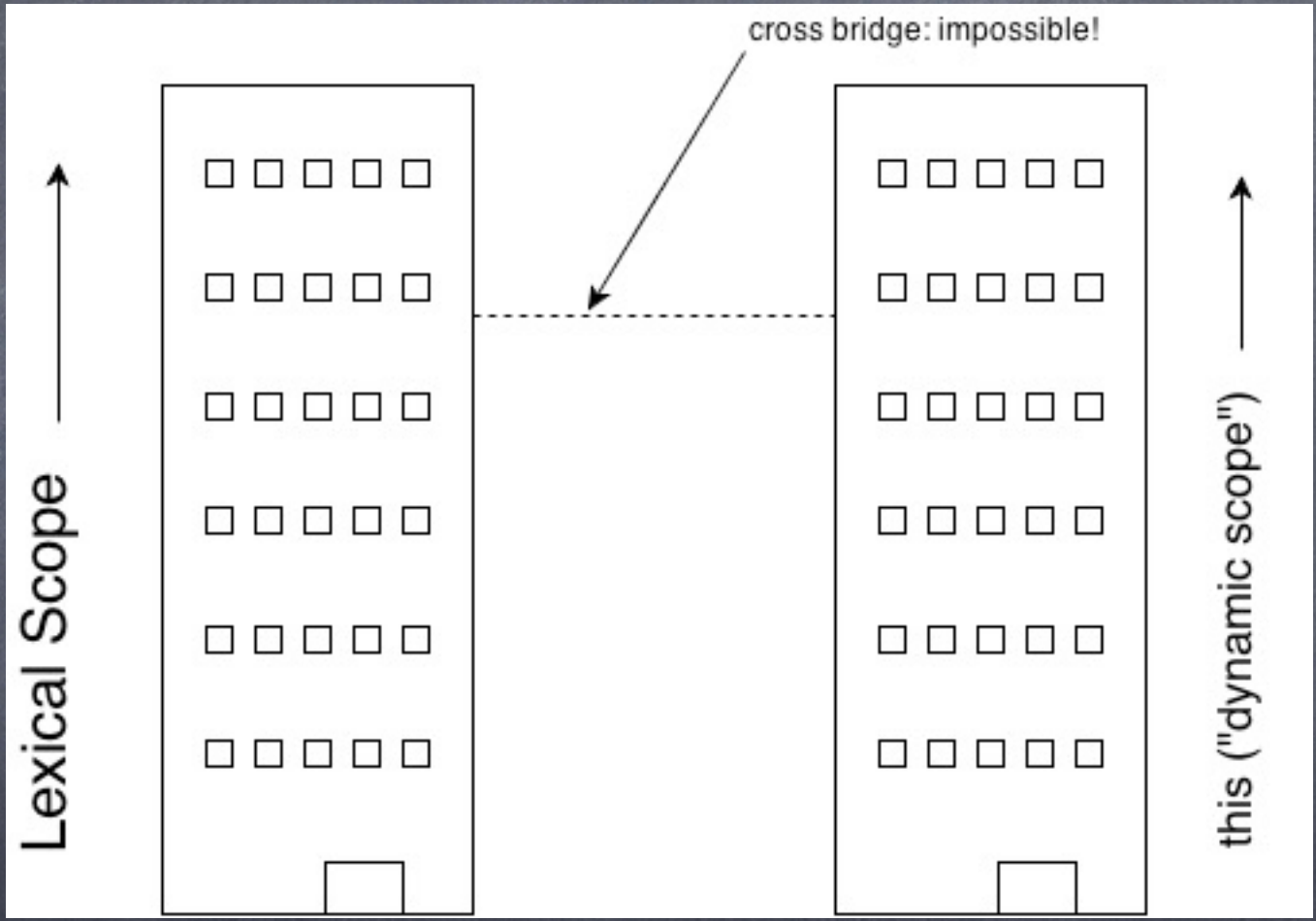
```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  var a2 = new Foo("a2");
10
11 a2.speak = function() {
12     alert("Hello, " + this.identify() + ".");
13 };
14
15 a1.constructor === Foo;
16 a1.constructor === a2.constructor;
17 a1.__proto__ === Foo.prototype;
18 a1.__proto__ === a2.__proto__;
```

prototype

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  var a2 = new Foo("a2");
10
11 a2.speak = function() {
12     alert("Hello, " + this.identify() + ".");
13 };
14
15 a1.__proto__ === Object.getPrototypeOf(a1);
16 a2.constructor === Foo;
17 a1.__proto__ == a2.__proto__;
18 a2.__proto__ == a2.constructor.prototype;
```

prototype



prototype

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  a1.identify();  // "I am a1"
10
11 a1.identify = function() {  // <-- Shadowing
12     alert("Hello, " +
13         Foo.prototype.identify.call(this) +
14     ".");
15 };
16
17 a1.identify();  // alerts: "Hello, I am a1."
```

Code Me

prototype

```
1  function Foo(who) {
2      this.me = who;
3  }
4
5  Foo.prototype.identify = function() {
6      return "I am " + this.me;
7  };
8
9  Foo.prototype.speak = function() {
10     alert("Hello, " +
11         this.identify() + // super unicorn magic
12     ".");
13 };
14
15 var a1 = new Foo("a1");
16 a1.speak(); // alerts: "Hello, I am a1."
```

prototype

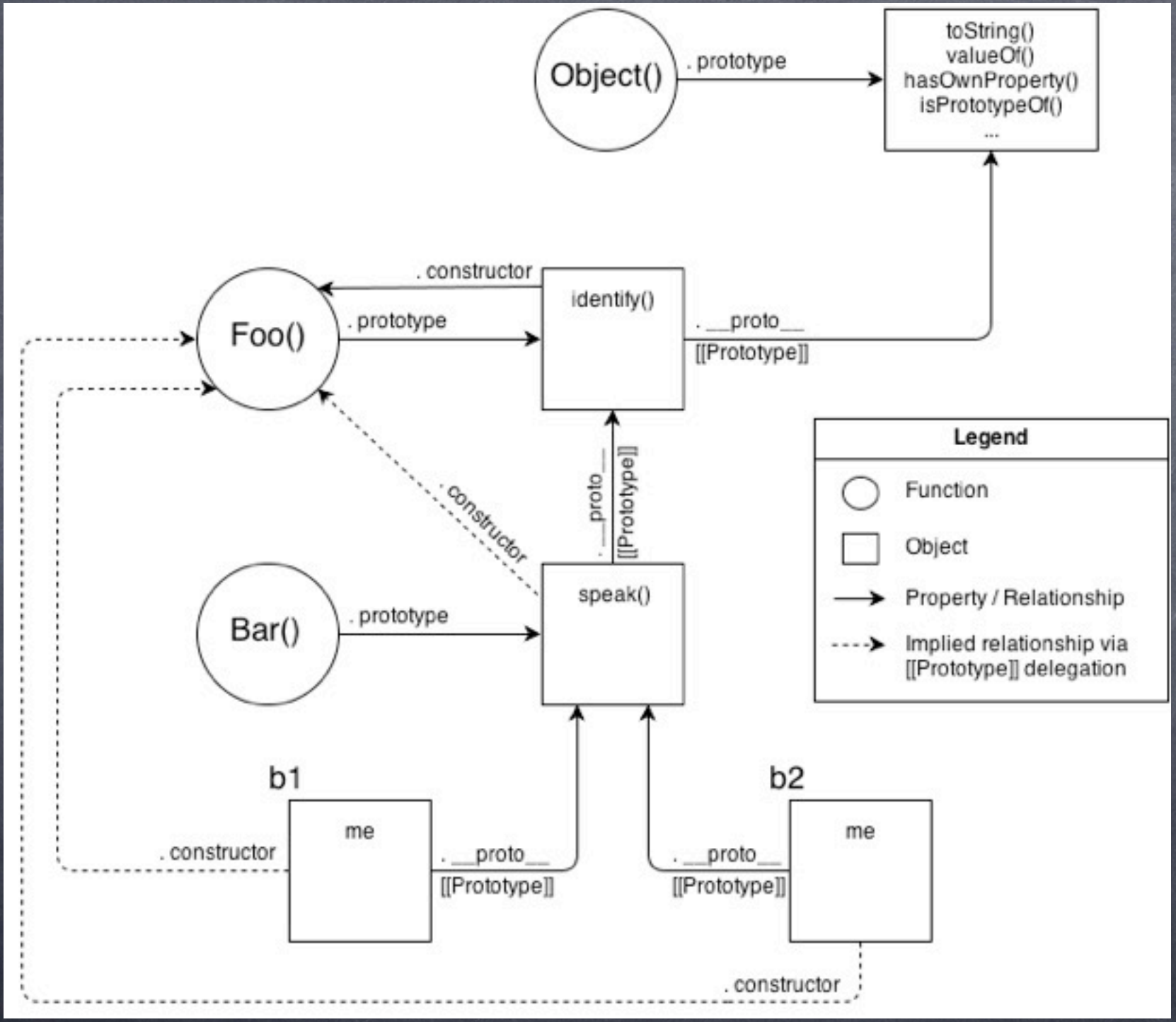
“Inheritance”

prototype

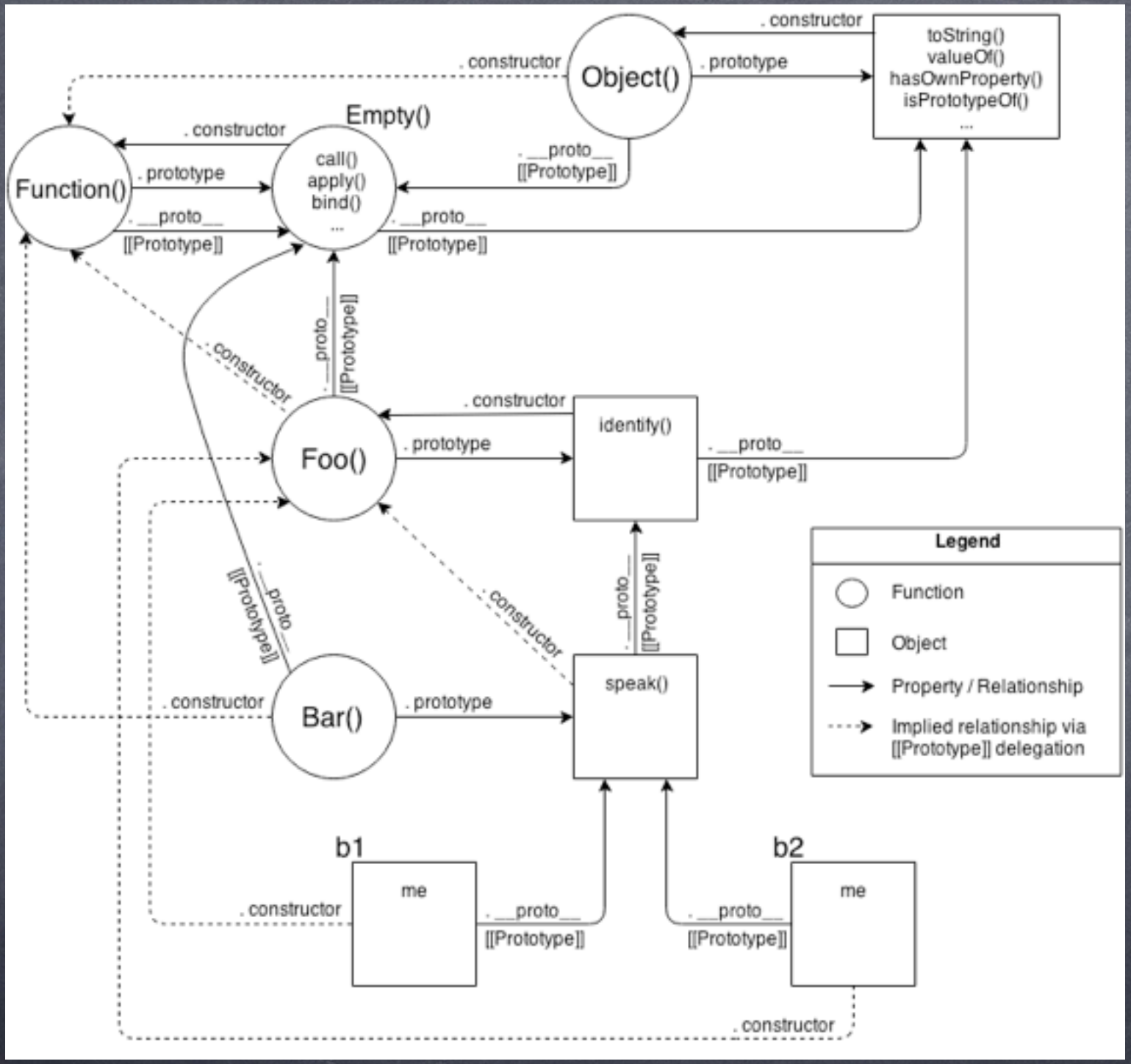
```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 // Bar.prototype = new Foo();    // Or...
12 Bar.prototype = Object.create(Foo.prototype);
13 // NOTE: constructor is borked here, need to fix
14
15 Bar.prototype.speak = function() {
16     alert("Hello, " + this.identify() + ".");
17 };
18
19 var b1 = new Bar("b1");
20 var b2 = new Bar("b2");
21
22 b1.speak(); // alerts: "Hello, I am b1."
23 b2.speak(); // alerts: "Hello, I am b2."
```

prototype: objects linked

Code Me



prototype: objects linked



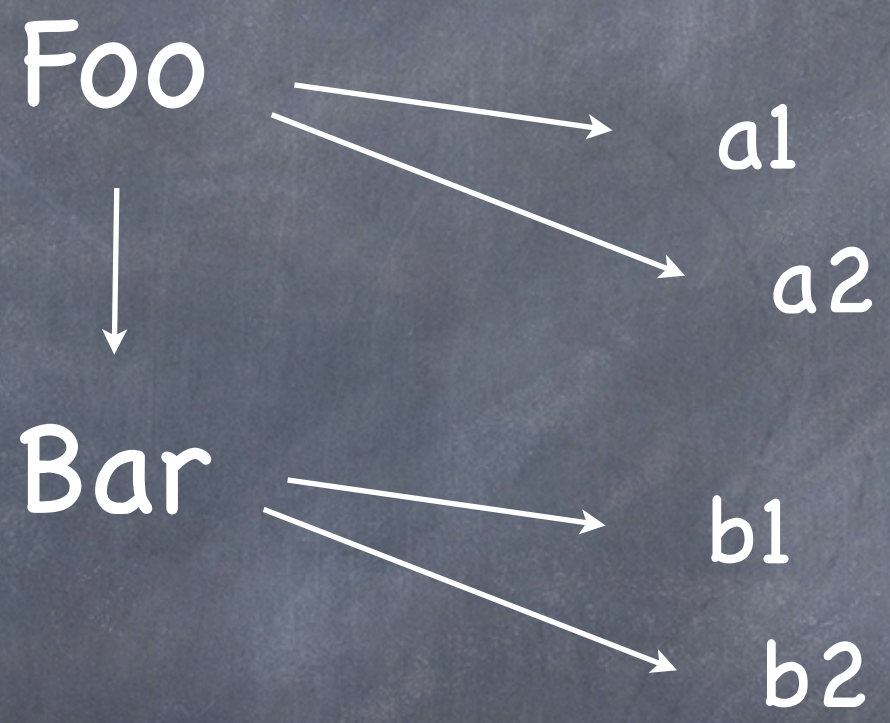
prototype: objects linked

Quiz

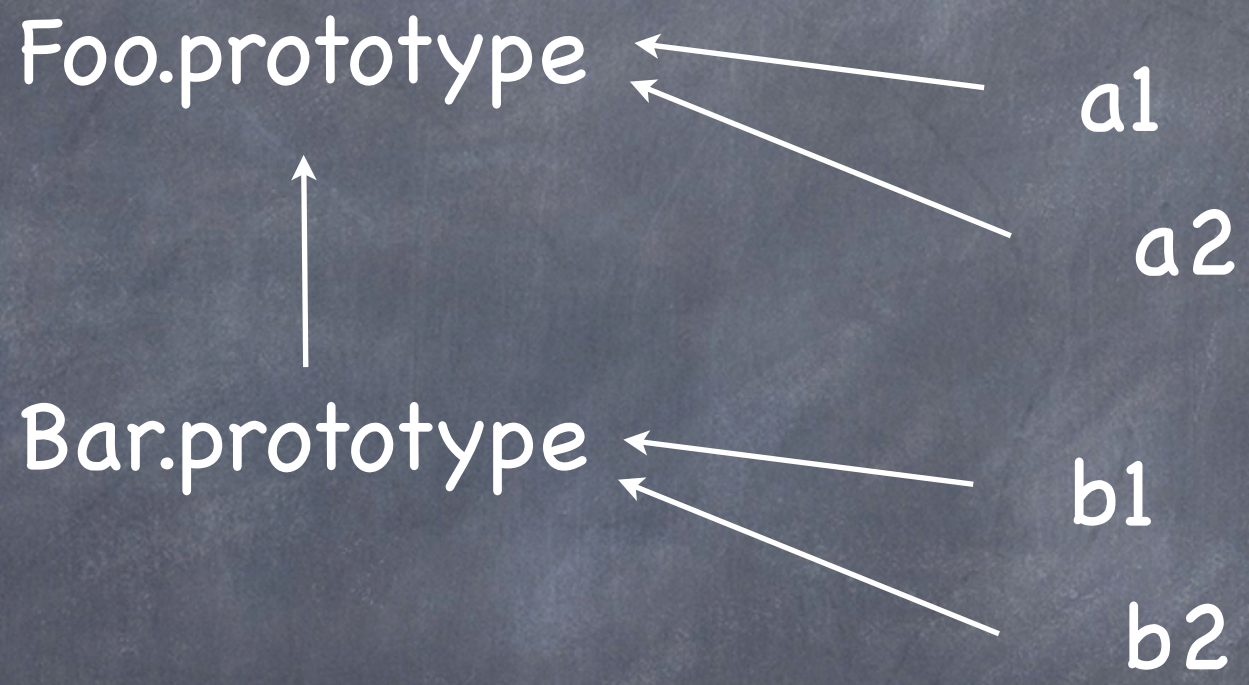
1. What is a constructor call?
2. What is [[Prototype]] and where does it come from?
3. How does [[Prototype]] affect the behavior of an object?
4. How do we find out where an object's [[Prototype]] points to (3 ways)?

(exercise #2: 20min)

Inheritance



OO: classical inheritance



(another design pattern)

OO: “prototypal inheritance”

JS ~~"Inheritance"~~
"Behavior Delegation"

Let's simplify!

OLOO:

Objects Linked to Other Objects

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 Bar.prototype = Object.create(Foo.prototype);
12
13 Bar.prototype.speak = function() {
14     alert("Hello, " + this.identify() + ".");
15 };
16
17 var b1 = new Bar("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: delegated objects

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 Bar.prototype = Object.create(Foo.prototype);
12
13 Bar.prototype.speak = function() {
14     alert("Hello, " + this.identify() + ".");
15 };
16
17 var b1 = Object.create(Bar.prototype);
18 Bar.call(b1,"b1");
19 b1.speak();
```

OLOO: delegated objects

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var Bar = Object.create(Foo.prototype);
9  Bar.init = function(who) {
10     Foo.call(this,who);
11 };
12 Bar.speak = function() {
13     alert("Hello, " + this.identify() + ".");
14 };
15
16 var b1 = Object.create(Bar);
17 b1.init("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: delegated objects

Code Me

```
1  var Foo = {
2      init: function(who) {
3          this.me = who;
4      },
5      identify: function() {
6          return "I am " + this.me;
7      }
8  };
9
10 var Bar = Object.create(Foo);
11
12 Bar.speak = function() {
13     alert("Hello, " + this.identify() + ".");
14 };
15
16 var b1 = Object.create(Bar);
17 b1.init("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

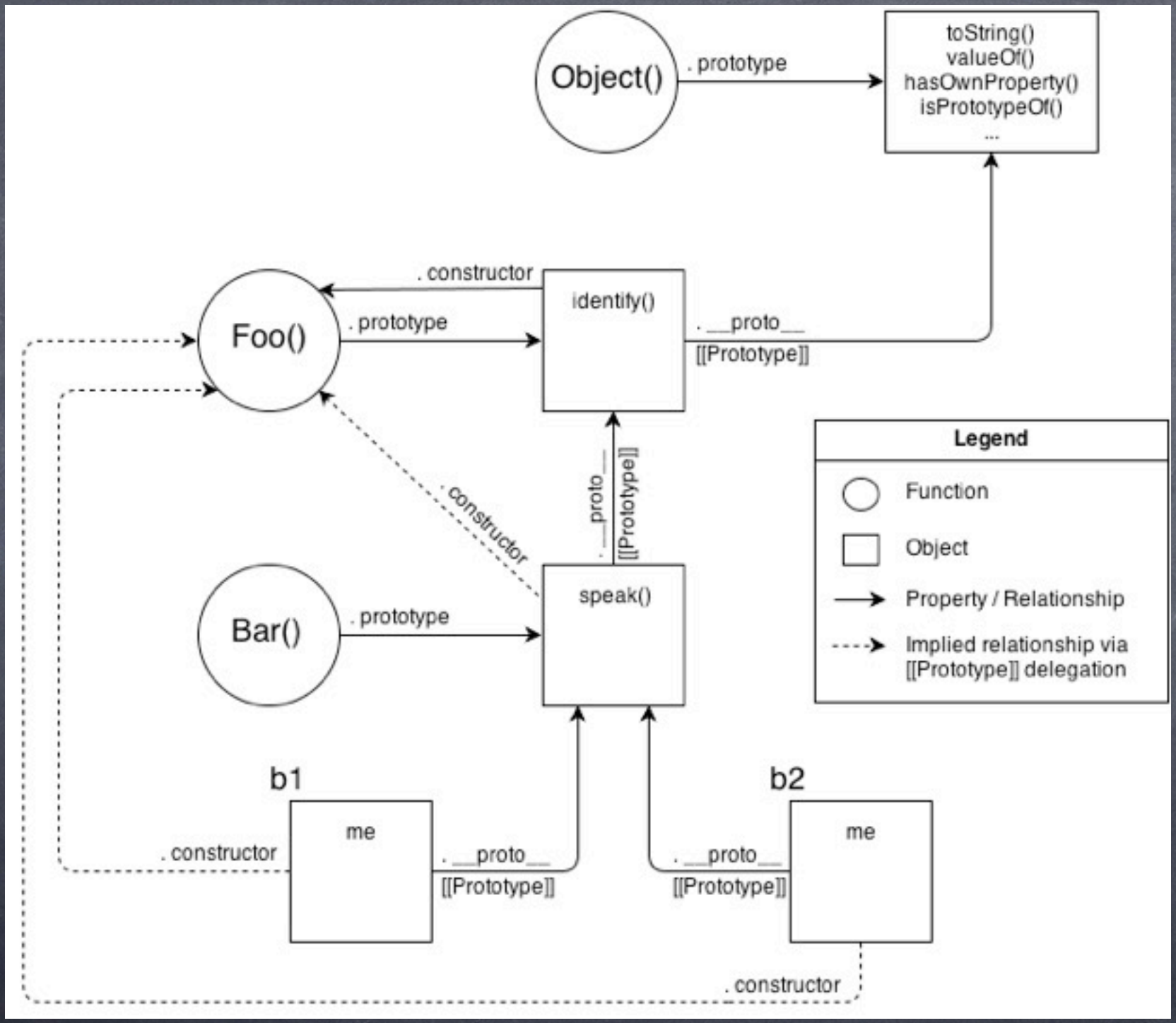
OLOO: delegated objects

Code Me

Mental Models

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 // Bar.prototype = new Foo();    // Or...
12 Bar.prototype = Object.create(Foo.prototype);
13 // NOTE: .constructor is borked here, need to fix
14
15 Bar.prototype.speak = function() {
16     alert("Hello, " + this.identify() + ".");
17 };
18
19 var b1 = new Bar("b1");
20 var b2 = new Bar("b2");
21
22 b1.speak(); // alerts: "Hello, I am b1."
23 b2.speak(); // alerts: "Hello, I am b2."
```

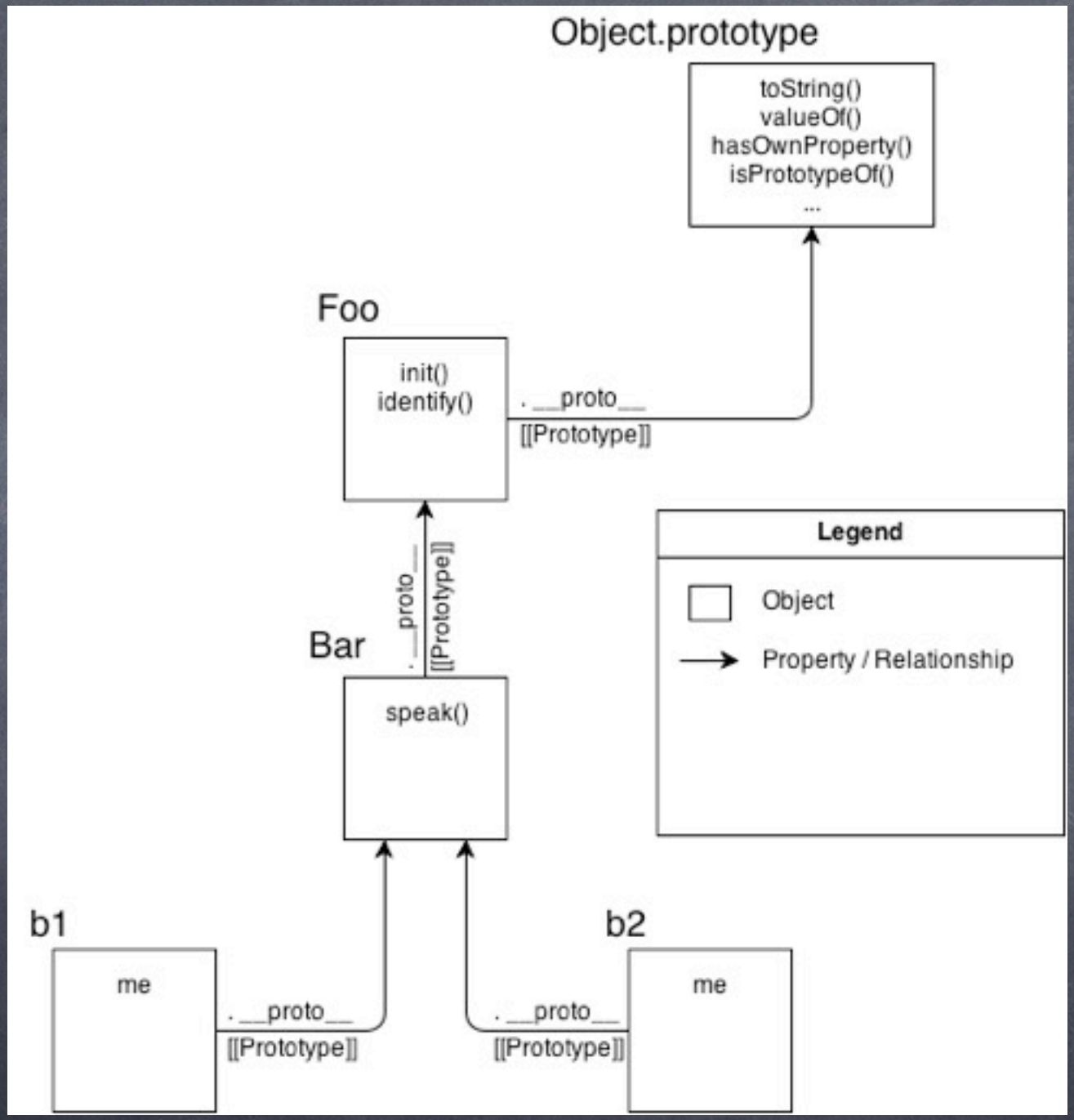
OO: old & busted



OO: old & busted

```
var Foo = {
    init: function(who) {
        this.me = who;
    },
    identify: function() {
        return "I am " + this.me;
    }
};

var Bar = Object.create(Foo);

Bar.speak = function() {
    alert("Hello, " + this.identify() + ".");
};

var b1 = Object.create(Bar);
b1.init("b1");
var b2 = Object.create(Bar);
b2.init("b2");

b1.speak(); // alerts: "Hello, I am b1."
b2.speak(); // alerts: "Hello, I am b2."
```

OLOO: new hotness



OLOO: new hotness

```
1 if (!Object.create) {
2     Object.create = function (o) {
3         function F() {}
4         F.prototype = o;
5         return new F();
6     };
7 }
```

OLOO: Object.create()

Delegation Design Pattern

~~Parent-Child~~

Peer-Peer

Delegation-Oriented Design

Quiz

1. How is JavaScript's [[Prototype]] chain not like traditional/classical inheritance?
2. What does [[Prototype]] "delegation" mean and how does it describe object linking in JS?
3. What are the benefits of the "behavior delegation" design pattern? What are the tradeoffs of using [[Prototype]]?

(exercise #3: 10min)

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Thanks!

Questions?