

O'REILLY®

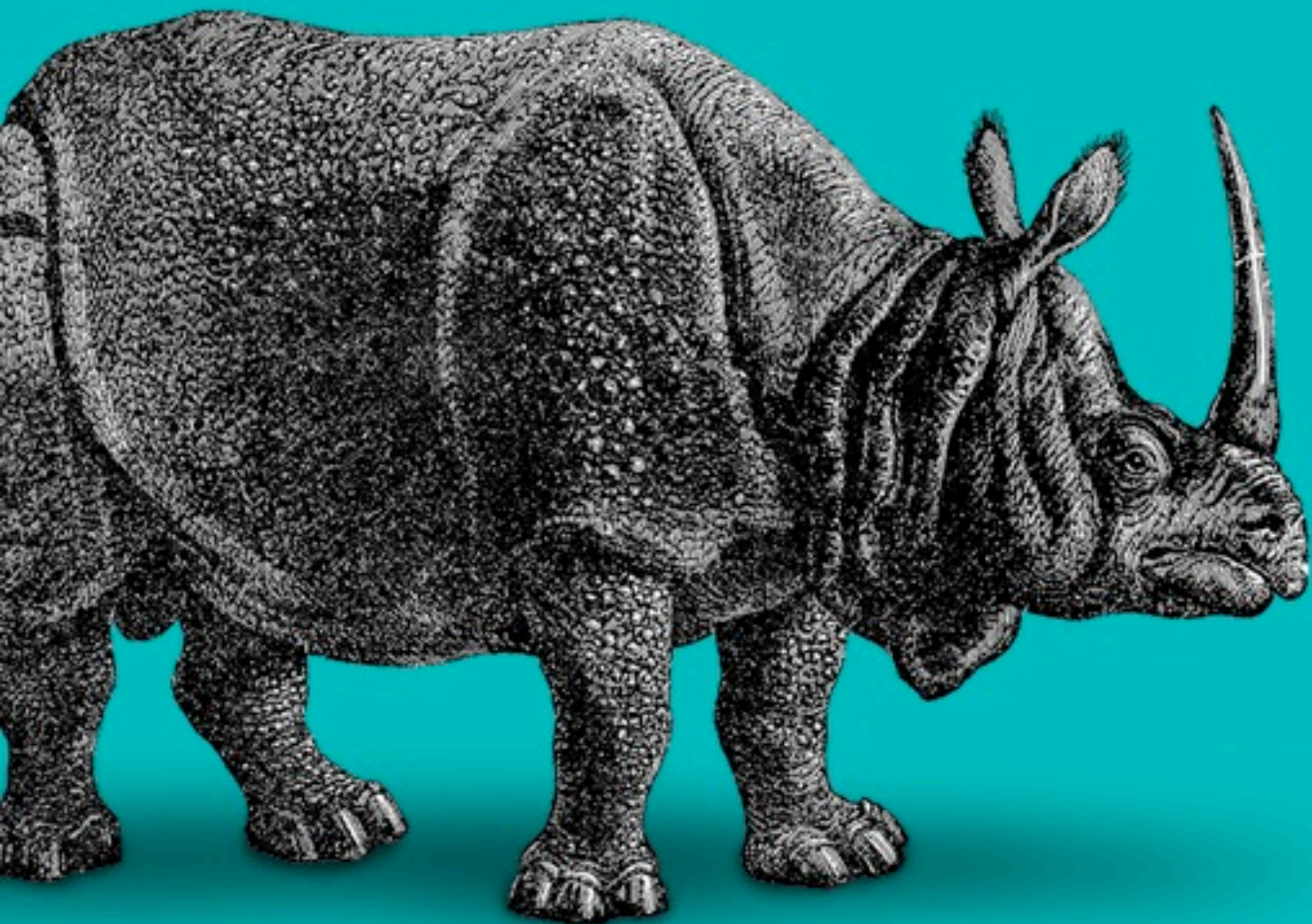
fluent

conference

JavaScript & Beyond

San Francisco, CA | May 28–30, 2013

#fluentconf



Improving JavaScript Code Quality: Strategies and Tools

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@ariyahidayat

whoami



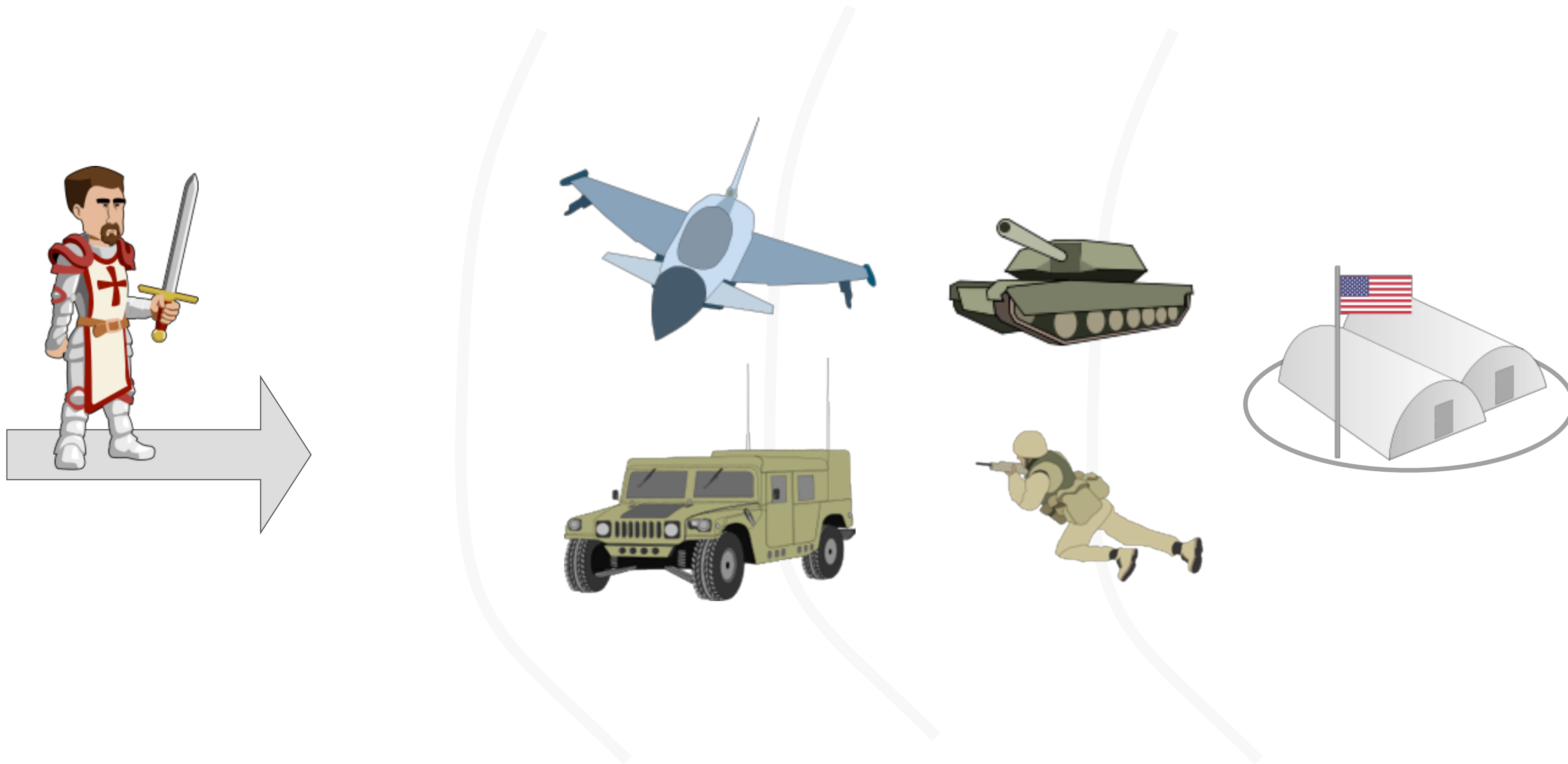
Sencha



Multi-Layer Defense

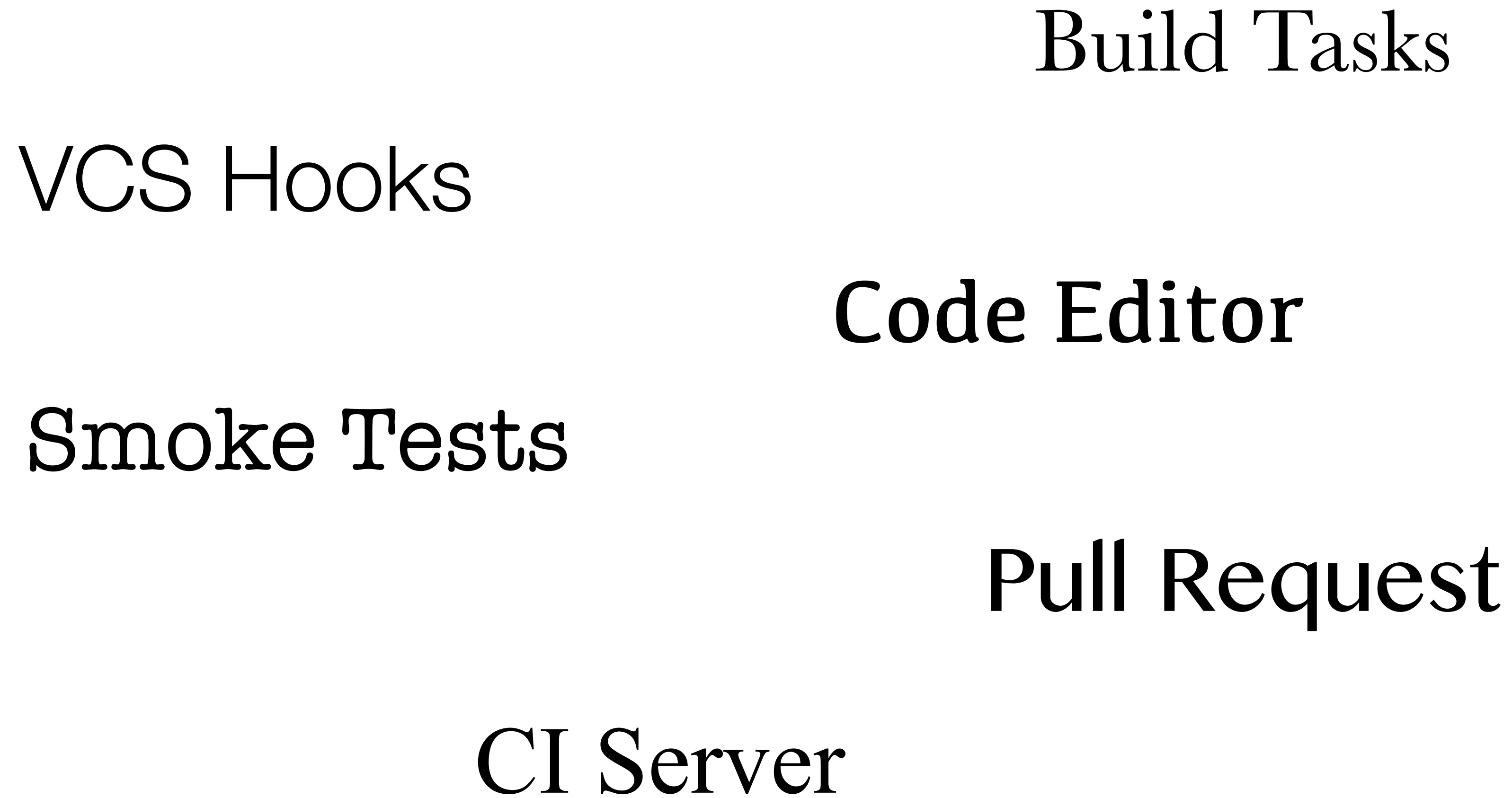


Defensive = Paranoid

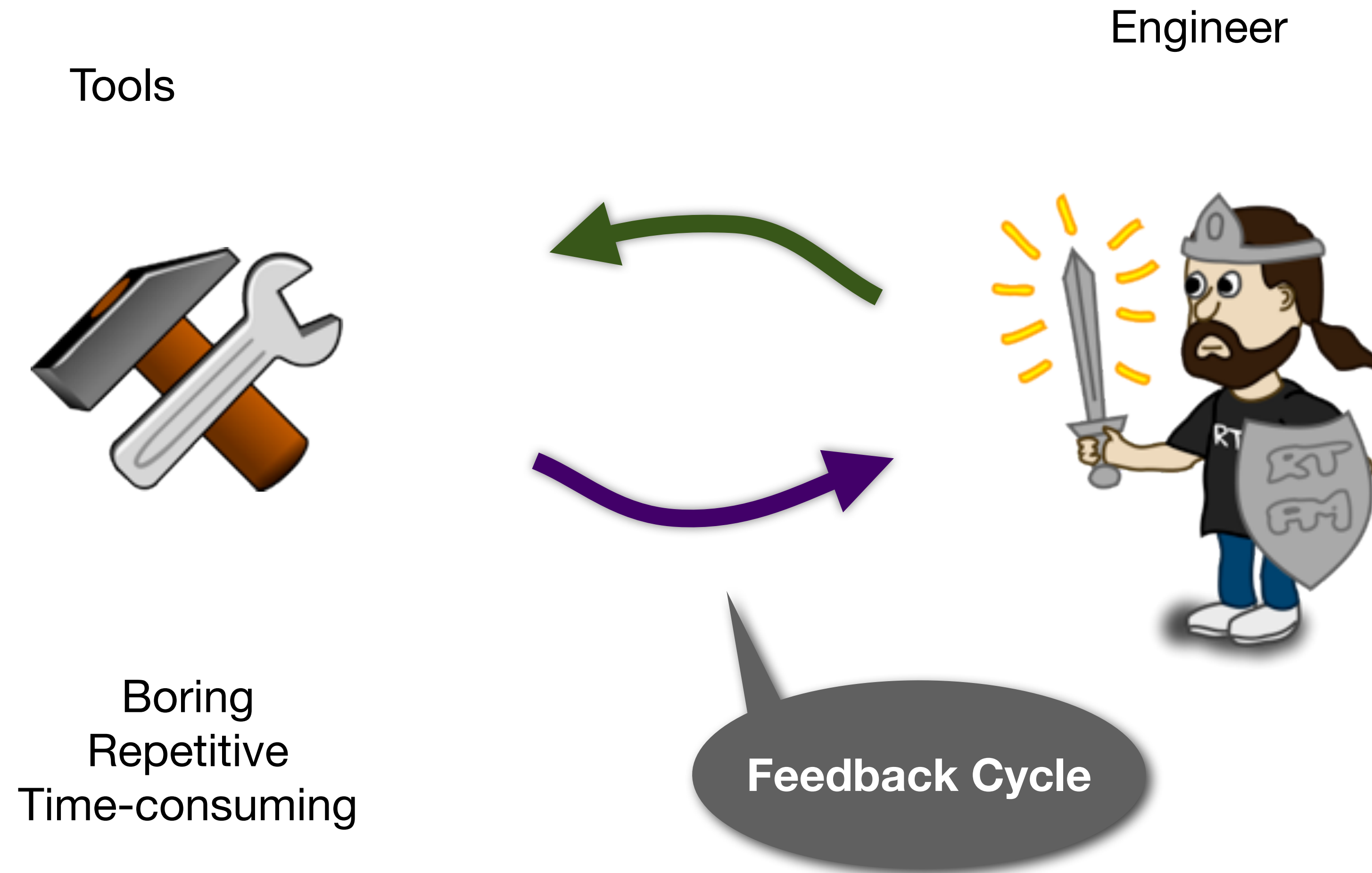


<http://ariya.ofilabs.com/2012/12/quality-code-via-multiple-layers-of-defense.html>

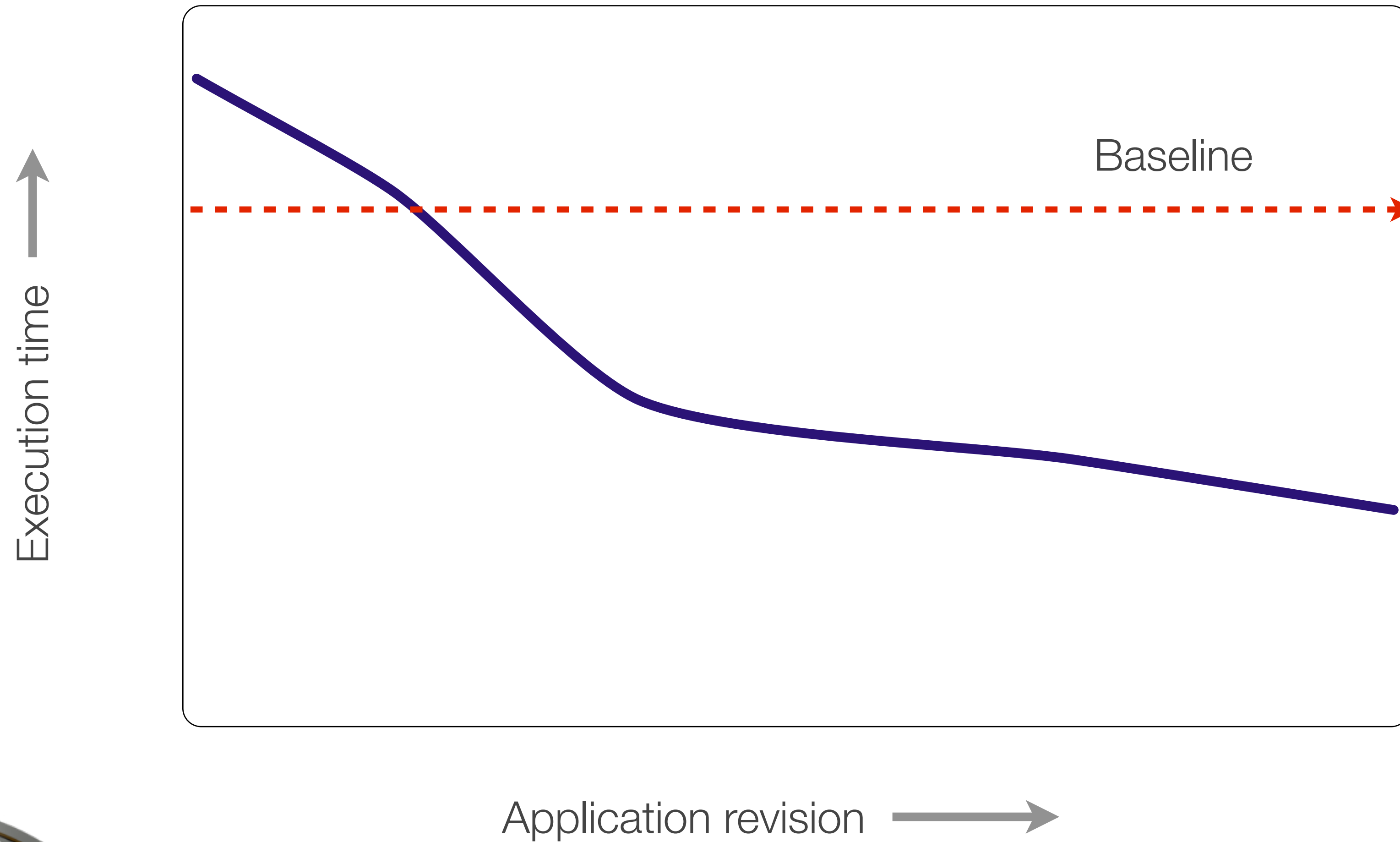
Placement of Layers



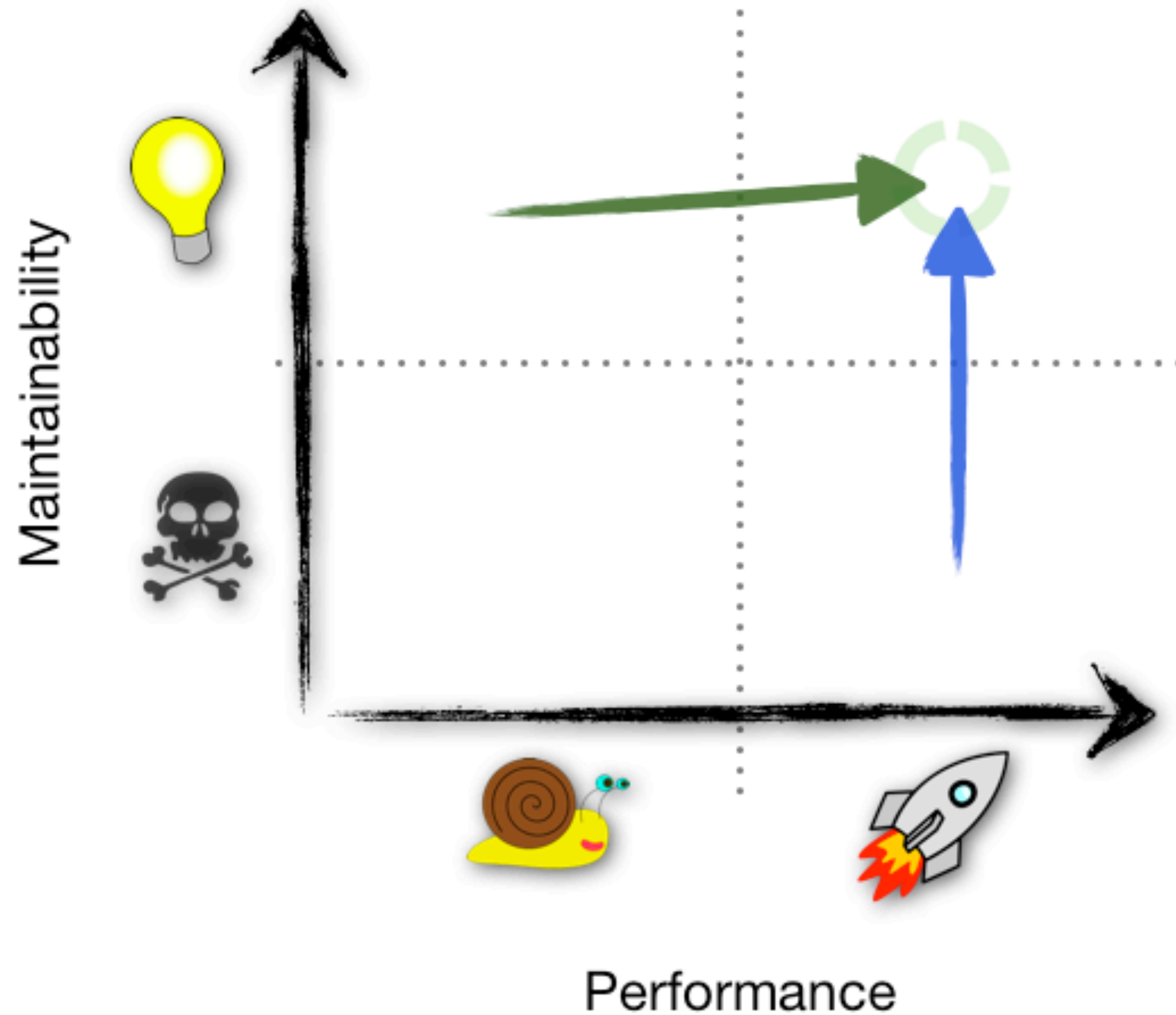
Feedback is Important



Track Quality Metrics

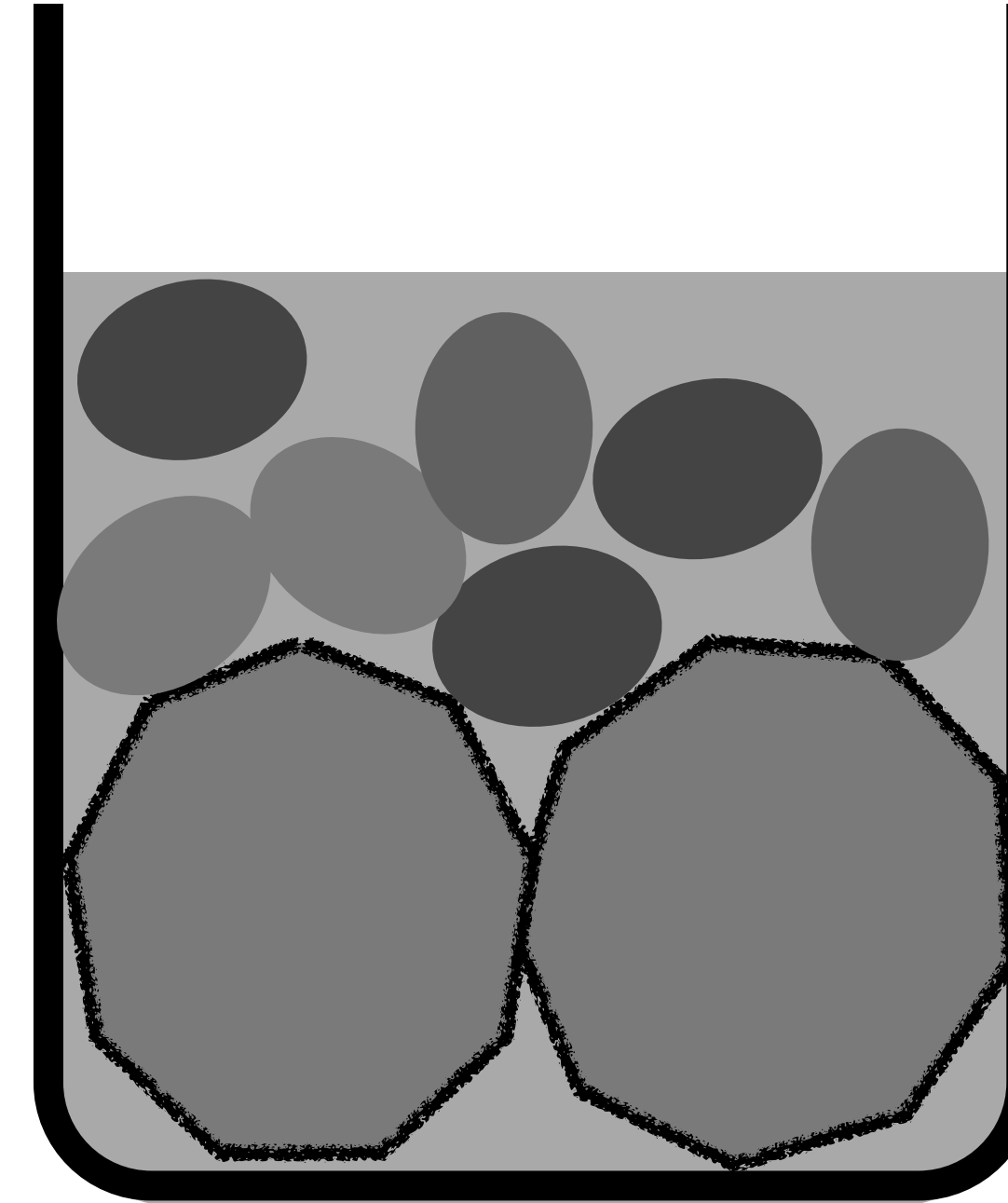
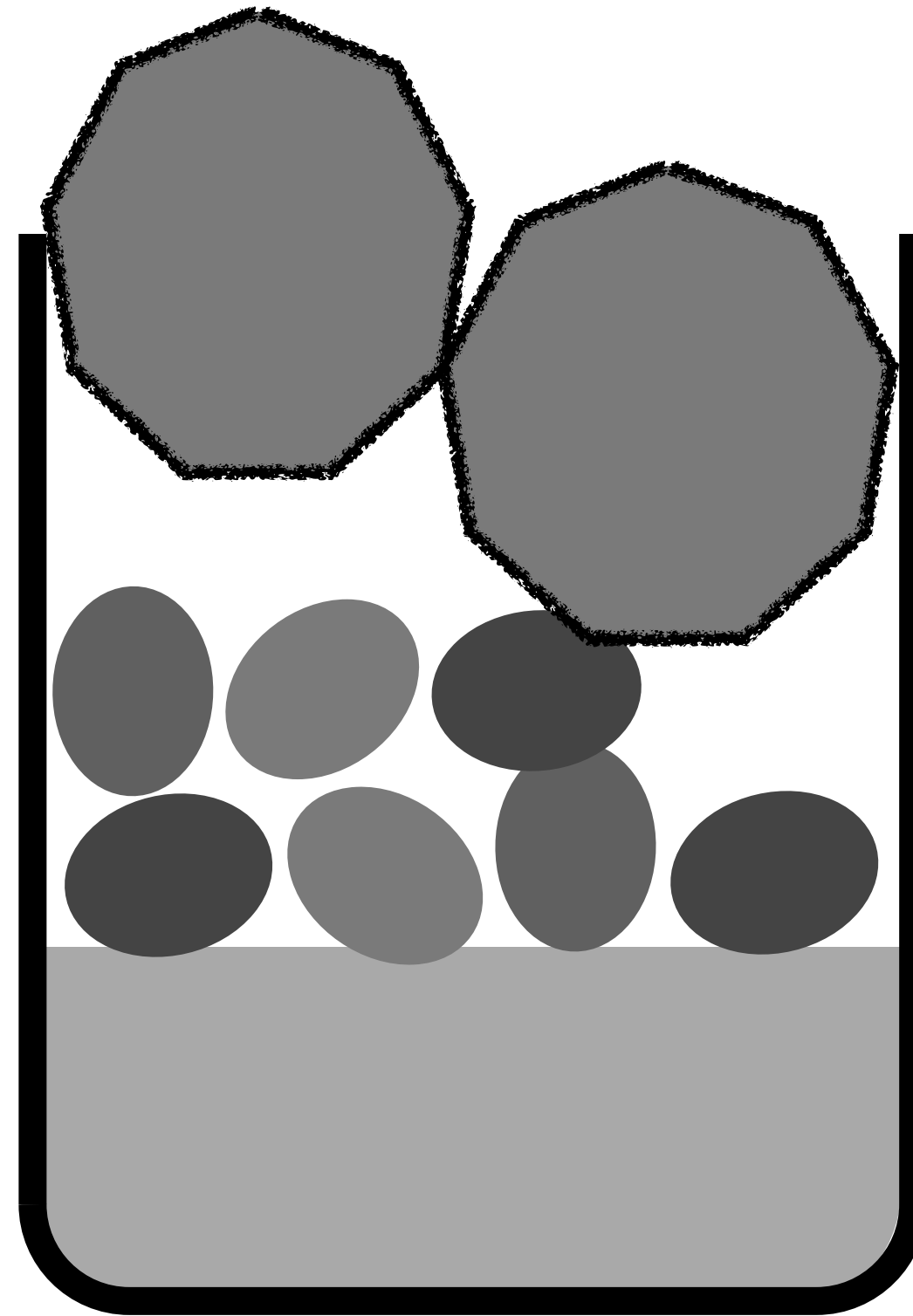


Metrics Quadrant



<http://ariya.ofilabs.com/2012/11/optimization-journey-vs-destination.html>

Be Reasonable

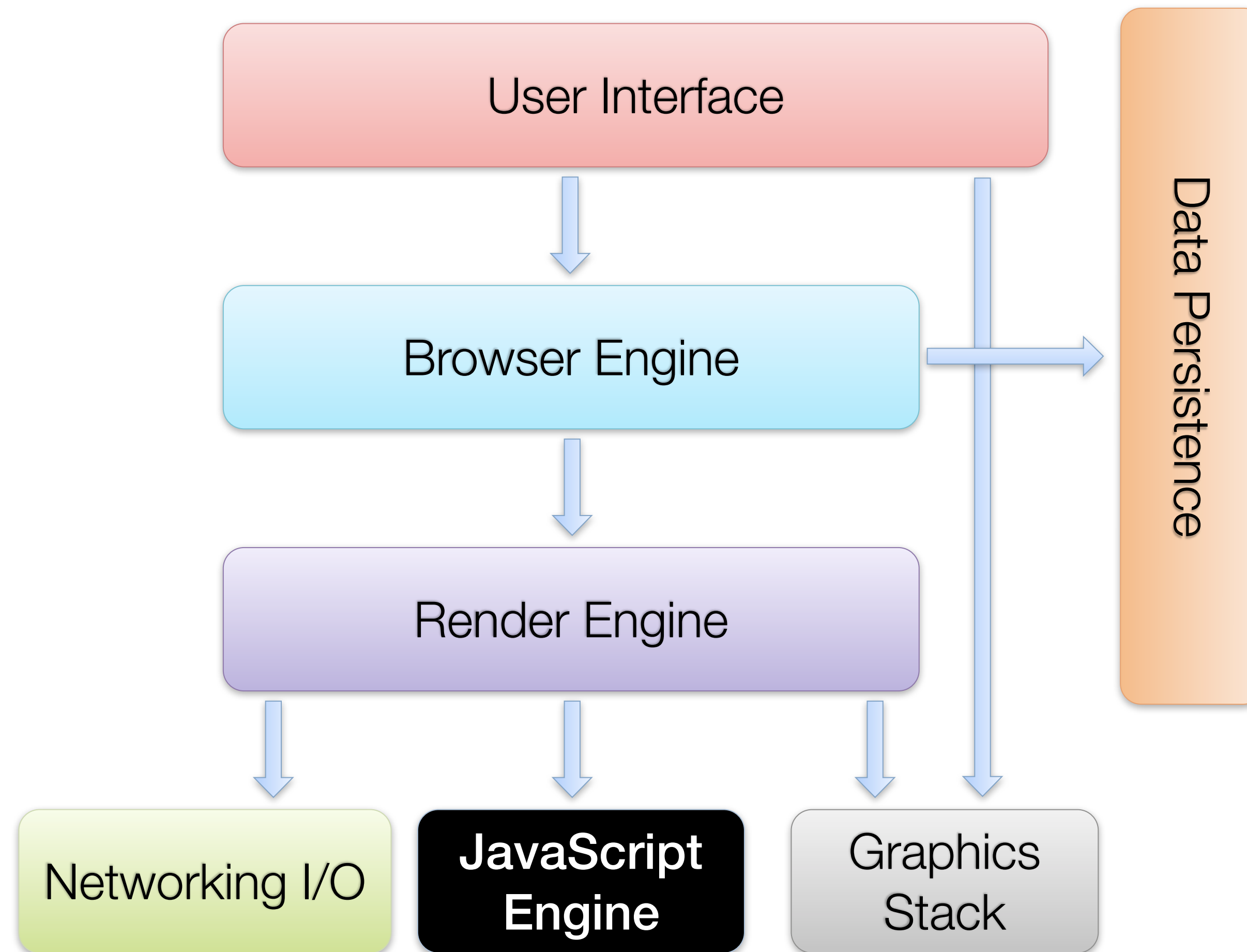


“The Big Rock”

Foundation



JavaScript in the Browser



JavaScript Engines

SpiderMonkey

Firefox



JavaScriptCore/Nitro

Safari



V8

Node.js, Chrome



JScript/Chakra

Internet Explorer

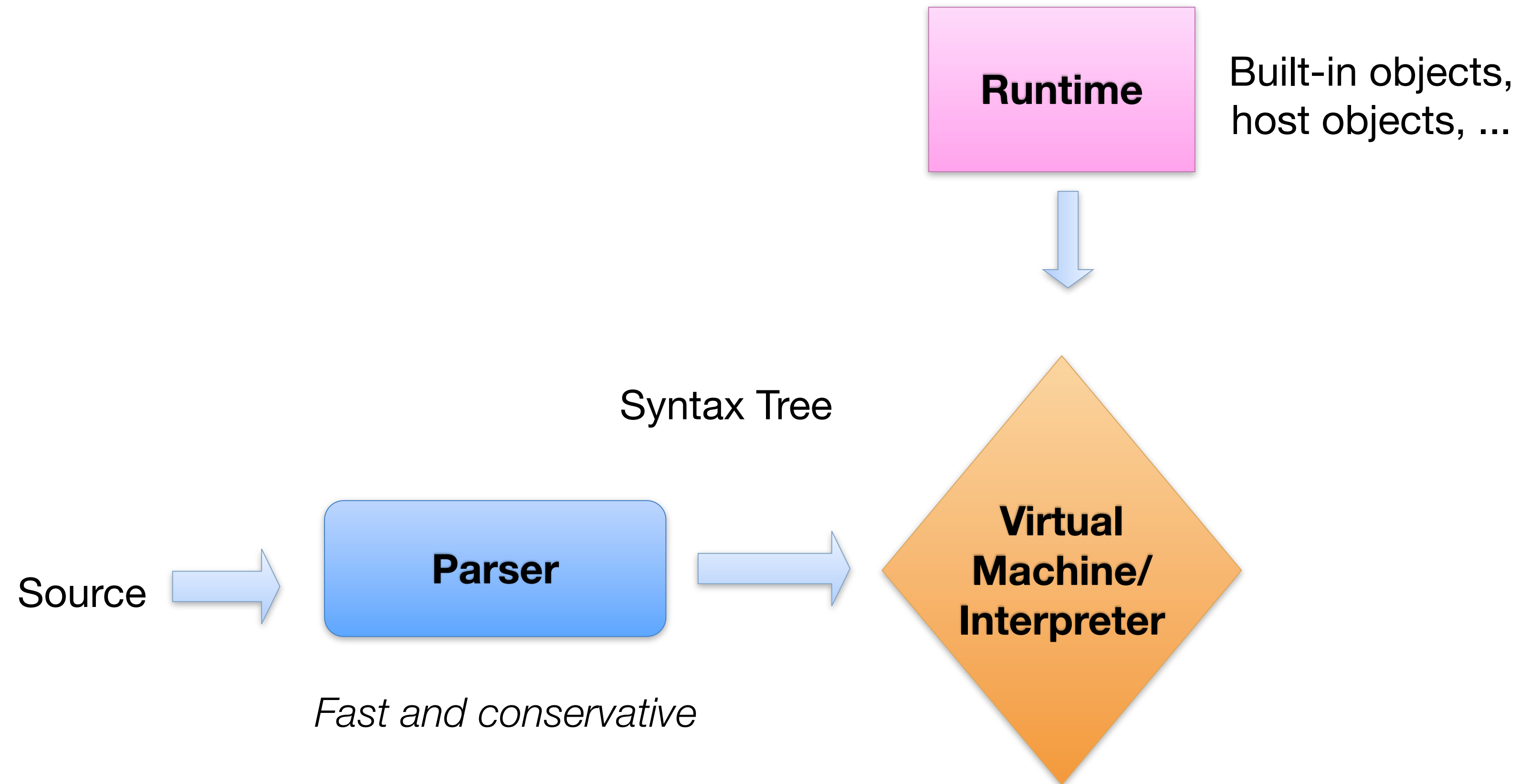


Carakan

Opera

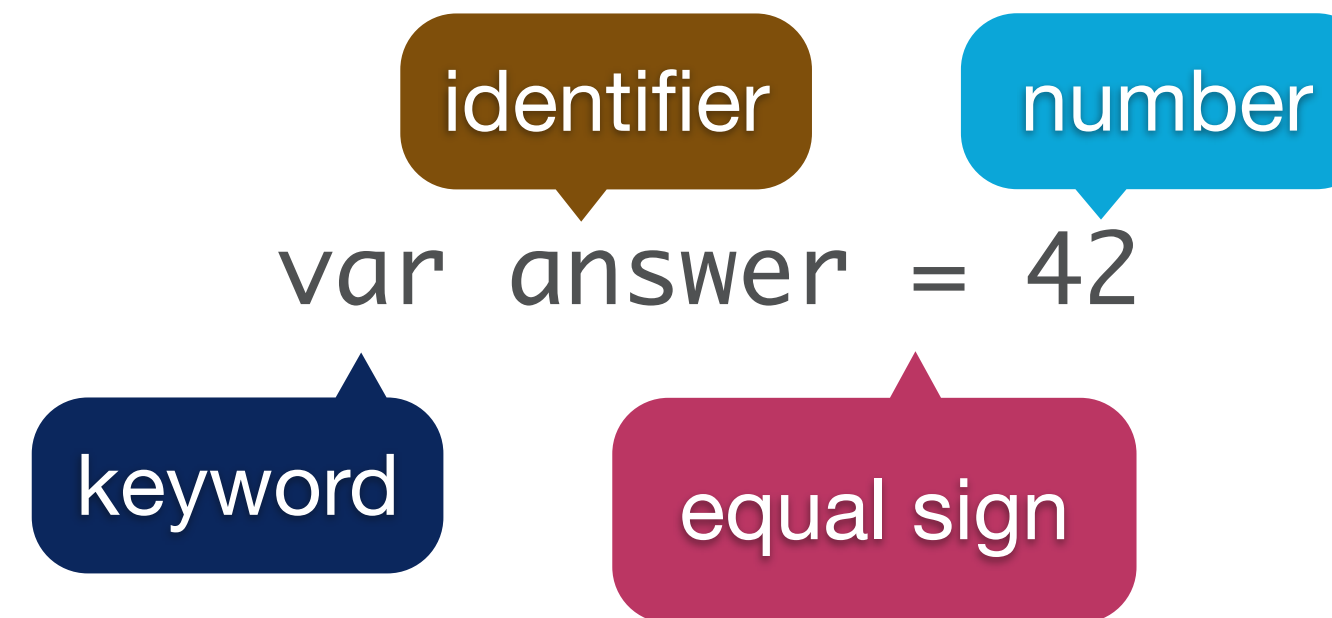


Engine Building Blocks

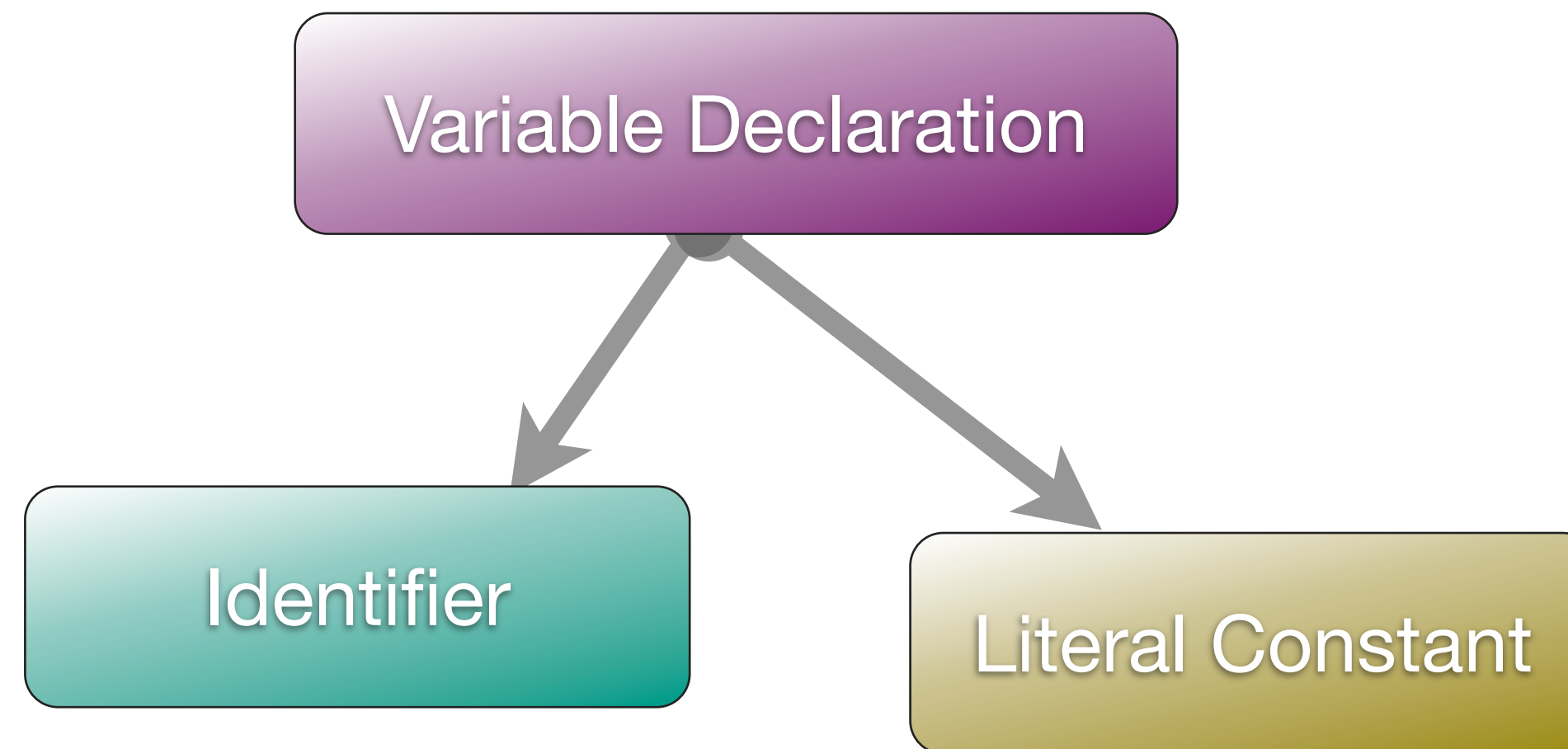


Parser

Tokenization →
Tokens



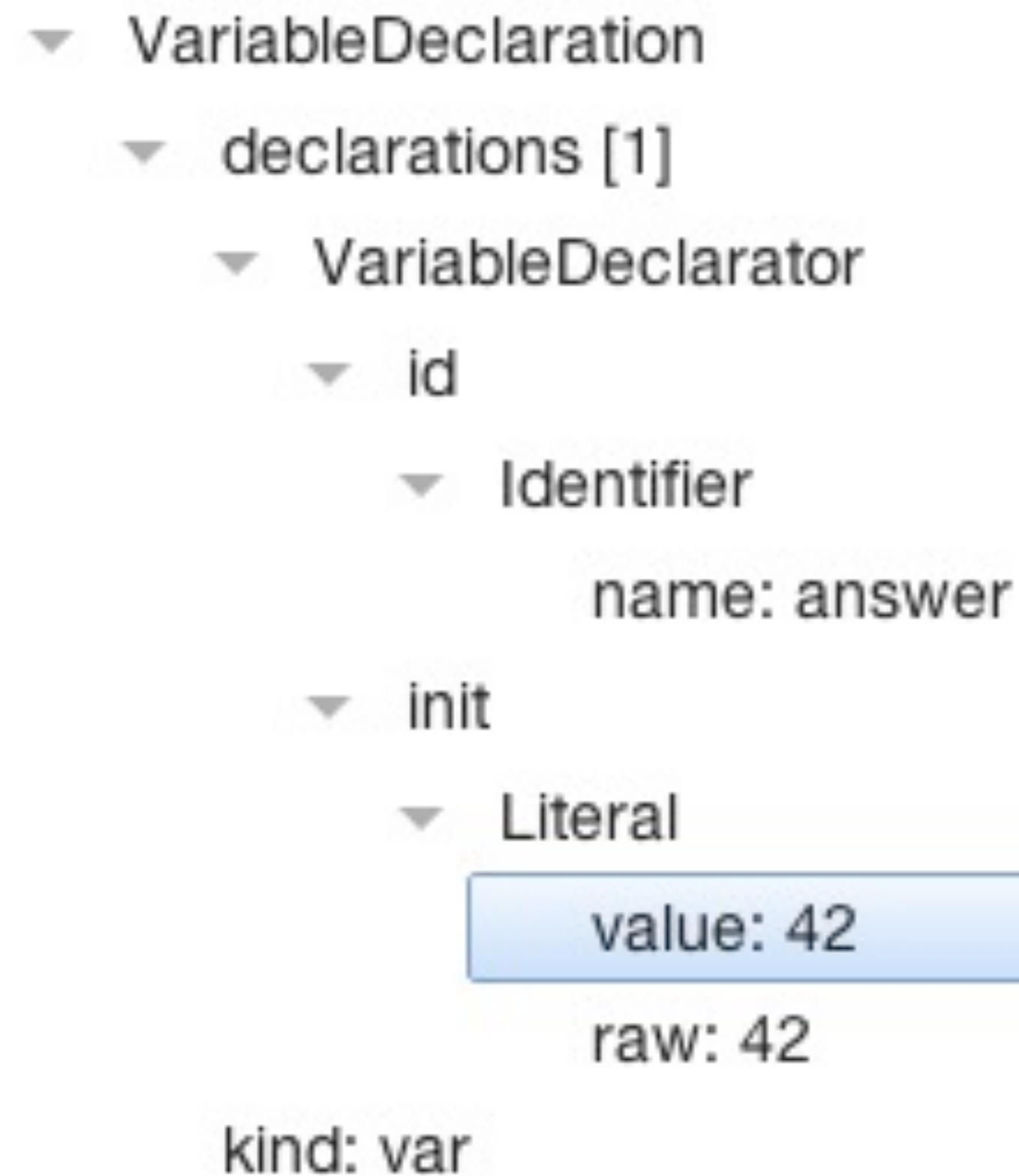
Parsing → Syntax Tree



Syntax Visualization

<http://esprima.org/demo/parse.html>

Try online!



Execution Visualization

Load Example: Y Combinator

```
var sum = 0;
for (var i = 0; i < 10; ++i) {
  sum += i;
}
```

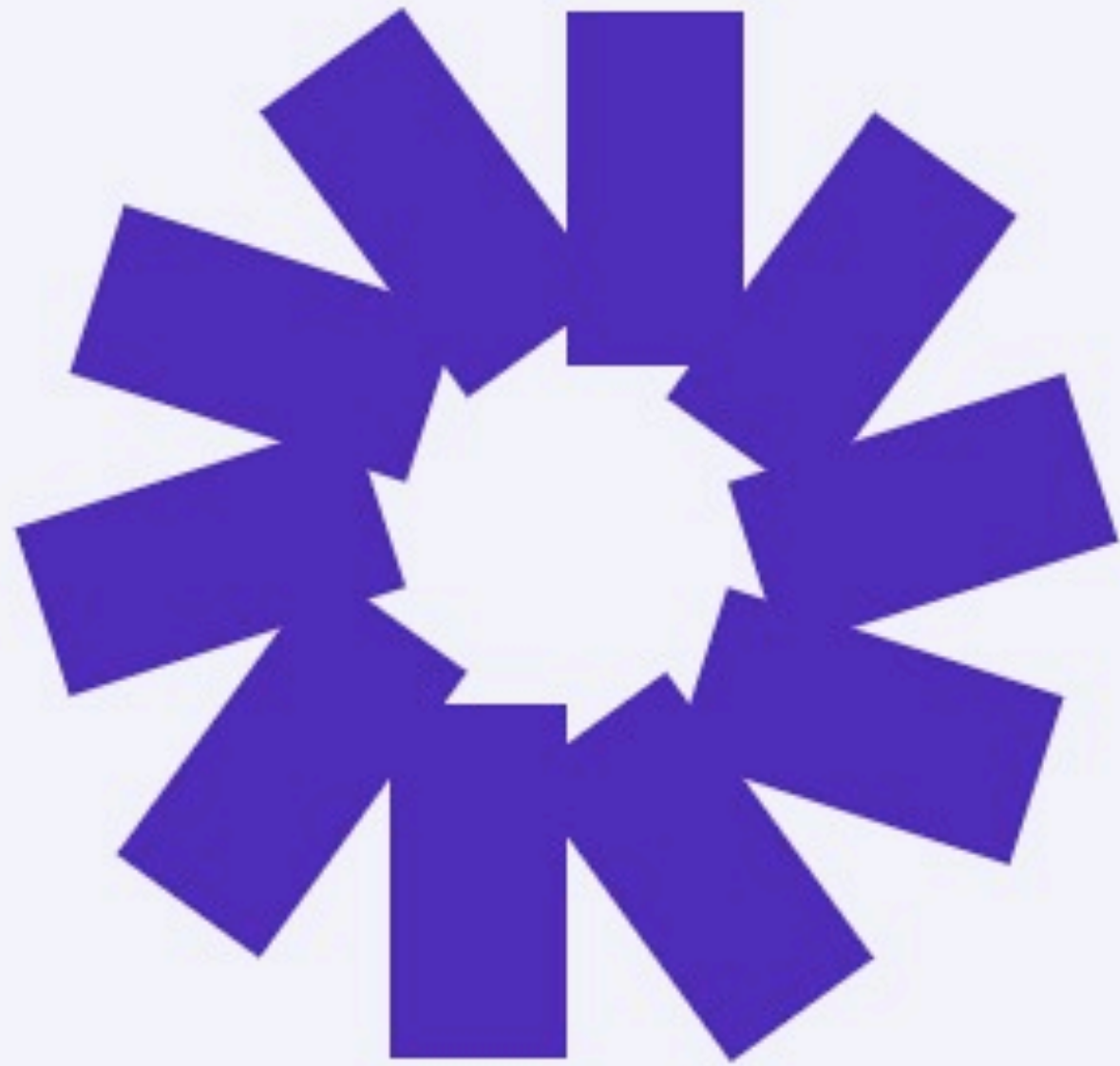
Environment

sum → 36
i → 9

Expression Stack

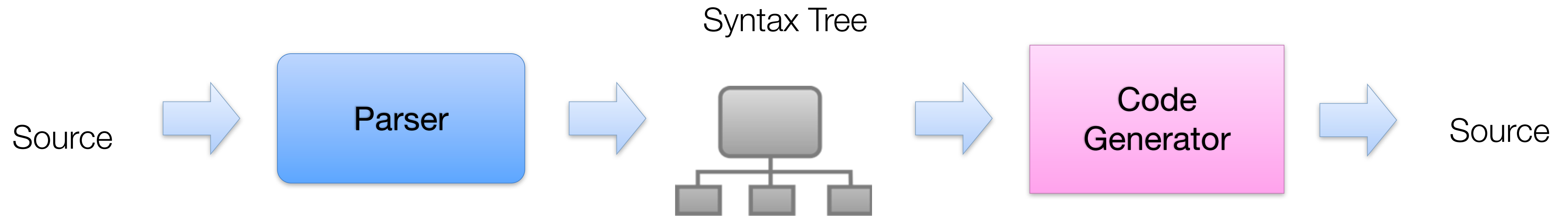
Program
ForStatement
BinaryExpression
Identifier 'i' → [object
Object]

Live Coding/Editing



```
function draw() {  
  canvas.width = canvas.height = 400  
  ctx = canvas.getContext('2d')  
  ctx.fillStyle = 'rgba('+240+', '+240+', '+250+', '+1+')'  
  ctx.fillRect(0, 0, canvas.width, canvas.height)  
  
  ctx.fillStyle = 'rgba('+62+', '+20+', '+170+', '+1+')'  
  
  ctx.translate(canvas.width/2, canvas.height/2)  
  var N = 10  
  for (var i = 0; i < N; i++) {  
    ctx.save()  
    ctx.rotate(i/N*Math.PI*2)  
    ctx.translate(0, 43)  
    ctx.rotate(90 * Math.PI/180)  
    ctx.fillRect(0, 0, 90, 45)  
    ctx.restore()  
  }  
}
```

Composition: Chains of Responsibilities



Obvious examples: minifier, obfuscator, ...

Quasi-Endless Possibilities



Inspection



Transformation



Static analysis

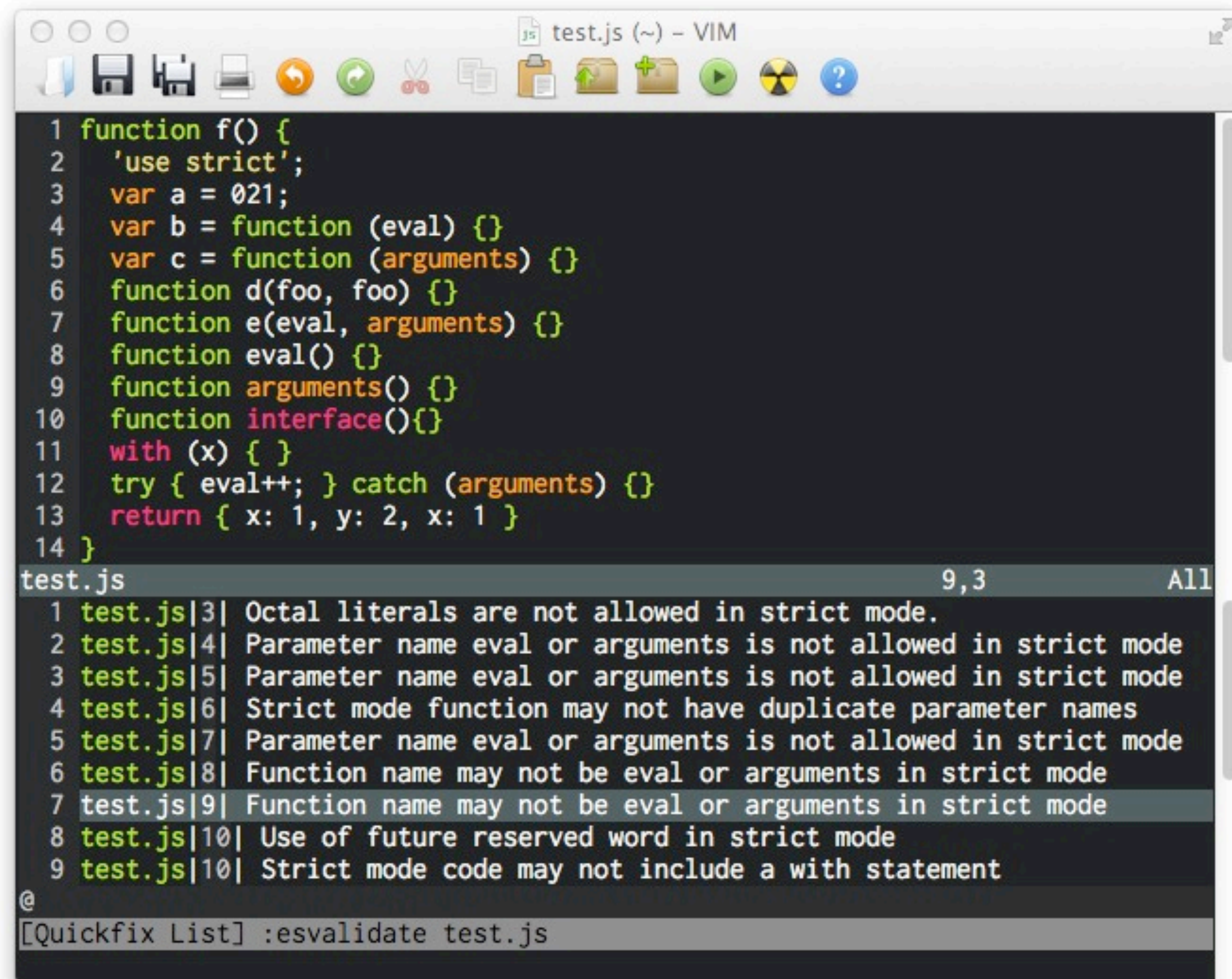


Dynamic analysis

Standard, Off-the-Shelf Tools



Syntax Validation



```
1 function f() {
2   'use strict';
3   var a = 021;
4   var b = function (eval) {}
5   var c = function (arguments) {}
6   function d(foo, foo) {}
7   function e(eval, arguments) {}
8   function eval() {}
9   function arguments() {}
10  function interface(){}
11  with (x) { }
12  try { eval++; } catch (arguments) {}
13  return { x: 1, y: 2, x: 1 }
14 }
```

test.js 9,3 All

- 1 test.js|3| Octal literals are not allowed in strict mode.
- 2 test.js|4| Parameter name eval or arguments is not allowed in strict mode
- 3 test.js|5| Parameter name eval or arguments is not allowed in strict mode
- 4 test.js|6| Strict mode function may not have duplicate parameter names
- 5 test.js|7| Parameter name eval or arguments is not allowed in strict mode
- 6 test.js|8| Function name may not be eval or arguments in strict mode
- 7 test.js|9| Function name may not be eval or arguments in strict mode
- 8 test.js|10| Use of future reserved word in strict mode
- 9 test.js|10| Strict mode code may not include a with statement

@

[Quickfix List] :esvalidate test.js

Try online!

<http://esprima.org/demo/validate.html>

Also available:
Grunt plugin, Ant task, ...

<http://ariya.ofilabs.com/2012/10/javascript-validator-with-esprima.html>

Strict Mode Validator

```
'use strict';  
block = {  
  color: 'blue',  
  height: 20,  
  width: 10,  
  color: 'red'  
};
```

Duplicate data property in object literal not allowed in strict mode

Linters vs Validators



Linters

- Searches for suspicious patterns
- Warns on style inconsistencies
- Works well on hand-written code

Validators

- Looks for specification violations
- Does not care about coding style
- Works well on generated/minified code

Polluting Variables

```
var height;  
// some fancy processing  
height = 200;
```

Leaks to
global

<https://github.com/kesla/node-leaky>

```
test.js:3  
height = 200;  
^  
LeakError: global leak  
detected: height
```


Unused Variables

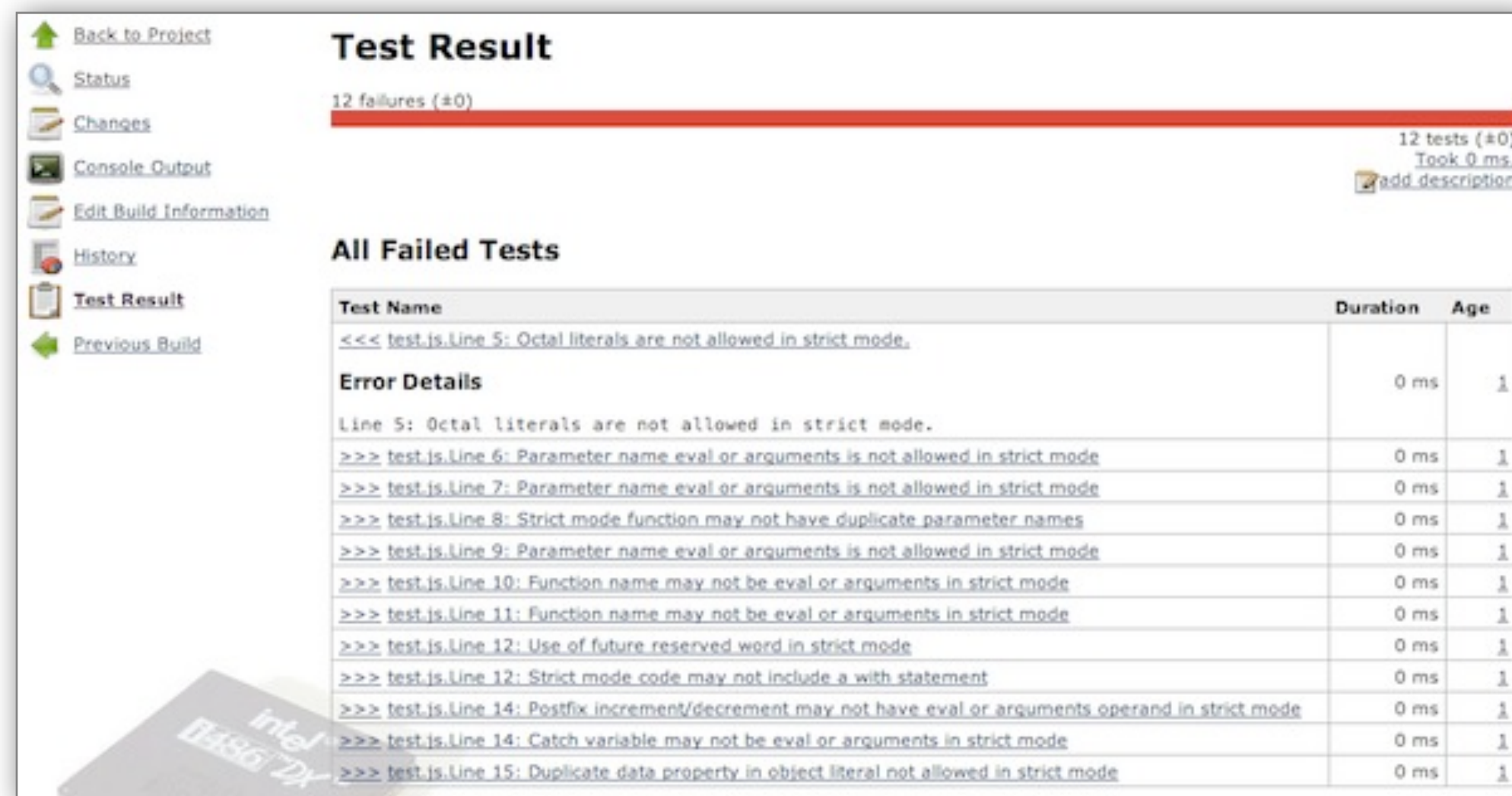
Declared
but not used

```
var height;  
// some fancy processing  
height = 200;
```

<https://github.com/Kami/node-unused>

```
test.js  
    height - on line 1
```

Protection Layers, Again

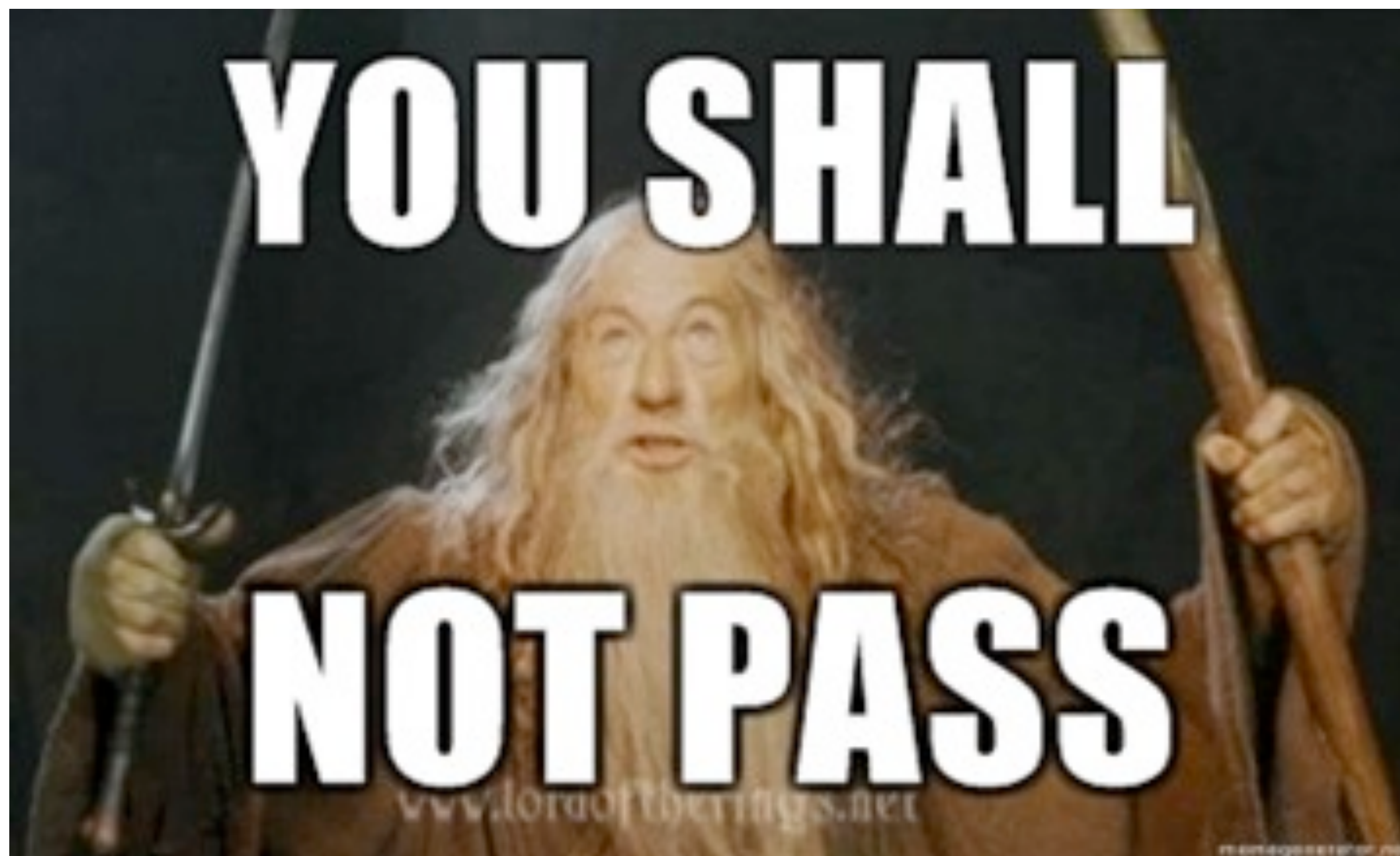


JUnit XML + Jenkins

```
files=$(git diff-index --name-only HEAD
| grep -P '\.js$')
for file in $files; do
    esvalidate $file
    if [ $? -eq 1 ]; then
        echo "Syntax error: $file"
        exit 1
    fi
done
```

Git Precommit Hook

<http://ariya.ofilabs.com/2012/03/git-pre-commit-hook-and-smoke-testing.html>



Code Complexity

<http://jscomplexity.org/>

```
if (true) "foo"; else "bar";
```

- Maintainability index: 139.99732896539635
- Physical LOC: 1
- Logical LOC: 4
- Aggregate cyclomatic complexity: 2

Continuous Monitoring of Complexity

```
var cr = require('complexity-report'),
    content = require('fs').readFileSync('index.js', 'utf-8'),
    list = [];

cr.run(content).functions.forEach(function (entry) {
  list.push({ name: entry.name, value: entry.complexity.cyclomatic });
});

list.sort(function (x, y) {
  return y.value - x.value;
});

console.log('Most cyclomatic-complex functions:');
list.slice(0, 6).forEach(function (entry) {
  console.log(' ', entry.name, entry.value);
});
```

```
198 > esprima@1.1.0-dev analyze-complexity /home/travis/build/ariya/
199 > node tools/list-complexity.js
200
201 Most cyclomatic-complex functions:
202     scanComment 21
203     skipComment 19
204     scanRegExp 17
205     parsePrimaryExpression 14
206     scanNumericLiteral 14
207     parse 14
208
209 > esprima@1.1.0-dev check-complexity /home/travis/build/ariya/e
210 > node node_modules/complexity-report/src/cli.js --maxcc 21 --s
    esprima.js
211
212
```


Complexity Visualization with Plato

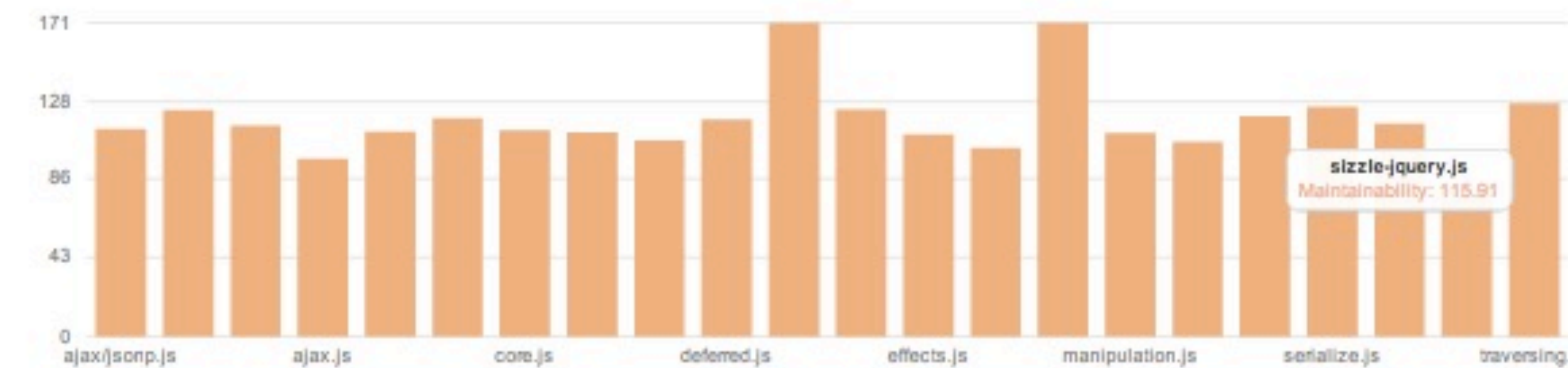
<https://github.com/jsoverson/plato>

Summary

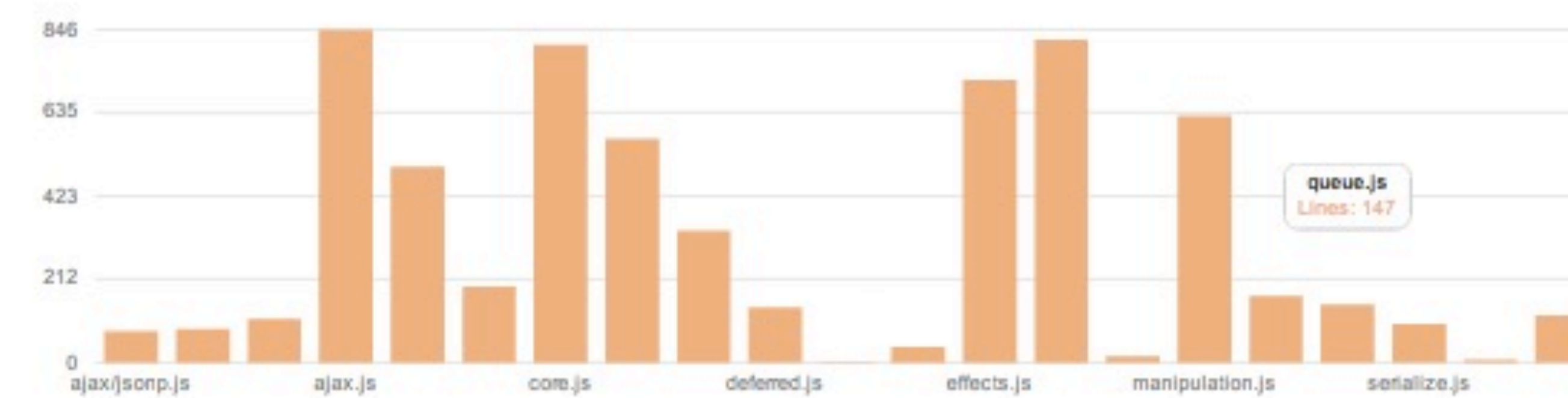
Total SLOC
6715

Average Maintainability
117.78

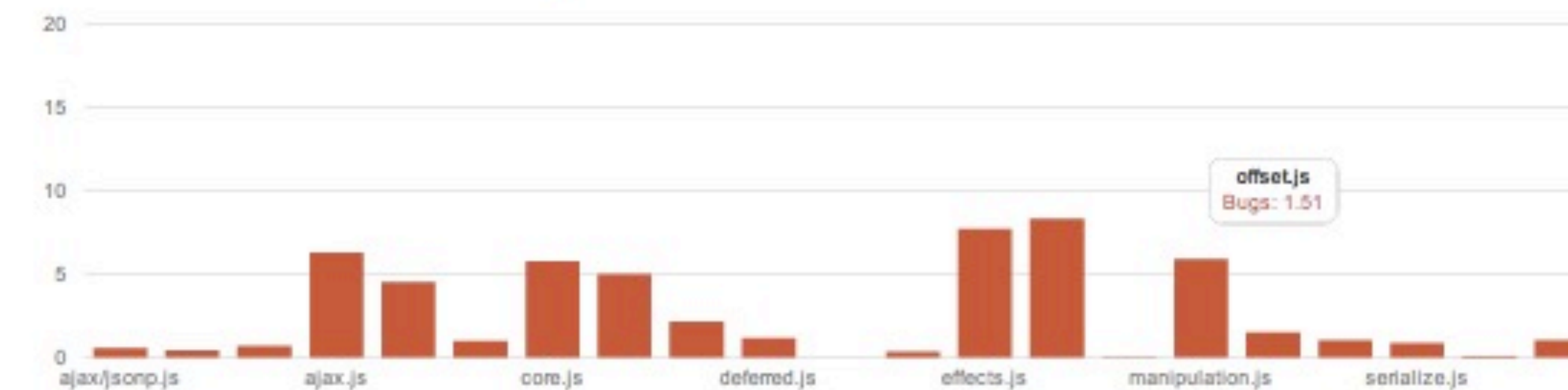
Maintainability



Lines of code



Estimated number of bugs



<https://ariya.ofilabs.com/2013/01/javascript-code-complexity-visualization.html>

Editing Autocomplete

<http://esprima.org/demo/autocomplete.html>

Try online!

```
1  var capitalDb = {  
2      Indonesia: 'Jakarta',  
3      Germany: 'Berlin',  
4      Norway: 'Oslo'  
5  };  
6  
7  // Property completion: "capitalDb." and press Ctrl+Space.  
8  capitalDb.  
9
```

Germany : String
Indonesia : String
Norway : String

hasOwnProperty(property) : Boolean
isPrototypeOf(object) : Boolean
propertyIsEnumerable(property) : Boolean
toLocaleString() : String
toString() : String

<http://ariya.ofilabs.com/2013/03/javascript-editing-with-autocomplete.html>

Scope and Highlight

<http://esprima.org/demo/highlight.html>

Try online!

```
1 // Array shuffling code from Underscore.js.
2
3 _.shuffle = function(obj) {
4   var shuffled = [], rand;
5   each(obj, function(value, index, list) {
6     rand = Math.floor(Math.random() * (index + 1));
7     shuffled[index] = shuffled[rand];
8     shuffled[rand] = value;
9   });
10  return shuffled;
11};
```

Scope Visualization

<http://mazurov.github.io/eslevels-demo/>

```
1 function MONAD(modifier) {  
2   'use strict';  
3  
4   var prototype = Object.create(null);  
5   prototype.is_monad = true;  
6  
7   function unit(value) {  
8     var monad = Object.create(prototype);  
9     monad.bind = function (func, args) {  
10       return func.apply(  
11         undefined,  
12         [value].concat(Array.prototype.slice.apply(args || []))  
13       );  
14     };  
15     if (typeof modifier === 'function') {  
16       value = modifier(monad, value);  
17     }  
18     return monad;  
19   }  
20   unit.method = function (name, func) {  
21     prototype[name] = func;  
22     return unit;  
23   };  
24   unit.lift_value = function (name, func) {  
25     prototype[name] = function () {  
26       return this.bind(func, arguments);  
27     };  
28     return unit;  
29   };  
30   unit.lift = function (name, func) {  
31     prototype[name] = function () {  
32       var result = this.bind(func, arguments);  
33       return result && result.is_monad === true ? result : unit(result);  
34     };  
35     return unit;  
36   };  
37   return unit;  
38 }  
39  
40 MONAD(modifier);  
41
```

Levels: implicit global 1 2 3 4 5 6 7 8 9

Rename Refactoring Assistant

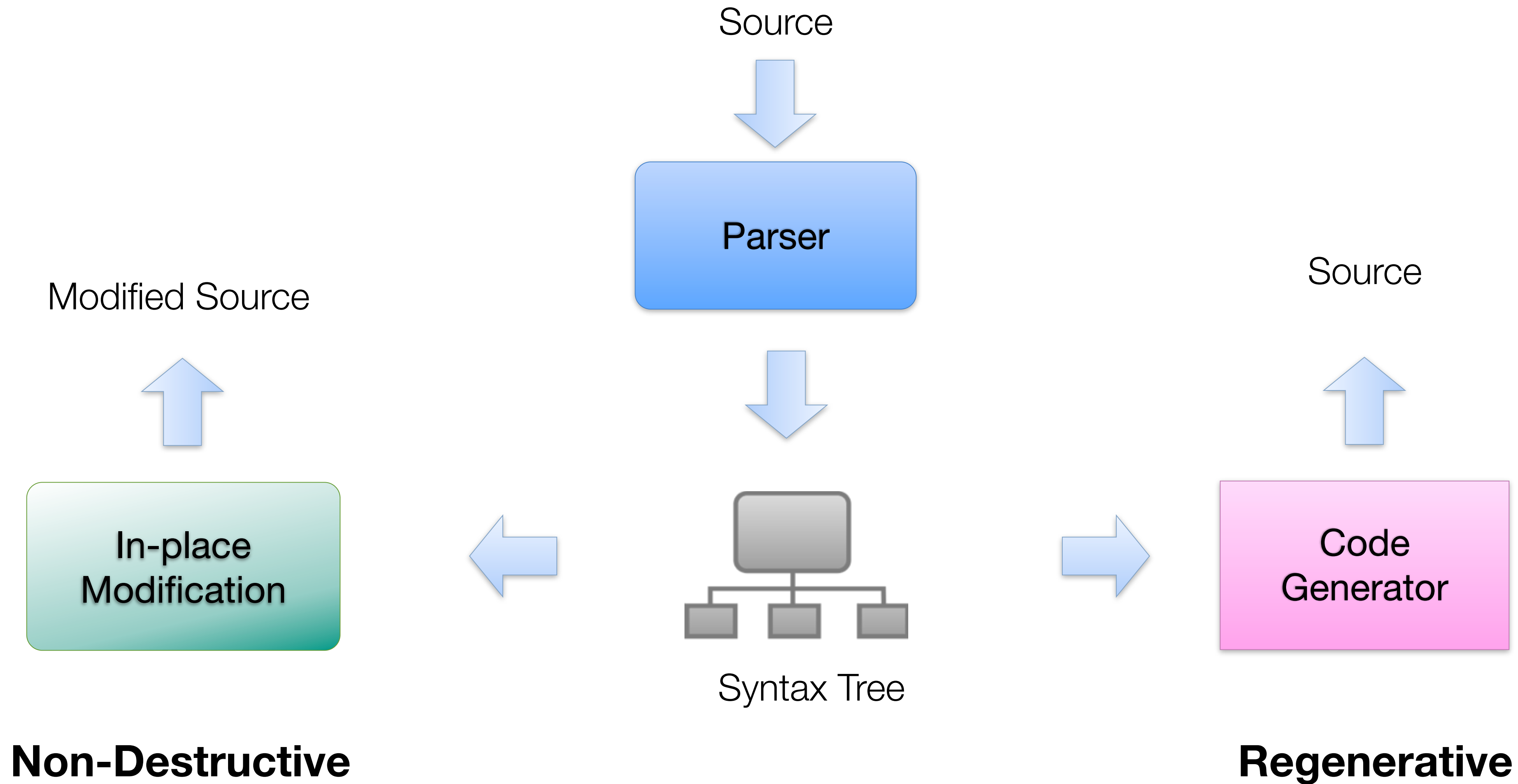
<http://esprima.org/demo/rename.html>

Try online!

```
1 function isHexDigit(ch) {  
2   return '0123456789abcdefABCDEF'.indexOf(ch) >= 0;  
3 }
```

```
1 function isHexDigit(digit) {  
2   return '0123456789abcdefABCDEF'.indexOf(digit) >= 0;  
3 }
```

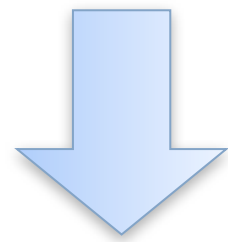

Source Transformation



Dynamic Code Coverage via Instrumentation

```
var answer = 42;  
alert(answer);
```

<http://gotwarlost.github.io/istanbul/>



```
var __cov_l$4m7m$L464yvav5F$qhNA = __coverage__['hello.js'];  
__cov_l$4m7m$L464yvav5F$qhNA.s['1']++;  
var answer = 42;  
__cov_l$4m7m$L464yvav5F$qhNA.s['2']++;  
alert(answer);
```

Statement Coverage and Latent Trap

```
function inc(p, q) {  
  if (q == undefined) q = 1;  
  return p + q/q;  
}  
  
assert("inc(4) must give 5", inc(4) == 5);
```

6 lines | 6 run | 0 missing

Does not catch the missing
code sequence

```
function inc(p, q) {  
  if (q == undefined)  
    return p + 1;  
  return p + q/q;  
}  
  
assert("inc(4) must give 5", inc(4) == 5);
```

7 lines | 6 run | 1 missing

```
1  function inc(p, q) {  
2    if (q == undefined)  
3      return p + 1;  
4    return p + q/q;  
5  }  
6
```

Branch Coverage

```
function inc(p, q) {  
  if (q == undefined) q = 1;  
  return p + q/q;  
}  
assert("inc(4) must give 5", inc(4) == 5);
```

```
1 1 function inc(p, q) {  
2 1   E if (q == undefined) q = 1;  
3 1   return p + q/q;  
   }
```

E = Else is not taken

Hard Thresholds on Code Coverage

```
istanbul check-coverage --statement -5 --branch -3 --function 100
```

```
Tests: 19   Failures: 0
=====
Writing coverage object [/home/ariya/dev/esrefactor/coverage/coverage.json]
Writing coverage reports at [/home/ariya/dev/esrefactor/coverage]
=====

===== Coverage summary =====
Statements   : 98.13% ( 105/107 )
Branches     : 93.55% ( 58/62 )
Functions    : 100% ( 12/12 )
Lines        : 98.11% ( 104/106 )
=====

> istanbul check-coverage --branch -3

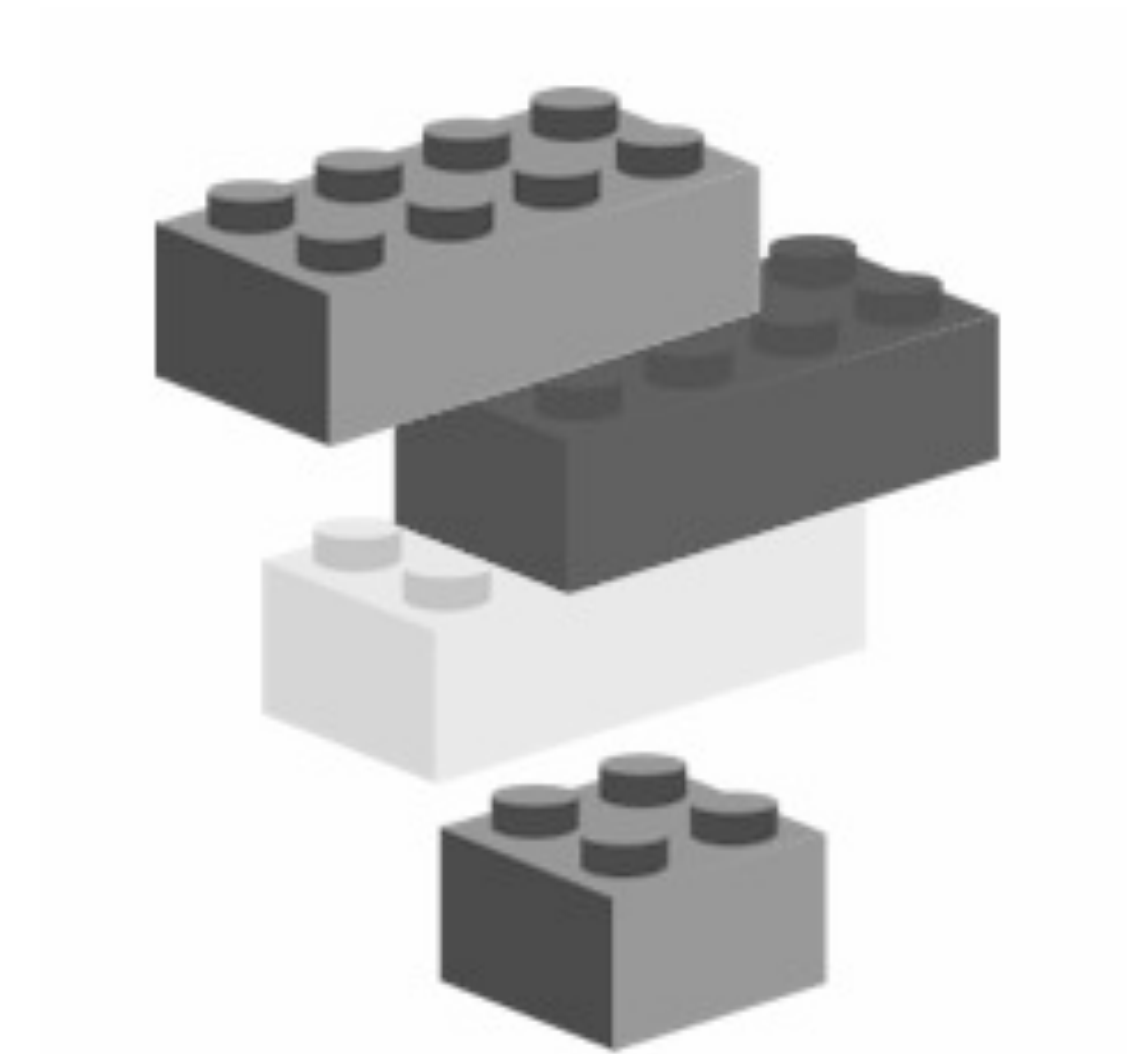
/usr/local/node/lib/node_modules/istanbul/lib/cli.js:31
    throw ex; // turn it into an uncaught exception
    ^
ERROR: Uncovered count for branches (4) exceeds threshold (3)
```

If you think JSLint hurts your feelings,
wait until you use Istanbul.

@davglass



BYOT (Bring Your Own Tools)



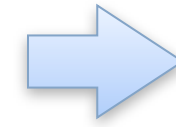
Consistency

Scalability

Convention

String Literal Quotes

```
console.log("Hello")
```

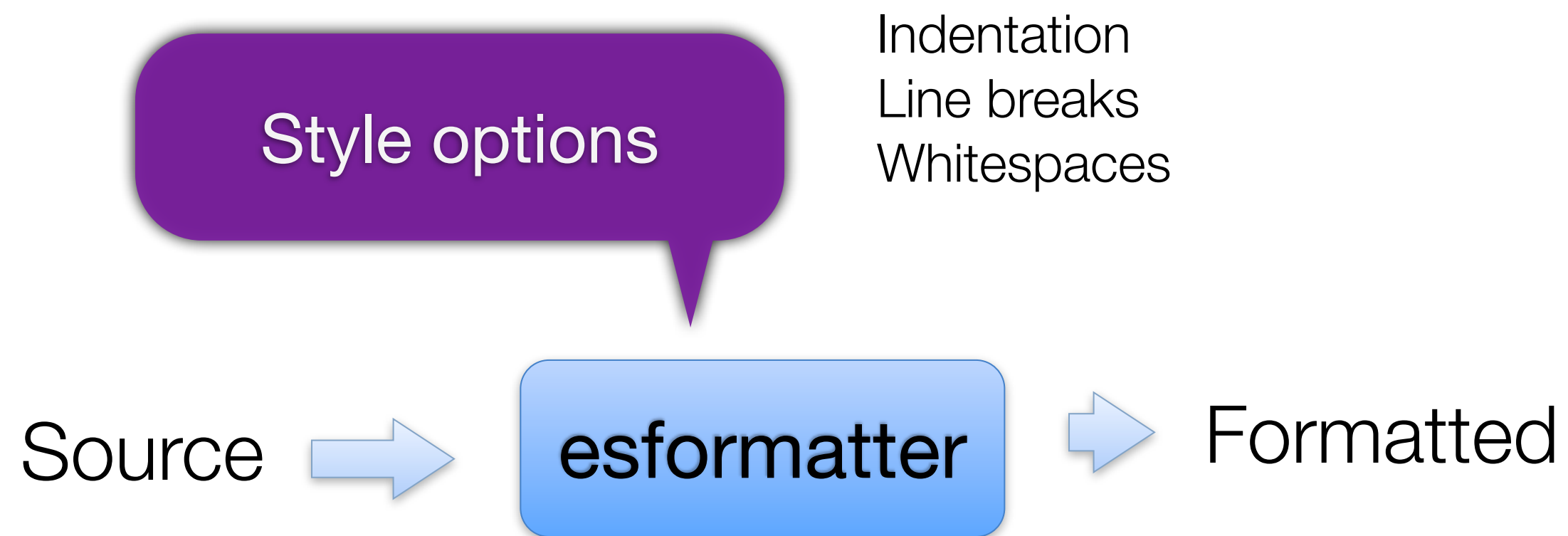


```
console.log('Hello')
```

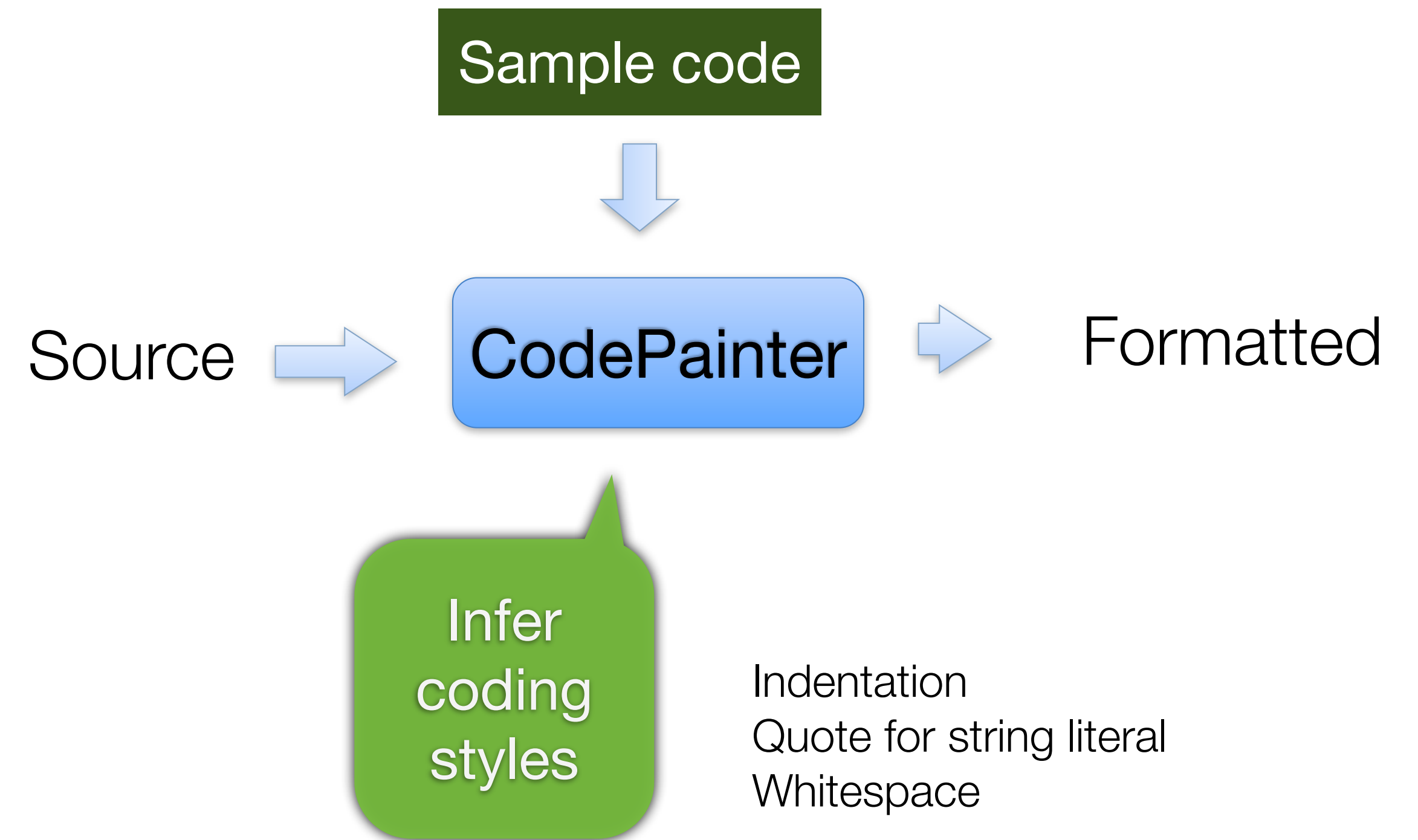
List of tokens

```
[  
  { type: "Identifier", value: "console", range: [0, 7] },  
  { type: "Punctuator", value: ".", range: [7, 8] },  
  { type: "Identifier", value: "log", range: [8, 11] },  
  { type: "Punctuator", value: "(", range: [11, 12] },  
  { type: "String", value: "\"Hello\"", range: [12, 19] },  
  { type: "Punctuator", value: ")", range: [19, 20] }  
]
```

Style Formatter

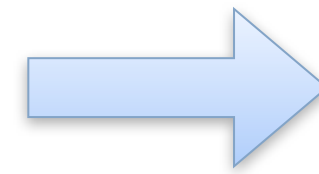


<https://github.com/millermedeiros/esformatter>



Application Structure

```
MyApp.create('MyApp.Person', {  
  name: 'Joe Sixpack',  
  age: 42,  
  
  constructor: function(name) {},  
  
  walk: function(steps) {}  
  run: function(steps) {}  
  
});
```



Metadata

```
{  
  objectName: 'MyApp.Person',  
  functions: ['walk', 'run'],  
  properties: ['name', 'age']  
}
```

Custom Linting



Not a strict equal

```
if (x == 9) {  
    // do Something  
}
```

```
var fs = require('fs'),  
    esprima = require('./esprima'),  
    files = process.argv.splice(2);  
  
files.forEach(function (filename) {  
    var content = fs.readFileSync(filename, 'utf-8'),  
        syntax = esprima.parse(content, { loc: true });  
  
    JSON.stringify(syntax, function (key, value) {  
        if (key === 'test' && value.operator === '==')  
            console.log('Line', value.loc.start.line);  
        return value;  
    });  
});
```


“Boolean Trap” Finder

Obfuscated choice

```
var volumeSlider = new Slider(false);
```

Double-negative

```
component.setHidden(false);  
filter.setCaseInsensitive(false);
```

Can you make up your mind?

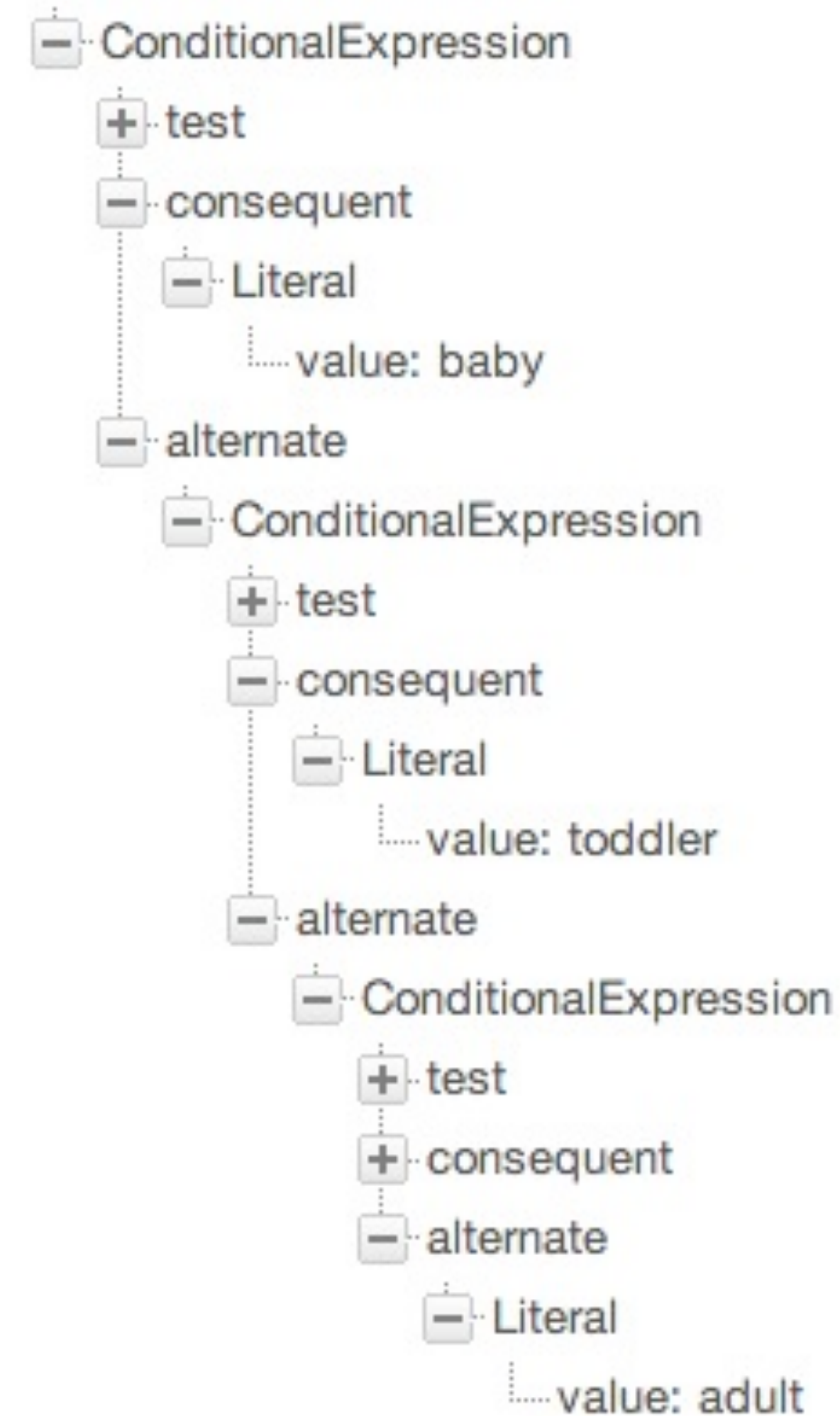
```
treeItem.setState(true, false);
```

The more the merrier?

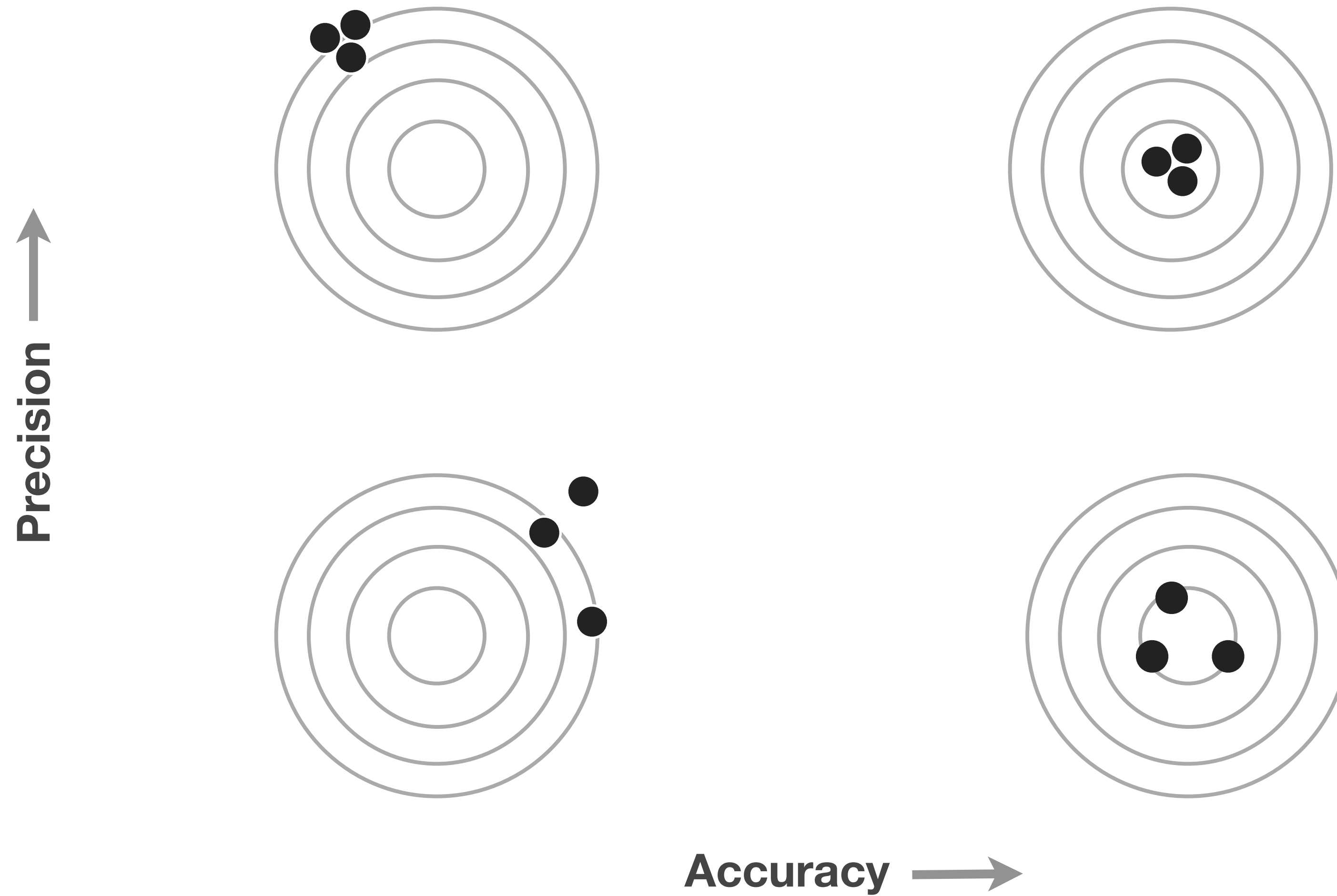
```
event.initKeyEvent("keypress", true, true, null, null,  
false, false, false, false, 9, 0);
```

Nested Ternary Conditionals

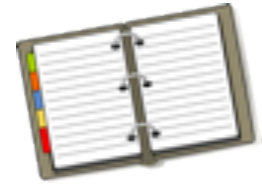
```
var str = (age < 1) ? "baby" :  
          (age < 5) ? "toddler" :  
          (age < 18) ? "child": "adult";
```



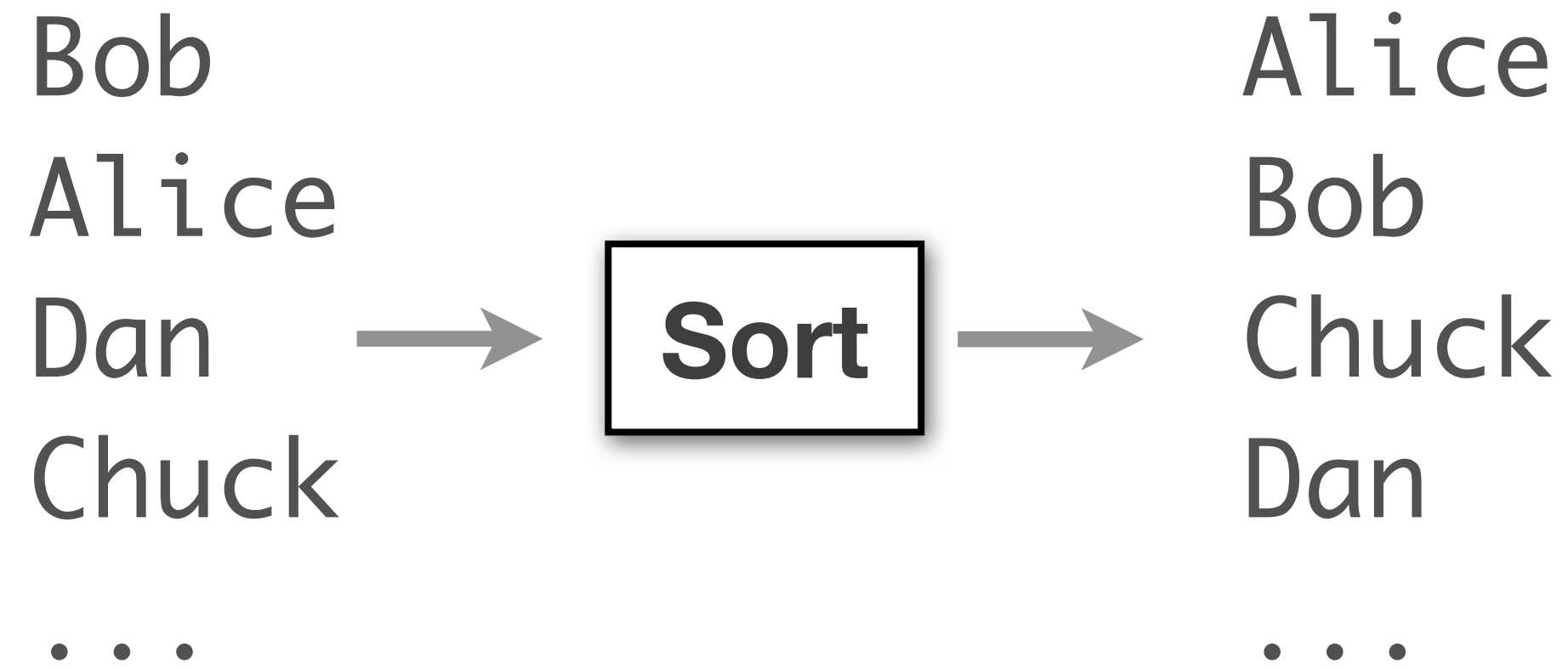
Performance: Measurement Confidence



Fast = Enough?



Address Book Application



How's the speed?

2 ms to sort 10 contacts

Bubble Sort ???



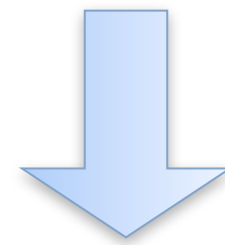
```
Array.prototype.swap = function (i, j) {  
    var k = this[i]; this[i] = this[j]; this[j] = k;  
}  
  
function sort(list) {  
    var items = list.slice(0), swapped = false, p, q;  
    for (p = 1; p < items.length; ++p) {  
        for (q = 0; q < items.length - p; ++q) {  
            if (items[q + 1] < items[q]) {  
                items.swap(q, q + 1);  
                swapped = true;  
            }  
        }  
        if (!swapped) break;  
    }  
    return items;  
}
```

Empirical Run-time Complexity

<http://esprima.org/demo/functiontrace.html>

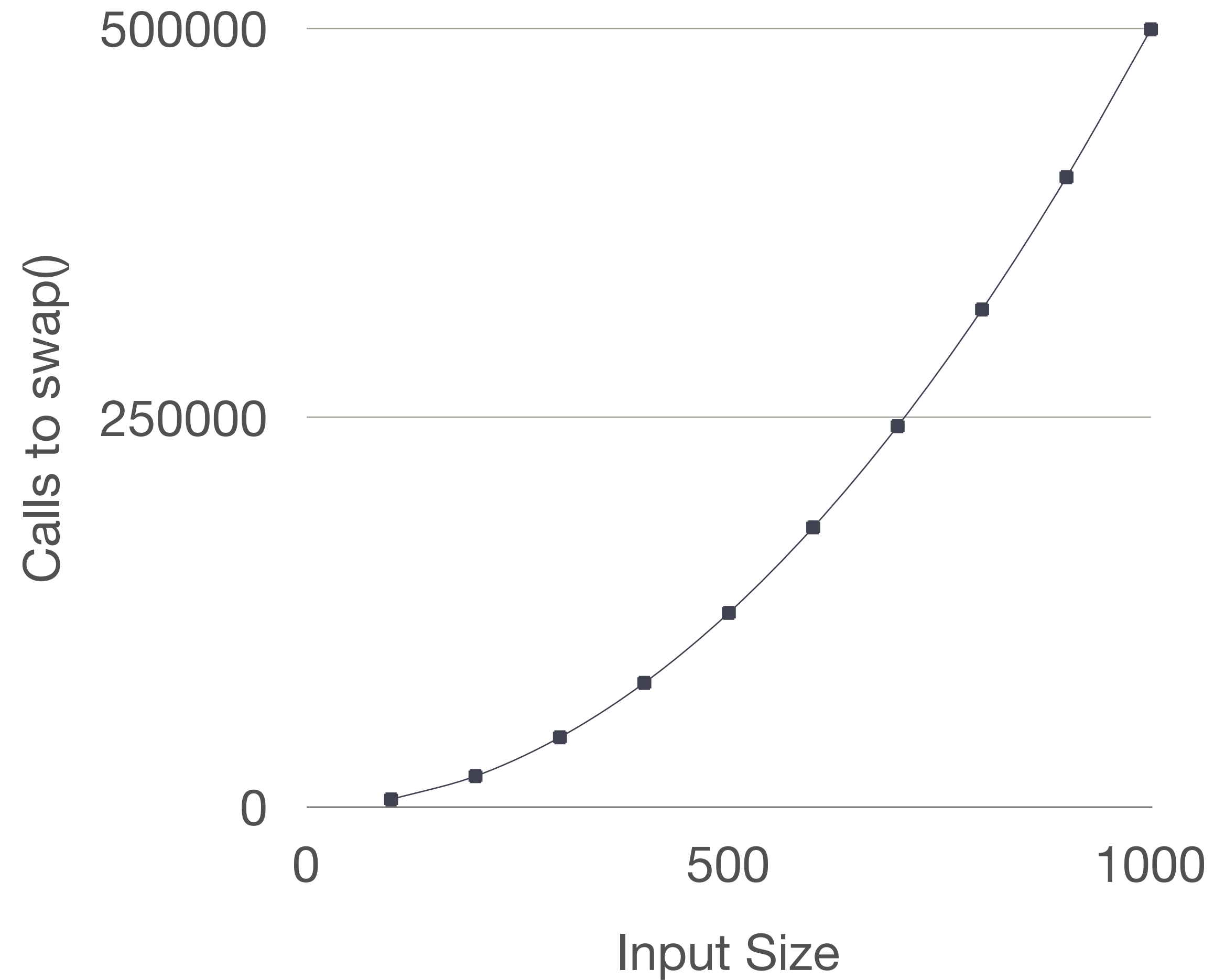
Try online!

```
Array.prototype.swap = function (i, j) {  
    var k = this[i]; this[i] = this[j]; this[j] = k;  
}
```



```
Array.prototype.swap = function (i, j) {  
    Log({ name: 'Array.prototype.swap', lineNumber: 1, range: [23, 94] });  
    var k = this[i]; this[i] = this[j]; this[j] = k;  
}
```

Run-time Analysis



Execution Tracing

4640 function calls

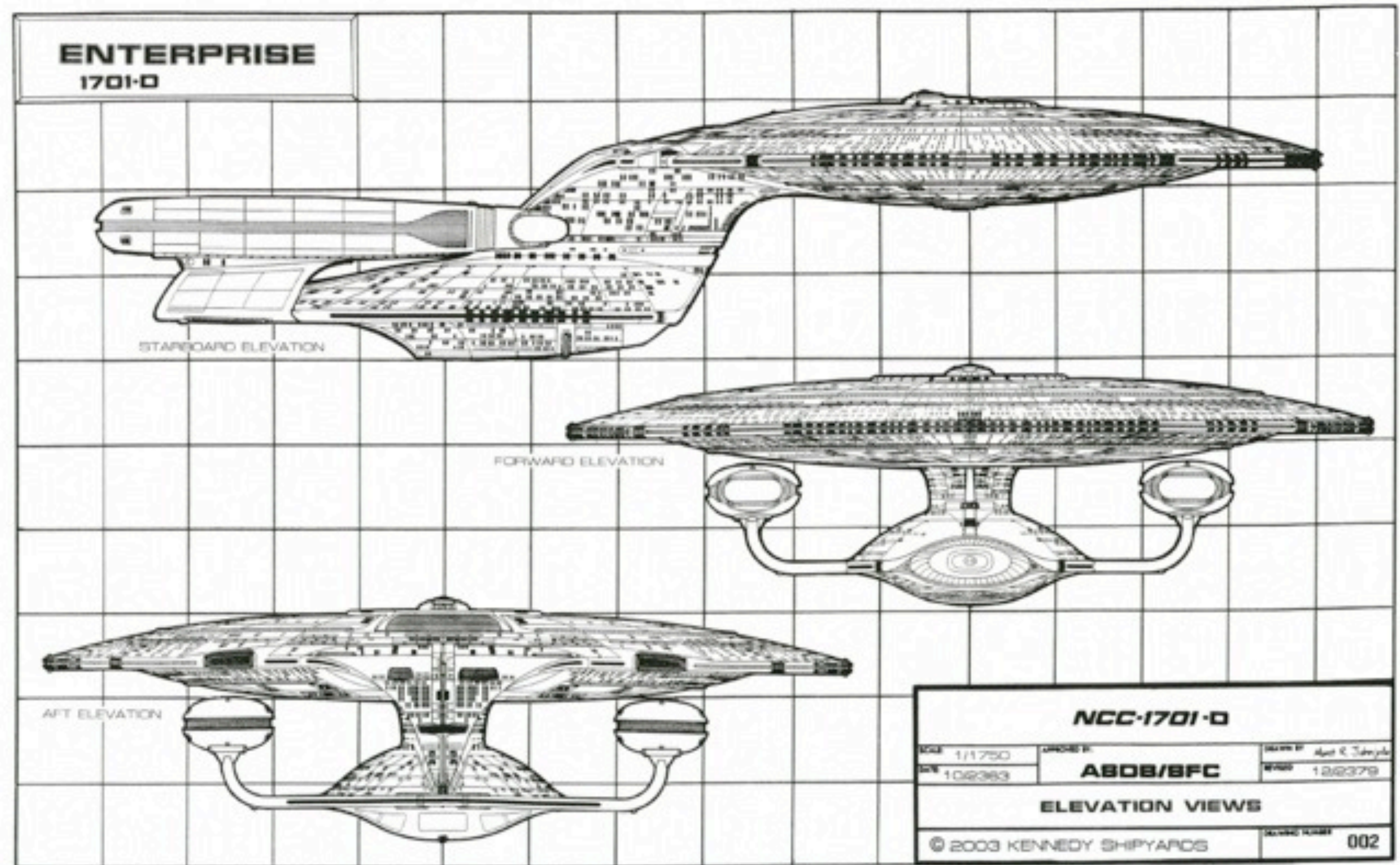
<https://gist.github.com/1823129>

jQuery Mobile startup log

jquery.js	26	jQuery	
jquery.js	103	init	undefined, undefined,
[object Object]			
jquery.js	274	each	(Function)
jquery.js	631	each	[object Object],
(Function), undefined			
jquery.js	495	isFunction	[object Object]
jquery.js	512	type	[object Object]
jquery.mobile.js	1857	[Anonymous]	
jquery.mobile.js	642	[Anonymous]	
jquery.mobile.js	624	enableMouseBindings	
jquery.mobile.js	620	disableTouchBindings	

<http://ariya.ofilabs.com/2012/02/tracking-javascript-execution-during-startup.html>

Embrace the Future



Copy Paste (Mistake) Detector

```
function inside(point, rect) {  
    return (point.x >= rect.x1) && (point.y >= rect.y1) &&  
           (point.x <= rect.x2) && (point.y <= rect.y1);  
}
```

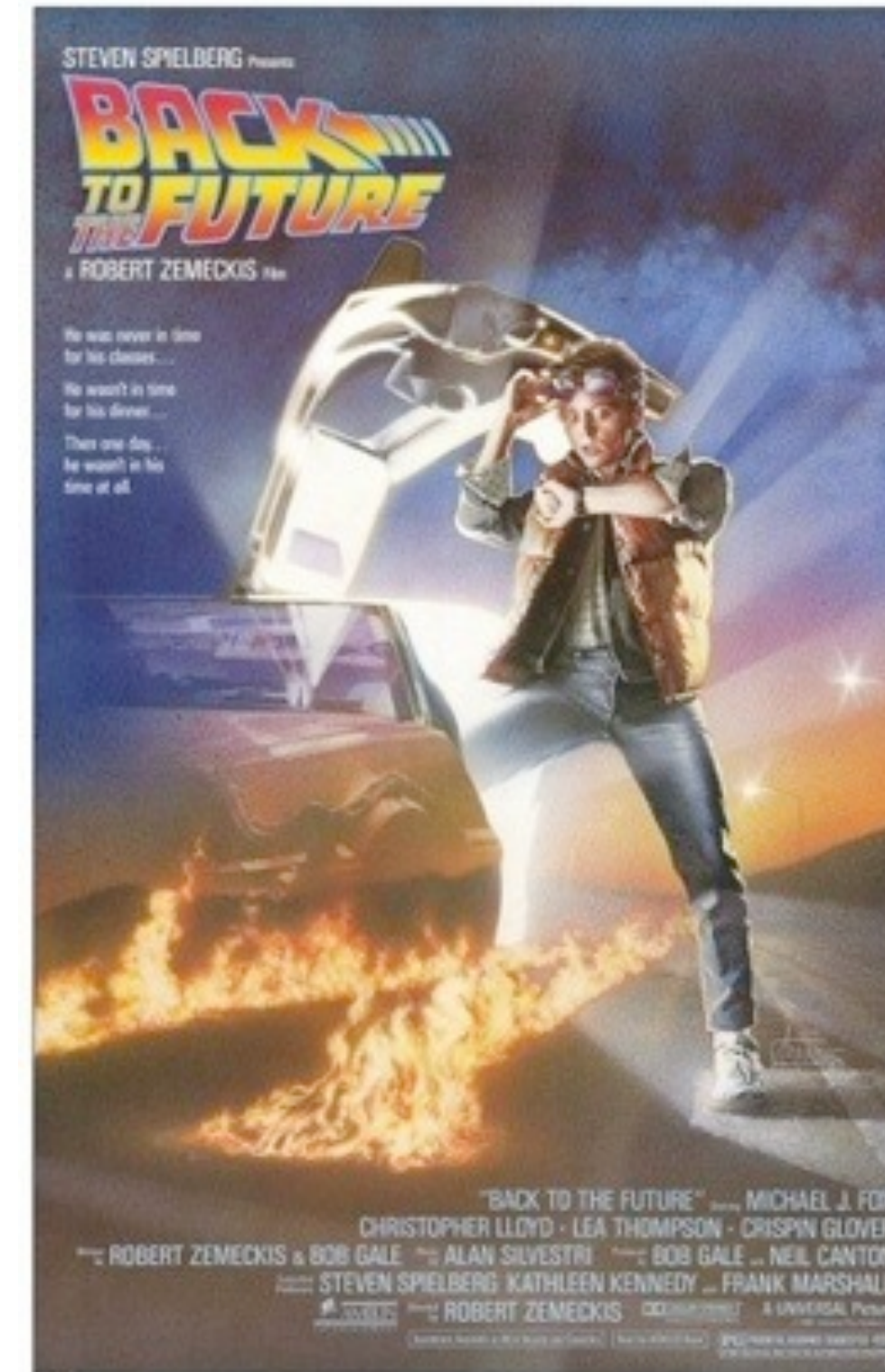
Wrong check

Syntax Augmentation

Exoskeleton:
LLJS, Sweet.js, ...



ES.Future:
Polyfills, Transpiler, ...

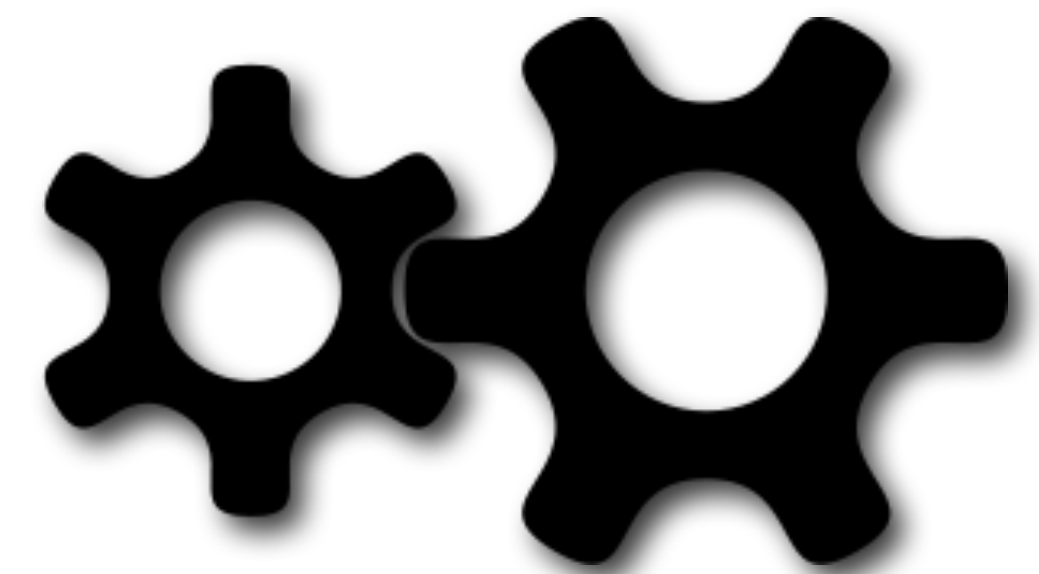


Adaptive Tools

Explicit

Customize analysis options

Define new sets of rules



Implicit

Infer from high-quality sample

Observe the engineer's behavior



Syntax Query

```
if (x = 0) { /* do Something */ }
```

`IfStatement.test AssignmentExpression[operator='=']`

Which *syntax family* should be the model?
CSS selector? XPath? SQL?

And Many More...

Semantic Diff

Informative syntax error

Symbolic execution

Declarative transformation

Pattern Matching

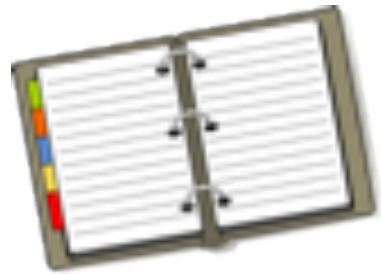


Her five-year mission: to explore strange new worlds, to seek out new lifeforms and new civilizations; **to boldly go where no one has gone before.**

Thank You



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