

# Wind.js

# 无障碍调试与排错

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# 关于我

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# Wind.js

- eval后的代码无法调试?
- 混淆后的代码不易理解?
- 堆栈信息混乱?

eval代码调试

# 代码调试

- 很久很久以前: `alert`
- 过了一段时间: `console.log`
- 其实从IE 5时代开始便可以调试代码

# 两个问题

- eval出来的代码可以调试吗？
- Node.js可以调试吗？

# 调试eval的代码

- 代码末尾: `//@ sourceMappingURL=<path>`
- 支持浏览器
  - Chrome
  - Safari
  - Firefox (Firebug)

# 调试Node.js代码

- Eclipse
- Eclipse Debugger Plugin for V8
- 启动程序
  - `node --debug[=port] app.js`
  - `node --debug-brk[=port] app.js`



调试混淆代码



# 调试混淆代码

```
1 (function(){var g,j,h=function(b){return"[object Array]"===Object.prototype.toString.call(b)},m=function(b,a,c){if(h(b)){for(var
2 arguments[d];return l(b,c)}return b.replace(/\{\{1,2\}\d+\}\{1,2\}/g,function(b){if(0===b.indexOf("{")&&b.indexOf("}")===b.length-2)r
3 e))return e},isEmpty:function(b){return h(b)?0===b.length:!j.each(b,function(){return!0})},map:m,clone:function(b){return m(b)},v
4 n.prototype={log:function(b,a){if(this.level<=b)try{console.log(a)}catch(c){}},trace:function(b){this.log(i.TRACE,b)},debug:funct
5 [],function(a,b){var c=g.modules[a];if(!c)throw Error(j.format("Missing required module: \"{0}\" (expected version: \"{1}\").",a,b));
6 d=!("function"===typeof require&&"function"===typeof define&&define.amd),f=function(b){var e=b.autoloads||[];if(a){var f=b.requi
7 module,exports,e();else if(d)define("wind-core",function(){g={};e();return g});else{var o=Function("return this")();if(o.Wind)thr
8 c){if("normal"===b||"continue"===b)e(f+1);else if("throw"===b||"return"===b)a(b,c);else if("break"===b)a("normal");else throw Error('I
9 Do: function(i,g){return{next: function(c,a){var d=function(){i.next(c,function(f,e){if("normal"===f||"continue"===f)try{g.call(c)?d(
10 g)}else a(d,f,e)}})},Return: function(g){return{next: function(h,c){c("return",g)}},Normal: function(){return{next: function(g,h){h
11 h.call(a,e)}catch(i){c?c.next(a,function(a,b,c){c("normal"===a?d("throw",i):d(a,b,c)):d("throw",i)}b&&b.next(a,function(b,e,f){c?c.
12 init: function(){m.BuilderBase=g}});if(j){try{m=require("./wind-core")}catch(l){m=require("wind-core")}k()}else if(h)require(["wi
13 a.prototype={_typeId:"4a73efb8-c2e2-4305-a05c-72385288650a",message:"This is an error contains sub-errors, please check the 'chil
14 1)}},cancel: function(){if(!this.isCancellationRequested){this.isCancellationRequested=!0;var a=this._handlers;delete this._handle
15 d||(d=this._listeners[a]=[]);d.push(b)}},remove: function(a,b){if(this._firing===a){var c=this;setTimeout(function(){c.remove(a,b)
16 "ready"};e.prototype={start: function(){if("ready"!==this.status)throw Error("Task can only be started in \"ready\" status.");this.st
17 var c=this._eventManager;this._eventManager=null;"success"===a?(this.status="succeeded",g?this._result=b:this.result=b,c.fire("su
18 if(!g)return this.error;var a=this._unobservedTimeoutToken;a&&(clearTimeout(a),this._unobservedTimeoutToken=null);this._errorObse
19 this.error);var b;try{b=a(this.result)}catch(e){return c.complete("failure",e)}"ready"===b.status&&b.start();if("running"===b.statu
20 this._eventManager;if(!a)throw Error("All the event listeners have been removed when the task was complete.");a.remove.apply(a,ar
21 b){f.remove.apply(f,arguments)};e.unobservedTimeout=1E4;var b=e.isTask=function(a){return a&&typeof a.start==="function"&&typeof
22 new a(e));else{var b=l.map(c,function(a){return a.result});d.complete("success",b)}},g=0;l.each(c,function(a,d){if(d){b(d)||c[a]
23 else{c=l.isArray(d);l.each(d,function(c,d){b(d)&&(a[c]=d)}))}else for(d=0;d<arguments.length;d++){var e=arguments[d];b(e)&&(a[d]=
24 c)}var d=function(){this.observeError();var c=this,e;l.each(a,function(a,b){if(c===b)e=a;else{b.off("complete",d);b.on("failure",
25 i.onEvent=function(a,b,d){return e.create(function(e){d&&d.isCancellationRequested&&e.complete("failure",new c);var f=function(){
26 p.prototype={Start: function(a,b){return e.create(function(c){b.next(a,function(a,b){if(a==="normal"||a==="return")c.complete("succe
27 e):e(a)}}});var h=i.Binding={},s=function(a,b){for(var c=[],d=0;d<a.length;d++)c.push(a[d]);for(;c.length<b;)c.push(void 0);retu
28 d)}e.complete("success",c)});a.apply(c,d)});h.fromCallback=function(a){var b=t(arguments);return function(){var c=this,d=s(arg
29 version:"0.7.0",require:u&&require,autoloads:["builderbase"],dependencies:{builderbase:"~0.7.0"},init: function(){l=k._;l.each(k.B
30 SortingAnimations=function(g){var j=g.getContext?g.getContext("2d"):null,h=function(c,a){j.clearRect(0,0,g.width,g.height);j.line
31 Wind.builders.async;return f.Start(this,f.Delay(function(){var e=c[a];c[a]=c[d];c[d]=e;h(c,[a,d]);return f.Bind(Wind.Async.sleep(
32 0;return a.For(function(){return f<c.length-d-1},function(){f++;a.Delay(function(){return a.Bind(m(c[f],c[f+1]),function(d){retu
33 b.Delay(function(){return b.Bind(m(c[f],h),function(a){if(0>a)f++;else return b.Break();return b.Normal()}})),b.Combine(b.While(
34 c),function(d){return b.Combine(b.Delay(function(){return a<d-1?b.Bind(f(a,d-1),function(){return b.Normal()})}:b.Normal()),b.Del
35 d+1;return a.For(function(){return e<c.length},function(){e++;a.Delay(function(){return a.Bind(m(c[e],c[f]),function(c){0>c&&(f=
36 a.Delay(function(){var e=c[f],g;return a.Combine(a.Delay(function(){g=f;return a.For(function(){return g>=d},function(){g=d},a.D
37 0.5});return c};this.paint=h;this.names=[];for(var n in i)this.names.push(n);this.sortAsync=function(c,a){var d=Wind.builders.asy
```



# 格式化以后

```
17 ,complete:function(a,b){
    if("success"!==a&&"failure"!==a)throw Error("Unsupported type: "+a);
    if("running"!==this.status)throw Error('The "complete" method can only be called in "running"
    var c=this._eventManager;
    this._eventManager=null;
    "success"===a?(this.status="succeeded",g?this._result=b:this.result=b,c.fire("success",this))
    c.fire("complete",this);
    if("failure"===a&&g&&!this._errorObserved){
        var d=this;
        this._unobservedTimeoutToken=setTimeout(function(){
            d._handleUnobservedError(b)
        },e.unobservedTimeout)
    }
}
18 ,observeError:function(){
    if("ready"===this.status||"running"===this.status)throw Error("The method could only be calle
    if(!g)return this.error;
    var a=this._unobservedTimeoutToken;
    a&&(clearTimeout(a),this._unobservedTimeoutToken=null);
    this._errorObserved=!0;
```

# 配合Source Map

```
Array[30]
0: 15
1: 16
2: 22
3: 19
4: 3
5: 6
6: 27
7: 18
8: 26
9: 12
10: 13
11: 1
12: 2
13: 30
14: 29
15: 5
16: 28
17: 9
18: 4
19: 11
```

# Source Map

- 记录目标代码到源代码的映射
- JSON格式 + 编码后的映射数据
- Source Map V3 Spec

# Source Map

- 记录目标代码到源代码的映射
- JSON格式 + 编码后的映射数据
- Source Map V3 Spec

脚本末尾加上: `//@ sourceMappingURL=<path>`, 或  
脚本请求头加上: `X-SourceMap: <path>`

# 深入Source Map

# Source Map V3

```
{  
  "version": 3,  
  "file": "all.min.js",  
  "lineCount": 37,  
  "sources": [  
    "wind-core.js",  
    "wind-builderbase.js",  
    "wind-async.js",  
    "sorting-animations.aot.js"  
  ],  
  "names": [ "Wind", "_", "isArray", "obj", ... ],  
  "mappings": "AAAC,SAAS,EAAG,CAGT,IAAIA, ..."  
}
```



# 解码 mappings 字段

- 用分号区分“行”，逗号区分“段”。
- Base64 Variable-Length Quantity 编码
- 节省空间，比V2节省50%左右

# 确定代码行号

```
AABBC;           // 第1行
KAUYM, GAKoEF;   // 第2行
CCDD, ...;       // 第3行
...
...
```

# Base64 VLQ解码

KAUYM, GAKoEF

# Base64 VLQ解码

KAUYM, GAKoEF

√  
√

[10, 0, 20, 24, 12], [6, 0, 10, 40, 4, 5]

# Base64 VLQ解码

KAUYM, GAKoEF

√  
√

[10, 0, 20, 24, 12], [6, 0, 10, 40, 4, 5]

√  
√

[001010, 000000, 010100, 011000, 001100],  
[000110, 000000, 001010, 101000, 000100, 000101]

# Base64 VLQ解码

KAUYM, GAKoEF

√  
√

[10, 0, 20, 24, 12], [6, 0, 10, 40, 4, 5]

√  
√

[001010, 000000, 010100, 011000, 001100],

[000110, 000000, 001010, 101000, 000100, 000101]

最低N-1位为数据位

最高位表示是否“连接后续数据”

# Base64 VLQ解码

KAUYM, GAKoEF

↓  
↓

[10, 0, 20, 24, 12], [6, 0, 10, 40, 4, 5]

↓  
↓

[001010, 000000, 010100, 011000, 001100],

最低N-1位为数据位

[000110, 000000, 001010, 101000, 000100, 000101]

最高位表示是否“连接后续数据”

↓  
↓

[1010, 0, 10100, 11000, 1100],

[110, 0, 1010, 10001000, 101]

# 数据解码

[1010, 0, 10100, 11000, 1100],  
[110, 0, 1010, 10001000, 101]



# 数据解码

[1010, 0, 10100, 11000, 1100],

[110, 0, 1010, 10001000, 101]

最高N-1位为数据位

最低位为符号位

# 数据解码

[1010, 0, 10100, 11000, 1100],

[110, 0, 1010, 10001000, 101]

最高N-1位为数据位

最低位为符号位

√  
√

[5, 0, 10, 12, 6], [3, 0, 5, 68, -2]

# 数据解码

[1010, 0, 10100, 11000, 1100],

[110, 0, 1010, 10001000, 101]

最高N-1位为数据位

最低位为符号位

∇  
∇

[5, 0, 10, 12, 6], [3, 0, 5, 68, -2]

∇  
∇

[5, 0, 10, 12, 6], [8, 0, 15, 80, 4]

# 含义

```
// 已确定行号  
[  
    5,    // 列号  
    0,    // 源文件，从sources查找  
    10,   // 源文件内行号  
    12,   // 源文件内列号  
    6     // 源文件内标示符，从names查找  
]
```

# 无需手动分析

- Google Closure Compiler可以生成V2版Source Map格式，未编码的明文数据
- 使用Mozilla的SourceMap项目读取或生成Source Map文件

# 堆栈定位

# 传统JS错误堆栈

```
128:  var baz = function () {  
129:      throw new Error("Hello World");  
130:  };  
131:  
132:  var bar = function () {  
133:      baz();  
134:  };  
135:  
136:  var foo = function () {  
137:      bar();  
138:  };  
139:  
140:  foo();
```

# 传统JS错误堆栈

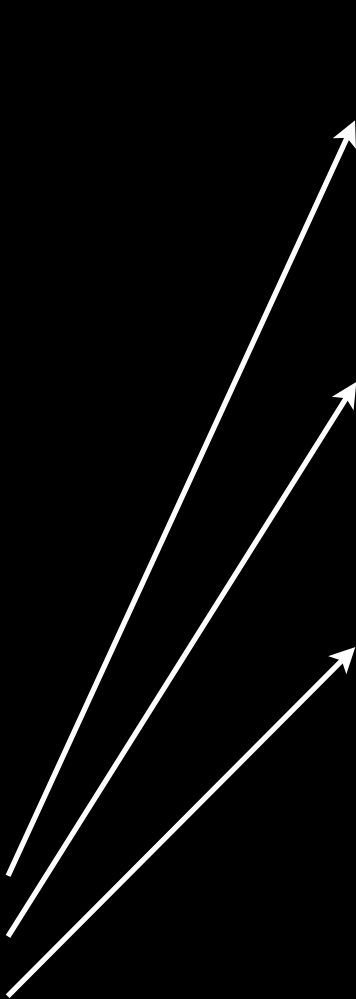
```
Error: Hello World
  at baz (.../test.js:129:11)
  at bar (.../test.js:133:5)
  at foo (.../test.js:137:5)
  at Object.<anonymous> (.../test.js:140:1)
  at Module._compile (module.js:449:26)
  at Object.Module._extensions..js (module.js:467:10)
  ...
```

```
128: var baz = function () {
129:     throw new Error("Hello World");
130: };
131:
132: var bar = function () {
133:     baz();
134: };
135:
136: var foo = function () {
137:     bar();
138: };
139:
140: foo();
```



# 传统JS错误堆栈

```
Error: Hello World
  at baz (.../test.js:129:11)
  at bar (.../test.js:133:5)
  at foo (.../test.js:137:5)
  at Object.<anonymous> (.../test.js:140:1)
  at Module._compile (module.js:449:26)
  at Object.Module._extensions..js (module.js:467:10)
  ...
```



The diagram illustrates the call stack for the error. Three arrows originate from the stack frames and point to the corresponding lines in the source code on the right:

- The first arrow points from `at baz (.../test.js:129:11)` to line 129: `throw new Error("Hello World");`
- The second arrow points from `at bar (.../test.js:133:5)` to line 133: `baz();`
- The third arrow points from `at foo (.../test.js:137:5)` to line 137: `bar();`

```
128: var baz = function () {
129:     throw new Error("Hello World");
130: };
131:
132: var bar = function () {
133:     baz();
134: };
135:
136: var foo = function () {
137:     bar();
138: };
139:
140: foo();
```

# Wind.js错误堆栈

```
128: var test = eval(..., function () {  
129:     var a = null;  
130:     a.b();  
131: }));  
132:  
133: test().on("failure", function () {  
134:     console.log(this.error.stack);  
135: }).start();
```

# Wind.js错误堆栈

```
128: var test = eval(..., function () {  
129:     var a = null;  
130:     a.b();  
131: }));  
132:  
133: test().on("failure", function () {  
134:     console.log(this.error.stack);  
135: }).start();
```

```
TypeError: Cannot call method 'b' of null  
    at eval (wind/anonymous_0.js:6:37)  
    at Object.BuilderBase.Delay.next (.../wind-async.js:143:46)  
    at Object.AsyncBuilder.Start [as _delegate] (.../wind-async:652:22)  
    at Object.Task.start (.../wind-async.js:196:22)  
    at Object.<anonymous> (.../test.js:135:4)  
    ...
```

# Wind.js错误堆栈

```
128: var test = eval(..., function () {  
129:     var a = null;  
130:     a.b();  
131: }));  
132:  
133: test().on("failure", function () {  
134:     console.log(this.error.stack);  
135: }).start();
```

```
TypeError: Cannot call method 'b' of null  
  at eval (wind/anonymous_0.js:6:37) ???  
  at Object.BuilderBase.Delay.next (.../wind-async.js:143:46)  
  at Object.AsyncBuilder.Start [as _delegate] (.../wind-async:652:22)  
  at Object.Task.start (.../wind-async.js:196:22)  
  at Object.<anonymous> (.../test.js:135:4)  
  ...
```

# 指向目标堆栈

```
01:  /* function () { */    (function () {
02:                                var _builder_$0 = Wind.builders["async"];
03:                                return _builder_$0.Start(this,
04:                                _builder_$0.Delay(function () {
05:  /*      var a = null; */      var a = null;
06:  /*      a.b(); */             a.b();
07:                                return _builder_$0.Normal();
08:                                })
09:                                );
10:  /* } */                      })
11:  //@ sourceMappingURL=wind/anonymous_2.js
```

```
TypeError: Cannot call method 'b' of null
    at eval (wind/anonymous_0.js:6:37)
    at Object.BuilderBase.Delay.next (.../wind-async.js:143:46)
    at Object.AsyncBuilder.Start [as _delegate] (.../wind-async:652:22)
    ...
```

# 指向目标堆栈

```
01:  /* function () { */    (function () {
02:                                var _builder_$0 = Wind.builders["async"];
03:                                return _builder_$0.Start(this,
04:                                _builder_$0.Delay(function () {
05:  /*      var a = null; */      var a = null;
06:  /*      a.b(); */             a.b();
07:                                return _builder_$0.Normal();
08:                                })
09:                                );
10:  /* } */                      })
11:  //@ sourceMappingURL=wind/anonymous_2.js
```

TypeError: Cannot call method 'b' of null  
at eval (wind/anonymous\_0.js:6:37)  
at Object.BuilderBase.Delay.next (.../wind-async.js:143:46)  
at Object.AsyncBuilder.Start [as \_delegate] (.../wind-async:652:22)  
...

有办法修复吗？

# 有办法修复吗？

当然有，编译器掌握了所有  
输入和输出的对应关系。



# 总结

- 调试eval出的代码不是问题
- 混淆后的代码可以利用Source Map直接定位到原始代码
- Wind.js编译器充分了解目标代码与原始代码的位置关系，可用于堆栈定位

Q & A

谢谢