Unit Testing

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Purpose

Isolate parts of the program and prove that they work correctly.

Benefits

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   - Testing units in isolation helps to expose tight coupling.

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   - It's easy to write unit tests for a good design.
   - Testing units in isolation helps to expose tight coupling.
   - Separation of concerns, single-responsibility principle is promoted.

What is a unit?

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- So, no dependency on outside state!
- A unit needs proper design to eliminate direct dependencies and allow for proper unit testing.
    - For example, use the SOLID design principles as guidelines.

Candidate units:

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- Functions

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- Functions
- Classes
- Namespaces
- Modules

Example

Find the unit to test...

```
1  var currentPos = {x: 100, y: 200};
2
3  var getCurrentPos = function() { return {x: currentPos.x, y: currentPos.y}; };
4  var setCurrentPos = function(x, y) { currentPos.x = x; currentPos.y = y; };
5
6  var updatePosition = function(velocity, timeDelta) {
7      var pos = getCurrentPos();
8      pos.x += velocity.x * timeDelta;
9      pos.y += velocity.y * timeDelta;
10     setCurrentPos(pos.x, pos.y);
11 };
```

Example

Refactored to support unit testing...

```
1  var currentPos = {x: 100, y: 200};
2
3  var getCurrentPos = function() { return {x: currentPos.x, y: currentPos.y}; };
4  var setCurrentPos = function(x, y) { currentPos.x = x; currentPos.y = y; };
5
6  var updatePosition = function(velocity, timeDelta) {
7      var pos = getCurrentPos();
8      pos = computeNewPosition(pos, velocity, timeDelta);
9      setCurrentPos(pos.x, pos.y);
10 };
11
12 var computeNewPosition = function(originalPos, velocity, timeDelta) {
13     var pos = {x: originalPos.x, y: originalPos.y};
14     pos.x += velocity.x * timeDelta;
15     pos.y += velocity.y * timeDelta;
16     return pos;
17 };
```

Skipped topics

1. Test suites.

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2. Fixtures. Setup, teardown.

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5. Test result visualization.

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Abstract away everything that uses...

- I/O (filesystem, network, ...)
- interprocess communication
- timers (time-outs, intervals)
- runtime environment
- undeterministic (random) behavior

How to abstract external depencies?

- Use dependency injection.

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- Create a fake or mock implementation of the interface.

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Spying

A spy is a wrapper around a function, capturing information about the function's invocations. E.g., invocation count and call arguments. It can assert correct behavior of the caller.

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- Only fake or mock public interfaces.
- Use spying only for...
  - events
  - callback functions
  - injected self-managed instances

Example

Unit has direct dependency on I/O functionality, yikes!

```
1  var fs = require("fs");
2
3  function Person(name) {
4      this.name = name;
5  }
6
7  Person.prototype.load = function() {
8      var filePath = this.name + ".json";
9      var jsonData = fs.readFile(filePath);
10     var data = JSON.parse(jsonData);
11     this.name = data.name;
12 };
13
14 Person.prototype.save = function() {
15     var filePath = this.name + ".json";
16     var jsonData = JSON.stringify({name: this.name});
17     fs.writeFile(filePath, jsonData);
18 };
```

Example

Now using dependency injection...

```
1  function Person(name, fsImpl) {
2      this._fsImpl = fsImpl;
3      this.name = name;
4  }
5
6  Person.prototype.load = function() {
7      var filePath = this.name + ".json";
8      var jsonData = this._fsImpl.readFile(filePath);
9      var data = JSON.parse(jsonData);
10     this.name = data.name;
11 };
12
13 Person.prototype.save = function() {
14     var filePath = this.name + ".json";
15     var jsonData = JSON.stringify({name: this.name});
16     this._fsImpl.writeFile(filePath, jsonData);
17 };
```

Example

Even better, separated fs into multiple disjoint interfaces...

```
1  function Person(name) {
2      this.name = name;
3  }
4
5  Person.prototype.load = function(fileReaderImpl) {
6      var filePath = this.name + ".json";
7      var jsonData = fileReaderImpl.readFile(filePath);
8      var data = JSON.parse(jsonData);
9      this.name = data.name;
10 };
11
12 Person.prototype.save = function(fileWriterImpl) {
13     var filePath = this.name + ".json";
14     var jsonData = JSON.stringify({name: this.name});
15     fileWriterImpl.writeFile(filePath, jsonData);
16 };
```

Example

And this is the unit test...

```
1  function testSuite_Person() {
2      function FileWriterMock(storage) {
3          this._storage = storage;
4      }
5      FileWriterMock.prototype.writeFile = function(filePath, data) {
6          this._storage[filePath] = data;
7      };
8
9      function FileReaderMock(storage) {
10         this._storage = storage;
11     }
12     FileReaderMock.prototype.readFile = function(filePath) {
13         return this._storage[filePath];
14     };
15
16     function testCase_saving_and_loading() {
17         var storage = {};
18
19         var person = new Person("Dave");
20         var fileWriter = new FileWriterMock(storage);
21         person.save(fileWriter);
22
23         var fileReader = new FileReaderMock(storage);
24         var samePerson = new Person();
25         samePerson.load(fileReader);
26
27         assert.equal(samePerson.name, person.name, "Names␣should␣be␣equal!");
28     }
29 }
```

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- Non-public interface, non-public behavior.
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  - Protected methods.
  - Internally scoped units.
- Effects on non-public properties.

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- As long as the unit's public interface doesn't change, its internals are allowed to be turned 180 degrees around.
- See unit testing benefits number 2, 4 and 5.

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(continued...)

- Non-public functions can not be treated as units. They rely on internals outside themselves, which might be subject to change.
    - If a non-public function can be treated as a unit, there is no reason for it to be non-public.
- A unit with complicated private functions probably has a hidden implicit internal class wanting to get out and which should be independently tested. The public functions are likely just facades.

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If not, then...

- the unit tests are written against non-public parts of the interface,
- or the unit being tested is not an actual unit, i.e. it is not self-contained.

Example

Unit being tested...

```
1  function Player(pos) {
2      this._pos = {x: pos.x, y: pos.y};
3  }
4  Pet.prototype.setX = function(x) { this._pos.x = x; };
5  Pet.prototype.getX = function() { return this._getPosCoord("x"); };
6  Pet.prototype._getPosCoord = function(coord) { return this._pos[coord]; };
```

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Unit test using non-public interface... (Wrong! But succeed.)

```
1  function testSuite_Player() {
2      function testCase_construct() {
3          var p = new Player({x: 10, y: 20});
4          assert.equal(p._getPosCoord("x"), 10, "X␣pos.␣should␣be␣set␣by␣ctor.");
5      }
6      function testCase_setX() {
7          var p = new Player({x: 0, y: 0});
8          p.setX(30);
9          assert.equal(p._pos.x, 30, "X␣pos.␣should␣be␣set␣by␣setter.");
10     }
11     function testCase_getX() {
12         var p = new Player({x: 0, y: 0});
13         p._pos = {x: 50, y: 10};
14         assert.equal(p.getX(), 50, "X␣pos.␣should␣be␣retrieved␣by␣getter.");
15     }
16 }
```

Example

Unit after refactoring...

```
1  function Player(pos) {
2      this._pos = new Vector([pos.x, pos.y]);
3  }
4  Pet.prototype.setX = function(x) { this._pos.set(0, x); };
5  Pet.prototype.getX = function() { return this._pos.get(0); };
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Original tests... (Fail!)

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Example

Correct unit tests on public interface, support refactoring...

```
1  function testSuite_Player() {
2      function testCase_get_and_set() {
3          var p = new Player({x: 10, y: 20});
4          assert.equal(p.getX(), 10, "X␣pos.␣should␣be␣set␣by␣ctor.");
5          assert.equal(p.getY(), 20, "Y␣pos.␣should␣be␣set␣by␣ctor.");
6          p.setX(30);
7          assert.equal(p.getX(), 30, "X␣pos.␣from␣get␣should␣be␣set␣by␣setter.");
8      }
9  }
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Signs that something is wrong and action is required

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  - Don't!
  - Just don't!

Red flags, part 2

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Questions & Discussion