

# Building Browser Based Games Using HTML5

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# HTML



Who am I?

Who are you?

# Outline

- Talk for about 40 minutes
- Take questions at the end

Why  ?

Why do people use Lua?

# 1. Fast Iteration

15 minutes to run the game!



The screenshot shows a development environment with a browser on the left and a code editor on the right. The browser window displays a game scene with a green field, several buildings (a house, a hospital, a factory, and a stadium), and a clipboard icon. Performance metrics are visible in the top left of the browser: 'average frame time: 0.18' and 'average interval: 11.08'. The code editor shows the following JavaScript code:

```

1 (function(){-
2   -
3   var self = this;-
4   -
5   var Layer = function(args){-
6     var self = this;-
7     self.element = $('<div class="layer"></div>');-
8     self.html = self.element.get(0);-
9     swrve.Init(self, args);-
10    self.tiles = [];-
11  }-
12  -
13  Layer.prototype.add_tile = function(tile){-
14    var self = this;-
15    self.tiles.push(tile);-
16    self.element.append(tile.element);-
17    tile.transform();-
18    return self;-
19  };-
20  -
21  Layer.prototype.update = function(dt){-
22    _._invoke(this.tiles, 'update', dt);-
23  }-
24  -
25  Layer.prototype.transform = function(){-
26    _._invoke(this.tiles, 'transform');-
27    swrve.CachedTransform(this);-
28  }-
29  -
30  Layer.prototype._click = function(x, y){-
31    _._invoke(this.tiles, '_click', x - this.x, y - this.y);-
32  }-
33  -
34  var swrve = self.swrve || {};-
35  swrve.Layer = Layer;-
36  -
37  }).call(this);

```

The code editor also shows a file explorer on the right with a directory structure:

- city
  - app
    - asset
      - im
      - jav
    - sty
    - contr
    - help
    - mail
    - mode
    - view
    - config
      - config.ru
    - db
    - doc
      - Gemfile
      - Gemfile.
    - lib
    - log
    - public
      - Rakefile
      - README
    - script
    - test
    - tmp
    - vendor

The status bar at the bottom of the code editor shows: 'Line: 19 Column: 5 JavaScript Soft Tabs: 2 add\_tile'.

# Bret Victor - “Inventing on Principle”

<http://vimeo.com/36579366>

<http://worrydream.com>

Why do people use Lua?

## 2. Scripts Are Data

# Escape the Walled Garden

Deliver the game directly to the player

What am I going to talk about?



# Topics:

HTML

The DOM

Rendering

Main Loop

User Input

iOS Web Apps

Developer Tools

Hosting

*Audio*

What type of game?

HTML

# How do we run code?

These tags make text `<b>bold</b>`.

Some tags make text  
<i>slanted</i>.

But a pair of `<script>` tags  
are different.

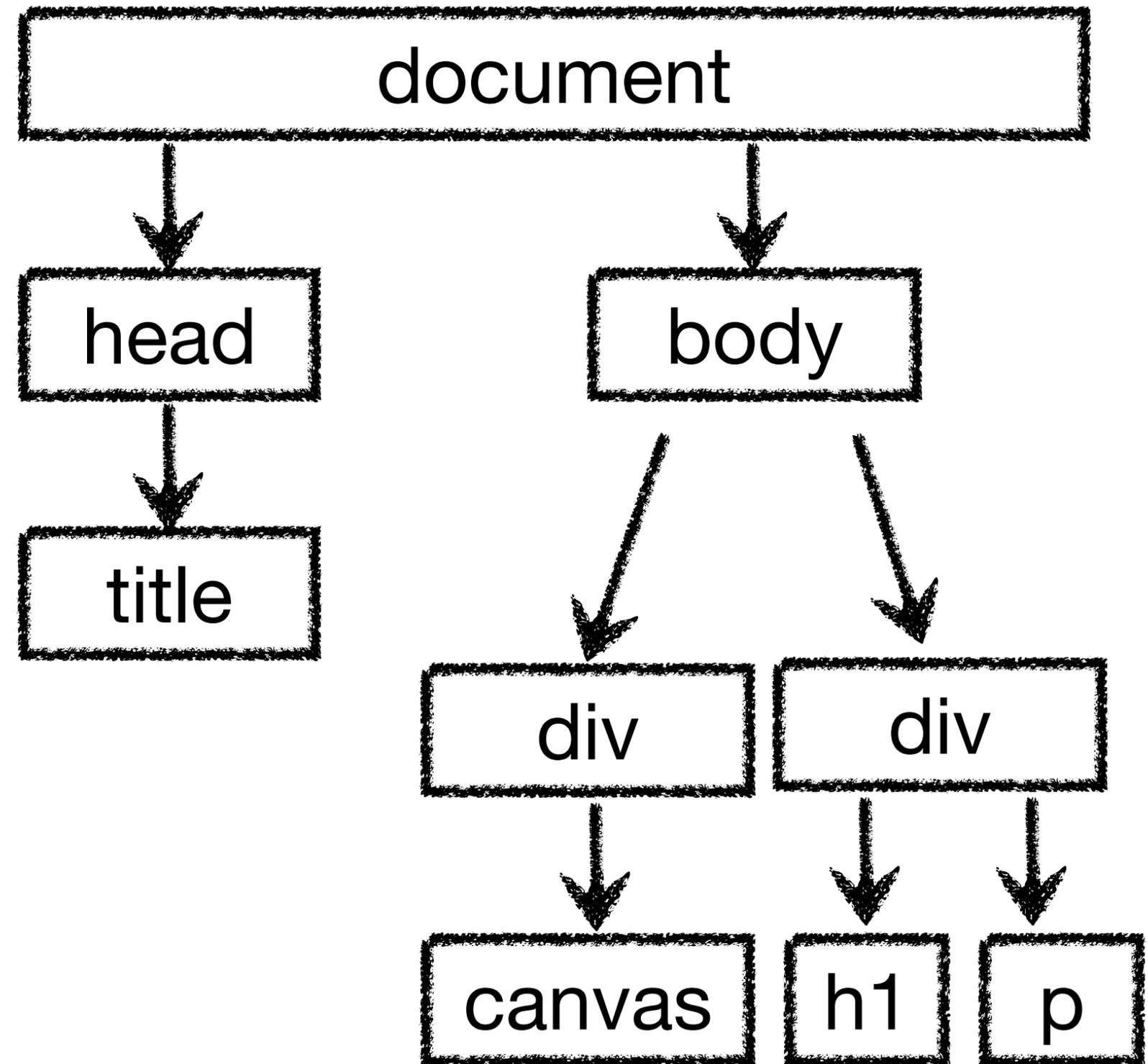
```
#include <stdio.h>
#include <stdlib.h>

// Code always starts here
int main(int argc, char** argv)
{
    printf("Hello GDC\n");
    return EXIT_SUCCESS;
}
```

```
<html>
  <head>
    <title>Hello GDC</title>
    <script src="main.js"
      type="text/javascript">
    </script>
  </head>
  <body>
    <h1>Hello GDC</h1>
    <p>Welcome to San Francisco.</p>
  </body>
</html>
```

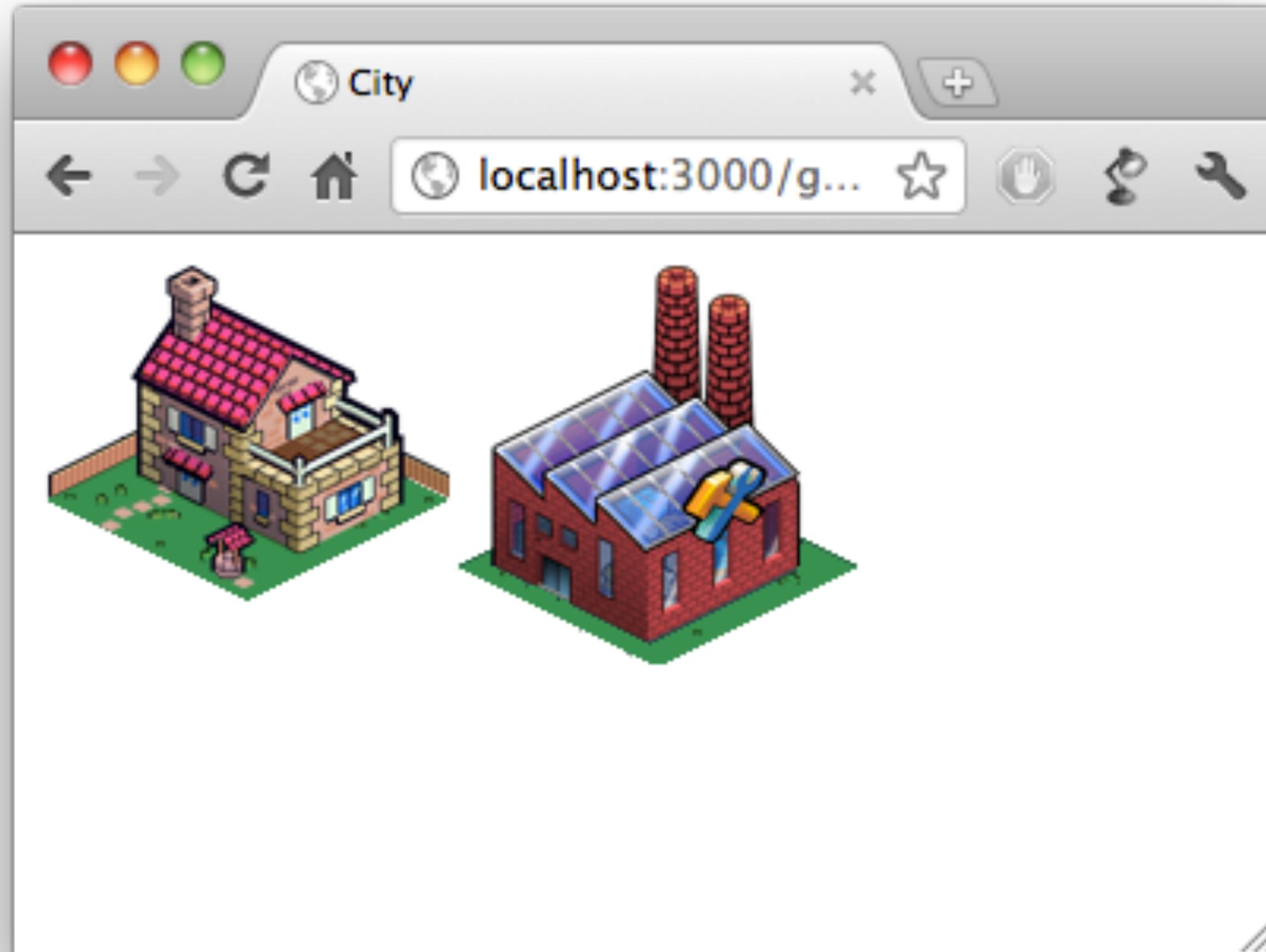
# DOM

The DOM is a tree  
exposed to  
JavaScript



# Rendering

<canvas>

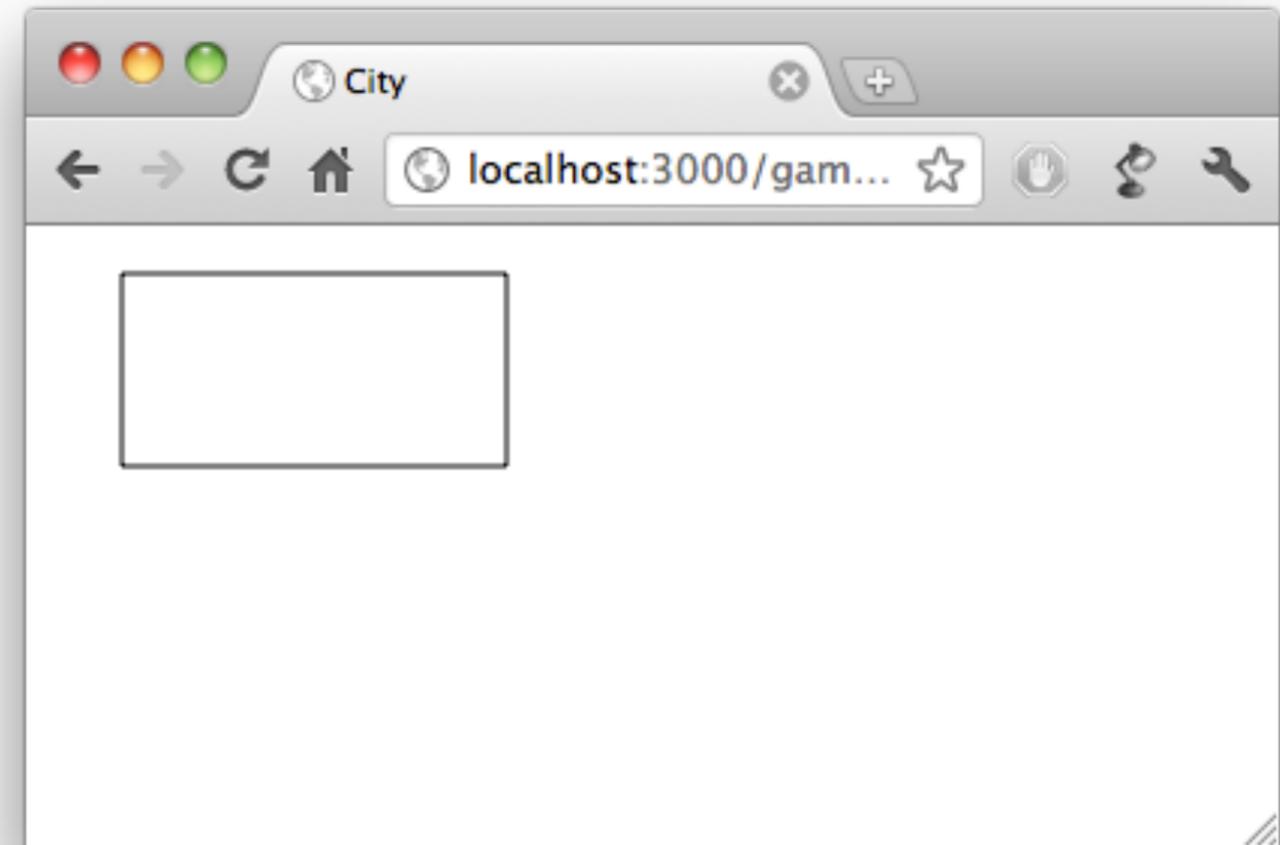


```
<html>
  <body>
    <canvas id="game"></canvas>
  </body>
</html>
```

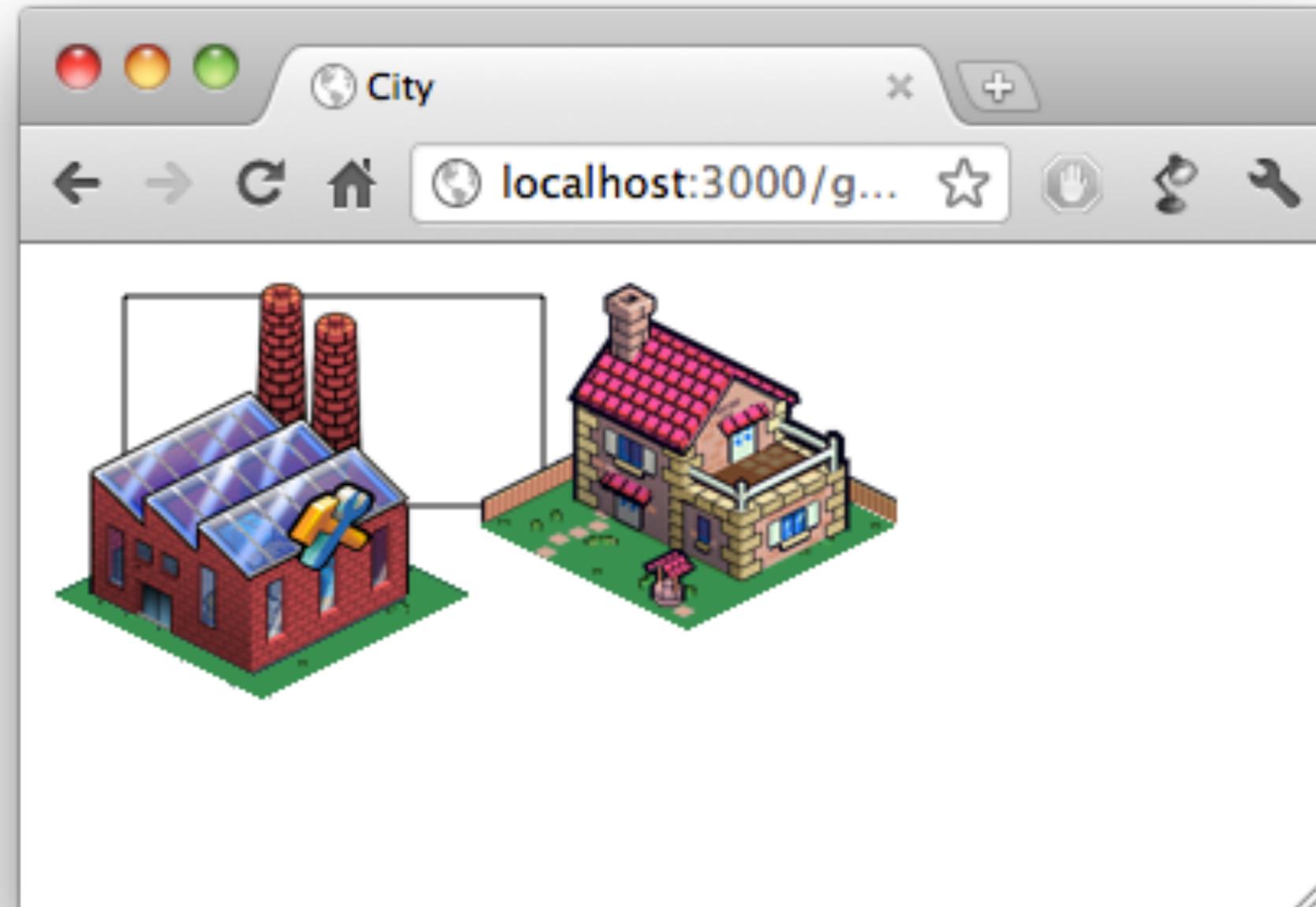
Make a canvas  
element that fills the  
screen

```
html, body {
  width: 100%;
  height: 100%;
  margin: 0px;
}
```

```
// JavaScript  
var canvas = document.getElementById( 'game' );  
var context = canvas.getContext( '2d' );  
  
canvas.width = window.innerWidth;  
canvas.height = window.innerHeight;  
  
context.strokeRect(32, 16, 128, 64);
```



```
var factory = new Image();  
var house = new Image();  
  
$(factory).load(function(){  
    context.drawImage(this, 10, 10);  
}).attr('src', 'factory.png');  
  
$(house).load(function(){  
    context.drawImage(this, 140, 10);  
}).attr('src', 'shop.png');
```



# <canvas> performance

Avoid `<canvas>` context changes

# <canvas> layers

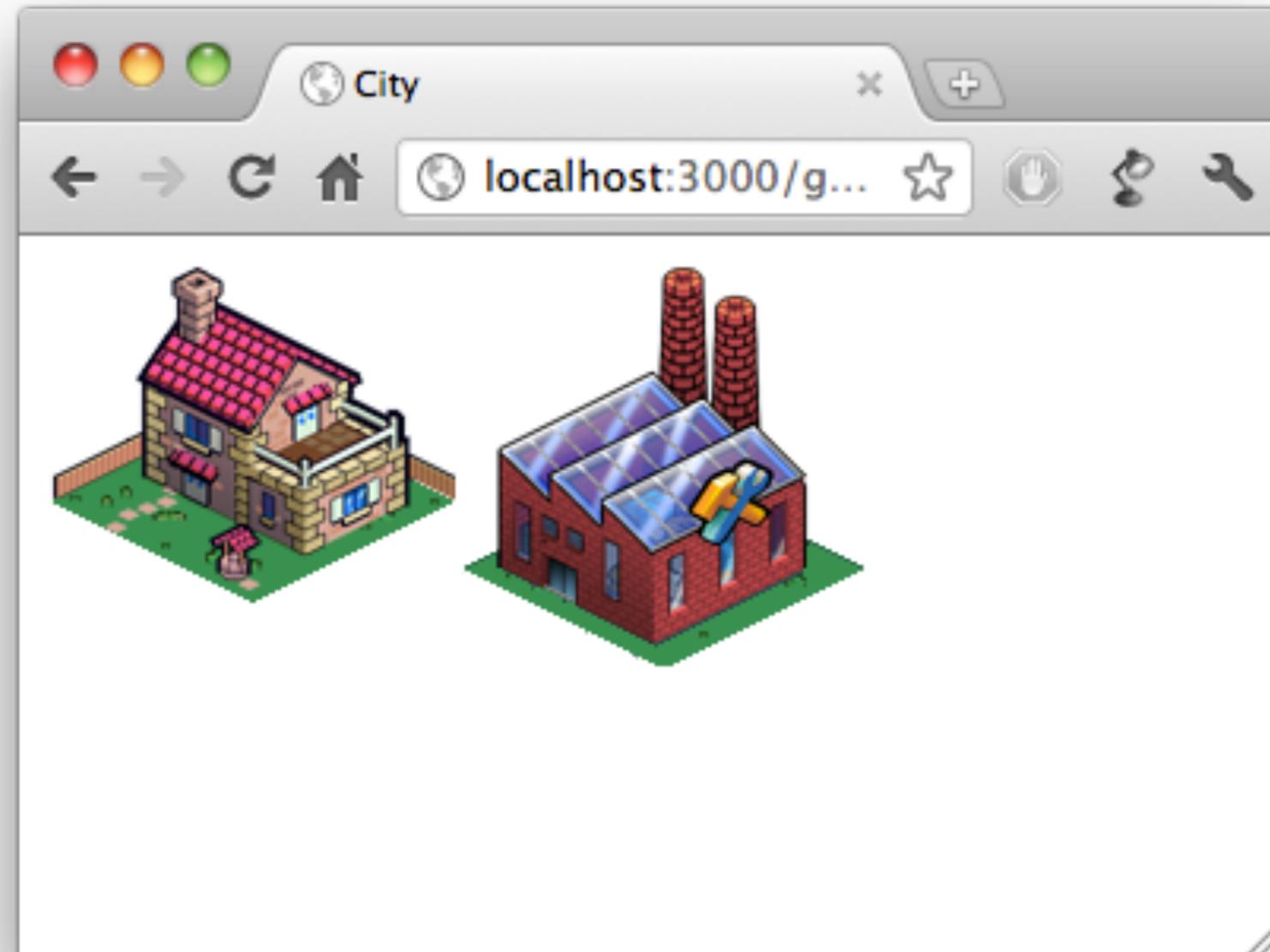


<canvas> text rendering

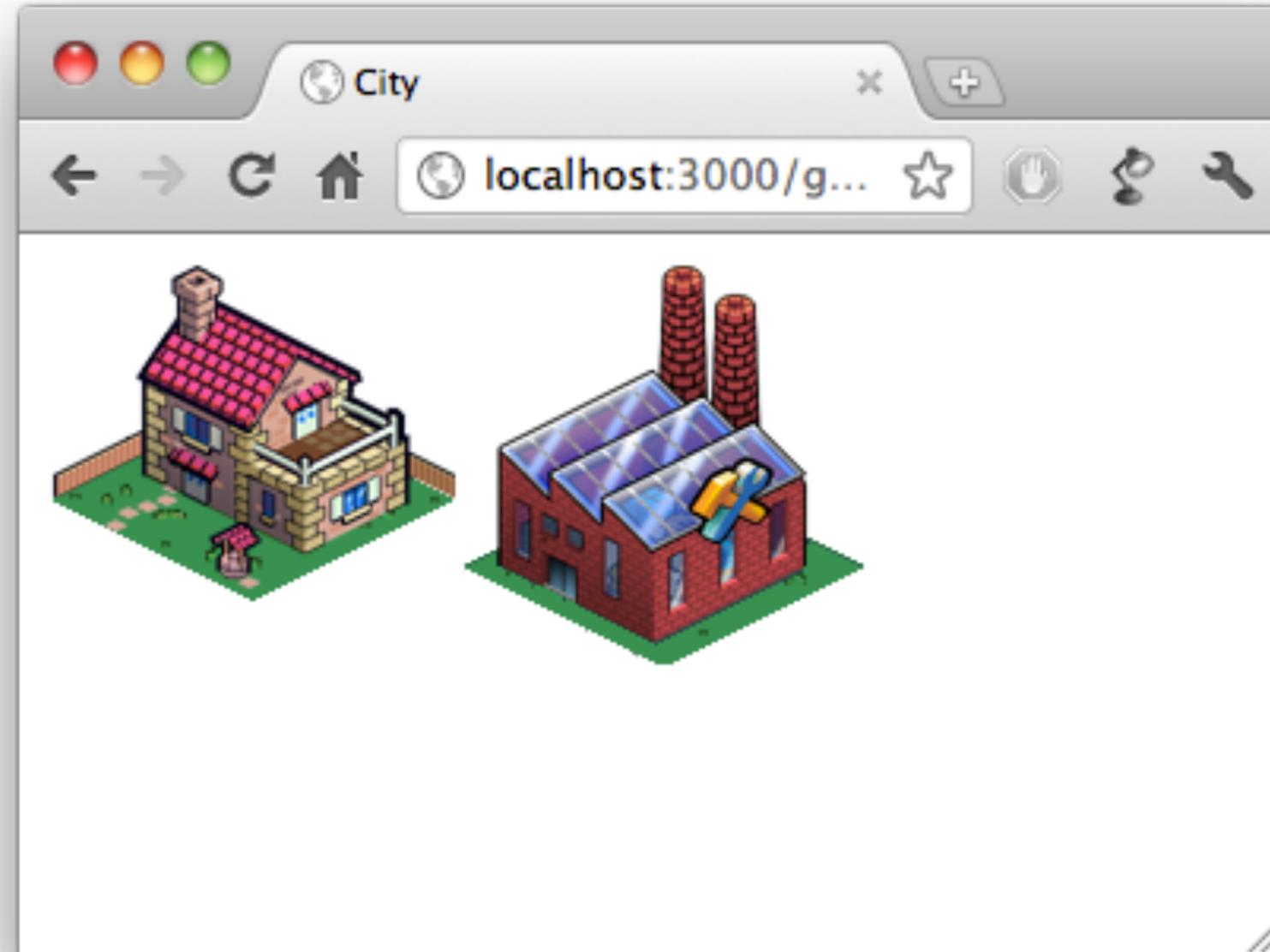
# WebGL

CSS

```
<html>
  <body>
    <div class="sprite" id="house"></div>
    <div class="sprite" id="factory"></div>
  </body>
</html>
```



```
.sprite {  
  width: 128px; height: 128px;  
  position : absolute;  
  background-repeat: no-repeat;  
}  
  
#house {  
  background-image: url(shop.png);  
  left: 32px;  
}  
  
#factory {  
  background-image: url(factory.png);  
  left: 150px;  
}
```

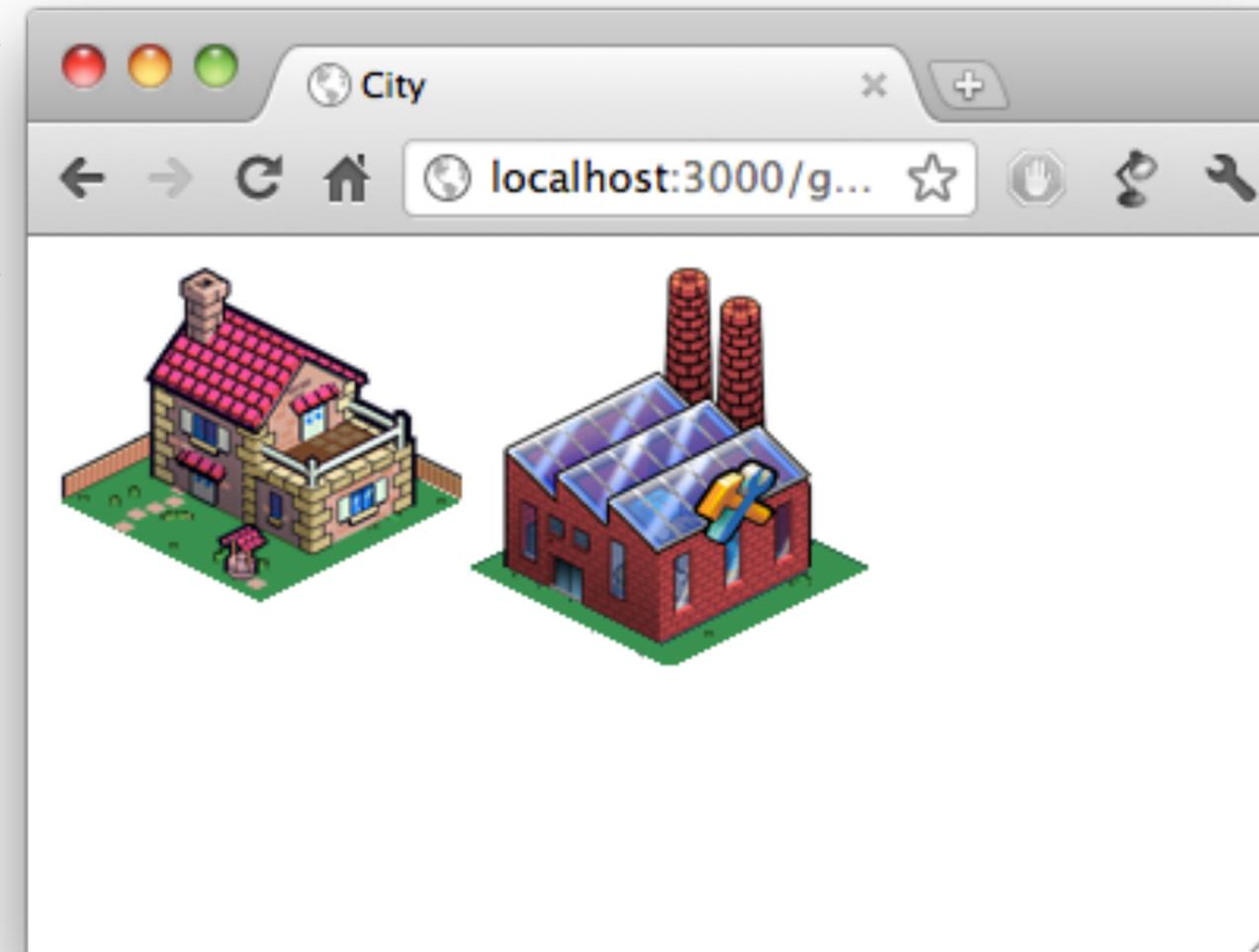


```
<html>
  <body>
    <div class="game" id="game"></div>
  </body>
</html>
```

```
var game = $('#game');

var house = $('<div class="sprite"
  style="width: 128px; height: 128px;
  background-image: url(house.png);
  position: absolute;
  background-repeat: no-repeat;"></div>');

game.append(house);
```



```
// Firefox
sprite.style.MozTransform = 'matrix(a, c, b, d, tx, ty)'
```

// Where a, b, c, d build the transformation matrix

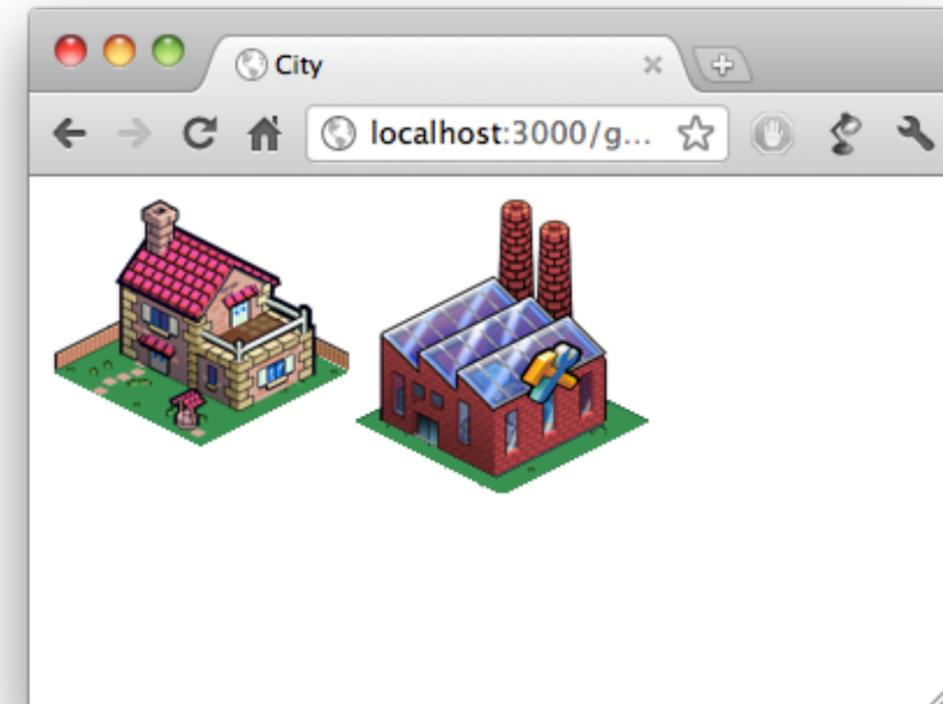
```
//  $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ 
```

// and tx, ty are the translate values.

// See <https://developer.mozilla.org/en/CSS/transform>

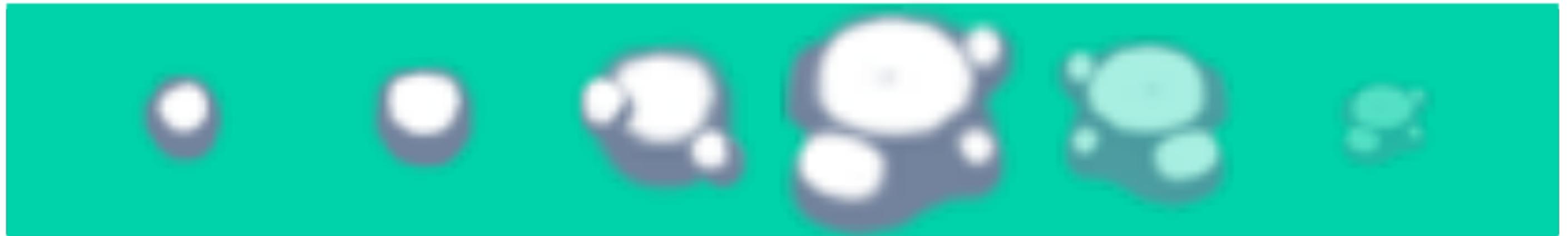
  

```
// Webkit based browsers – hardware accelerated
var transform = 'translate3d(10px, 20px, 1px) rotate(0.3rad) scale(2, 2)';
sprite.style.webkitTransform = transform;
```



# Animation

# Sprite Sheets



```
// canvas  
  
var frame = 2;  
var width  = 32;  
var height = 32;  
  
context.drawImage(particles,  
                  frame * width, 0,  
                  width, height,  
                  x, y,  
                  width, height);
```

```
// using CSS

var frame = 2;
var width  = 32;
var height = 32;

var element = ...

// Set the 'background-position' CSS attribute
element.style.backgroundPositionX =
    -(frame * width) + 'px';
```



128 x 128  
(5 frames)



Single 128 x 128 image

smaller 32 x 32  
overlay animation

# Main Loop

```
var intervalID = window.setInterval(func, delay);  
var intervalID = window.setTimeout (func, delay);
```

# Request Animation Frame

```
// How long does update take to call?  
// How long since last call to update?  
  
var update = function(dt) {  
  
    var now = new Date();  
    var now = window.mozAnimationStartTime;  
  
}
```

# User Input

# Keyboard

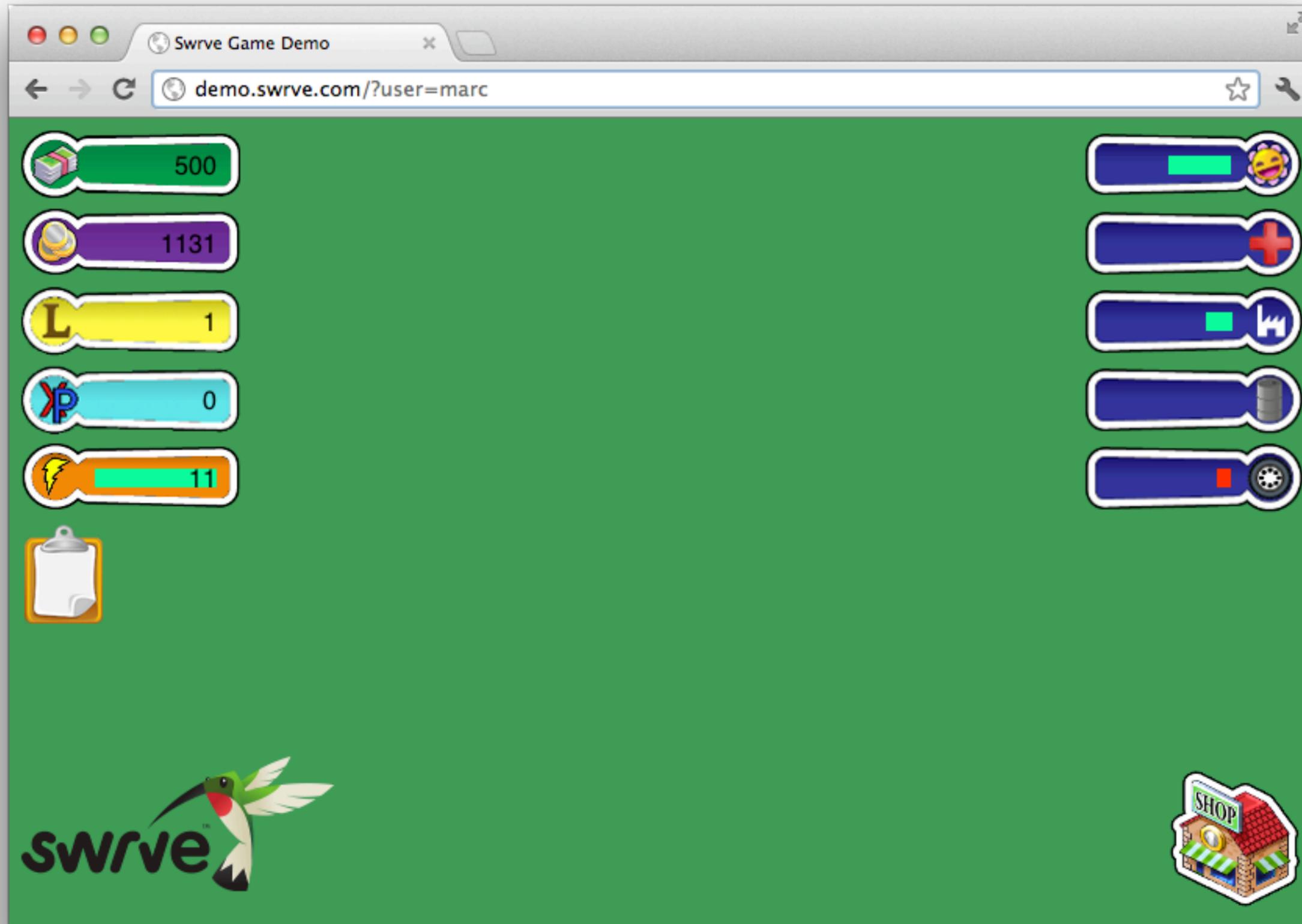
# Mouse + Touch

# Mouse

One click handler on the `<canvas>`

What did the user click on?







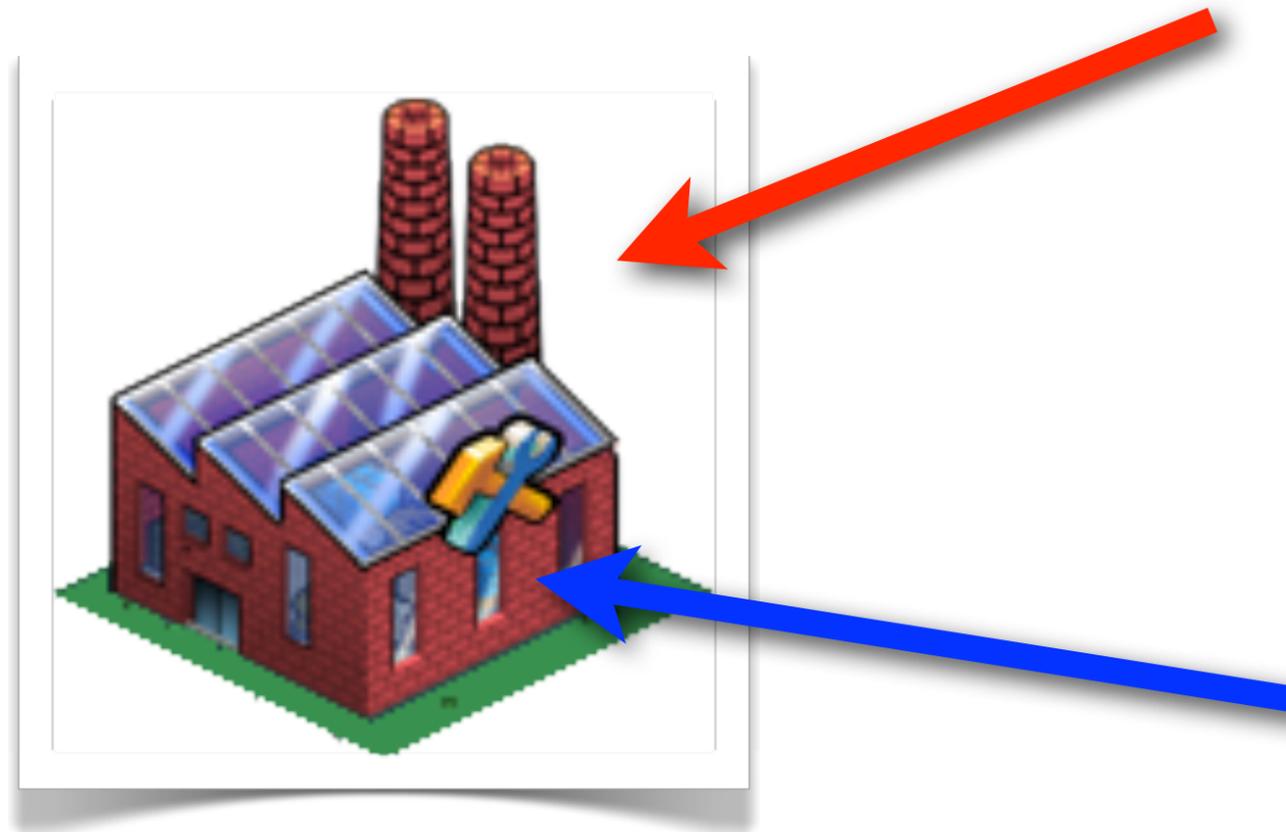
Build a tree of all clickable  
objects in the scene

# Click Maps

What happens player  
clicks on a background  
pixel?



Need to be able to tell  
when a click is on the  
image





Original Image  
128x128



Black and white  
alpha channel



32x32 pixel  
click map

```
0000000000000000001111000000000000
0000000000000000001111011000000000
0000000000000000001111111100000000
0000000000000000001111111100000000
0000000000000000001111111110000000
00000000001111111111111100000000
00011111111111111111111110000000
000111111111111111111111110000
0001111111111111111111111110000
0001111111111111111111111110000
0001111111111111111111111110000
000111111111111111111111111100
001111111111111111111111111110
000000111111111111111111100000
000000000011111111111100000000
00000000000000001111000000000000
```

Text array

Render image to off-screen  
<canvas>

```
1 window.onload = function(){
2
3 var image = new Image();
4 image.onload = function(){
5     var canvas = document.createElement('canvas');
6     canvas.width = image.width;
7     canvas.height = image.height;
8
9     var context = canvas.getContext('2d');
10    context.drawImage(image, 0, 0);
11
12    var i,j;
13
14    var pixels = context.getImageData(0, 0, image.width, image.height);
15
16    for (i=0; i<image.width; i++){
17        for(j=0; j<image.height; j++){
18            pixels.data[i+(j*image.width)];
19        }
20    }
21    image.src = 'http://www.html5rocks.com/static/images/identity/html5-badge-h-graphics.png';
22
23 };
24
```

✘ Uncaught Error: SECURITY\_ERR: DOM Exception 18

✘ 2



Do the work once on the server

```
var click_map_data = {
```

```
  'factory.png' : '000000000000000000001111000000000000' +
                  '000000000000000000001111011000000000' +
                  '000000000000000000001111111100000000' +
                  '000000000000000000001111111100000000' +
                  '00000000000000000011111111100000000' +
                  '000000000001111111111111100000000' +
                  '0000001111111111111111100000000' +
                  '00011111111111111111111110000000' +
                  '0001111111111111111111111110000' +
                  '00011111111111111111111111110000' +
                  '000111111111111111111111111110000' +
                  '00011111111111111111111111111100' +
                  '0011111111111111111111111111110' +
                  '00000011111111111111111111100000' +
                  '00000000000111111111111000000000' +
                  '00000000000000000011110000000000000',
```

```
  'burger.png' : '0000000000000000111110000000000000' +
                 '00000000000011111111100000000000' +
                 '00000000000011111111110000000000' +
```



# Touch

# iOS Click Delay

300ms

```
var mouse_start_x = 0;
var mouse_start_y = 0;
var mouse_x = 0;
var mouse_y = 0;

document.ontouchstart = function(event) {
    mouse_x = mouse_start_x = event.pageX;
    mouse_y = mouse_start_y = event.pageY;
}
```

```
document.ontouchmove = function(event) {  
    mouse_x = event.pageX;  
    mouse_y = event.pageY;  
}  
  
document.ontouchend = function(event) {  
    if (distance_between(mouse_x, mouse_y,  
        start_mouse_x, start_mouse_y) > 10) {  
        click_at(mouse_x, mouse_y);  
    }  
}
```

# Pinch

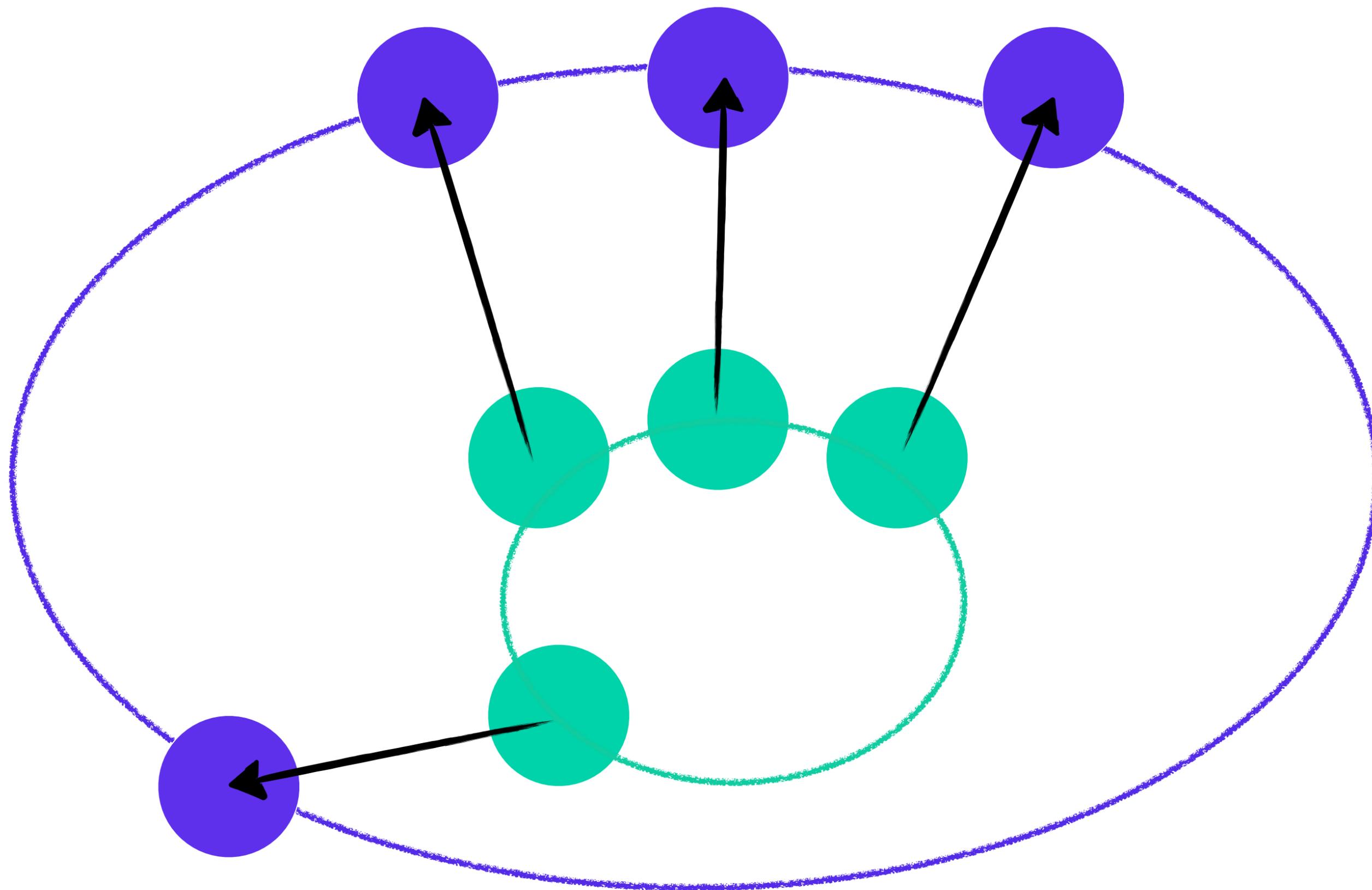


```
var pinch_distance = 0;

document.ontouchmove = function(event){
    if (event.touches.length == 2){
        var t0 = event.touches[0];
        var t1 = event.touches[1];

        var d = distance_between(t0.pageX, t0.pageY,
                                t1.pageX, t1.pageY);

        on_pinch(d - pinch_distance);
        pinch_distance = d;
    }
}
```

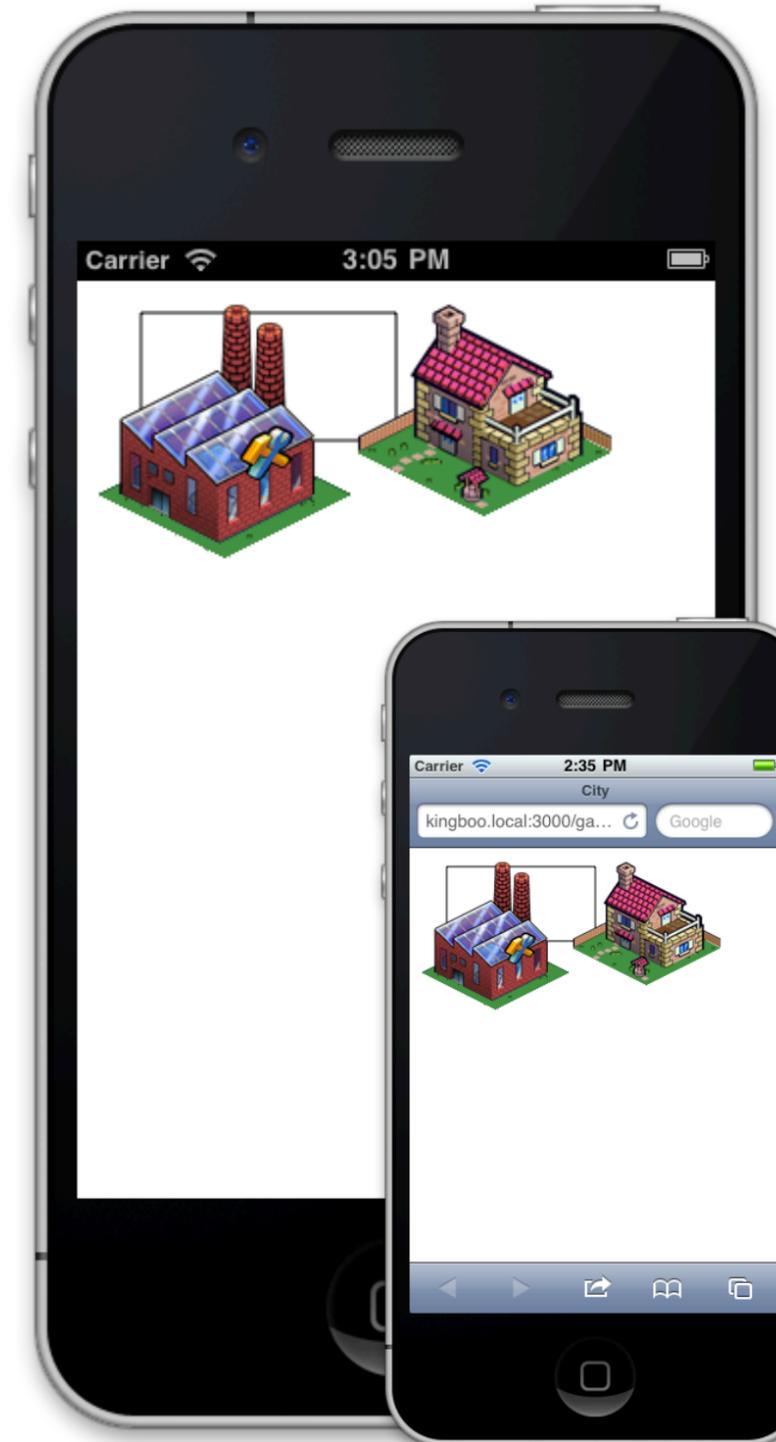


# Throttling Input

# Event Based Callbacks Can Fire Multiple Times Per Frame

# iOS Web Apps

```
<html>
  <head>
    <meta name="viewport" content="width=device-width,
      initial-scale=1.0,
      maximum-scale=1.0,
      user-scalable=0" />
    <meta name="apple-mobile-web-app-capable" content="yes" />
    <meta name="apple-mobile-web-app-status-bar-style" content="black" />
    <link rel="apple-touch-icon" sizes="72x72" href="touch-icon-ipad.png" />
    <link rel="apple-touch-icon" sizes="114x114" href="touch-icon-iphone4.png" />
    <link rel="apple-touch-startup-image" href="/startup.png">
```



# Development Tools

# Writing Code

```

1 (function(){
2
3
4 // Return the linear distance between 2 points
5 var distance_between = function(x1, y1, x2, y2){
6     var x = x2 - x1;
7     var y = y2 - y1;
8     return Math.sqrt((x*x)+(y*y));
9 }
10
11
12 // touch
13 var distance_between_touches = function(event){
14     var touch_a = event.touches[0];
15     var touch_b = event.touches[1];
16     return distance_between(touch_a.pageX,
17                             touch_a.pageY,
18                             touch_b.pageX,
19                             touch_b.pageY);
20 };
21
22
23
24 var self = this;
25 var swrve = self.swrve || {};
26
27
28 var var = this;
29
30 swrve.setup_mouse = function(){
31
32     var jdoc = $(document);
33
34
35     var mouse_down = false;
36     var mouse_x = 0;
    
```

Validate Javascript

Theme: Bright

Input.js

### JavaScript Lint

1 error(s), 1 warning(s)

- 13: **WARNING:** [missing semicolon](#)

```
var distance_between_touches = function(event){
..^
```

- 28: **SYNTAX ERROR:** [missing variable name](#)

```
var var = this;
.....^
```

gcc -Wall -Werror

# Unit Tests

# Jasmine

<http://pivotal.github.com/jasmine/>

```
describe("Maths", function() {  
    it("should be able to add numbers", function() {  
        expect(2 + 2).toEqual(4);  
    });  
  
    describe("subtraction", function() {  
        it("should be able to subtract numbers", function() {  
            expect(10 - 2).toEqual(8);  
            expect(100 - 90).toEqual(10);  
        });  
    });  
});
```

# Profiling

# Performance Profiling

The screenshot shows a web browser window with the URL `demo.swrve.com/?user=steve`. The game interface includes a HUD on the left with values: 500 (green), 1090 (purple), 1 (yellow), and a 'SWRVE' logo. On the right, there are several blue buttons with icons: a green bar, a red cross, a green bar with a cursor, a red heart, and a 'SHOP' icon. The developer tools are open, showing a table of CPU profiles.

Self	Total	Function	
94.19%	94.19%	(program)	
0.03%	4.04%	▼ (anonymous function)	<a href="#">game.js:1323</a>
0.83%	2.07%	▶ GameState.update	<a href="#">game.js:178</a>
0.21%	0.21%	jQuery.each(jQuery.fn.(anonymous function))	<a href="#">jquery.js:6199</a>
0.02%	0.08%	▶ jQuery.fn.jquery.init	<a href="#">jquery.js:75</a>
0%	1.18%	▼ Layer.draw	<a href="#">swrve_layer.js:89</a>
0.72%	0.72%	transform	<a href="#">swrve_layer.js:276</a>
0.06%	0.45%	▼ drawOnce	<a href="#">swrve_layer.js:45</a>
0.17%	0.40%	▼ swrve.Sprite.draw	<a href="#">swrve_sprite.js:121</a>
0.23%	0.23%	transform	<a href="#">swrve_layer.js:276</a>
0%	0.47%	▶ Hud.update	<a href="#">hud.js:330</a>
0.01%	0.01%	(garbage collector)	
0%	1.39%	▶ jQuery.event.add.elemData.handle.eventHandle	<a href="#">jquery.js:1595</a>
0%	0.38%	▶ jQuery.extend.ajax.xhr.onreadystatechange	<a href="#">jquery.js:5163</a>

At the bottom of the developer tools, there are icons for 'Tree (Top Down)', a percentage sign, a magnifying glass, and a close button. A status bar at the very bottom shows '1' error and '702' warnings.





Marc O'Morain (deadbankclerk) on Twitter - Windows Internet Explorer

https://twitter.com/#!/de Twitter, Inc. [US] Bing

Marc O'Morain (deadbankclerk) on Twitter

Home @ Connect # Discover Search

File Find Disable View Outline Images Cache Tools Validate

Browser Mode: IE8 Document Mode: IE8 Standards

HTML CSS Script Profiler Search Profiler

Start Profiling Current View: Call Tree Report 1

Function	Count	Inclusive Time (...)	Exclusive Time (...)	URL	Line Numb...
JScript - window script block	13	2,308.00	1.00		
eventHandle	176	1,320.00	8.00		
Function.apply	176	1,312.00	0.00		
dispatch	176	1,312.00	15.00		
Function.apply	182	941.00	3.00		
is	910	232.00	4.00		
filter	910	226.00	1.00		
RegExp.test	910	2.00	2.00		
fix	176	84.00	13.00		
_data	176	19.00	0.00		
quickIs	1,669	19.00	18.00		
RegExp.test	1,080	1.00	1.00		
String.toLowerCase	608	0.00	0.00		
Function.call	176	1.00	1.00		

Done Internet | Protected Mode: On 100%

# Garbage Collection

So what code  
allocates memory?

```
var dict = {  
    foo: 'bar',  
    baz: 'qux'  
};
```

```
var object = new FooBar();
```

```
var string = 'Head ' + tail;
```

```
var string = 'foo';  
var dict   = { foo: 1 };  
  
// Closes over dict and string  
var func = function(){  
    return dict[string];  
};
```

How can we refactor code to  
avoid allocation?

Change code like this:

```
// This code is going to
// allocate a dictionary on each
// iteration of the loop
// unless the compiler/JIT can
// prove otherwise.

for (i=0; i < items.length; i++){
    items[i].foo({x: i, y: 2 * i});
};
```

To be more like this:

```
// Allocate the dictionary once
var pos = {x: 0, y: 0};

for (i=0; i < items.length; i++){

    // Update the one dictionary
    // in the body of the loop.
    pos.x = i;
    pos.y = 2 * i;

    items[i].foo(pos);
};
```

The screenshot shows a web browser window displaying a game demo at `demo.swrve.com/?user=steve`. The game interface includes a score of 500, a level indicator of 2372, and an XP bar at 0. The browser's developer tools are open to the Profiles tab, showing a CPU profile for 'Profile 1'.

**Profiles**

- Profile 1
- Profile 2

**HEAP SNAPSHOTS**

- Snapshot 1 (4.78MB)
- Snapshot 2 (4.78MB)

**Constructor**

	#	Shallow ...	Retained..
swrve.IsoEngine.Entity	1	52B	> 312B
swrve.IsoEngine.Entity: @134871		52B	312B
sprite: Object: @134921		12B	948B
draw: function (): @2043		36B	19.76KB
shared: : @38703		92B	6.88KB
32: function (): @52565		36B	3.38KB
transparent: function (): @132887		36B	828B
initWhenLoaded: function (): @25303		36B	36B
makeHtmlElement: function (): @47127		36B	36B
__proto__: function Empty(): @6873		36B	36B
local_canvas: HTMLCanvasElement: @106501		20B	20B
elements: []: @68403		8B	8B

**Object's retaining tree**

Object	Shallow ...	Retained...
retained by Object: @121677.draw	12B	916B
retained by Object: @115297.draw	12B	904B
retained by Object: @134921.draw	12B	948B
retained by Object: @121363.draw	12B	904B

Summary: Objects allocated between Snapshots 1 and 2: % ?

# Debugging

The screenshot shows a web browser window titled "Swrve Game Demo" with the URL "demo.swrve.com/?user=steve". The game interface features a top-left HUD with a green box containing the number "500" and a purple box containing "1057". A hummingbird is flying over the "swrve" logo. The game scene is an isometric view of a town with houses, a tree, and a shop.

Below the game is the Chrome DevTools interface. The "Scripts" panel is open, showing the file "swrve\_layer.js" with the following code:

```

89 Layer.prototype.draw = function(context){
90     if (context){
91         context.save();
92         if (this.rx || this.ry) {
93             var x_count = 1;
94             var y_count = 1;
95             var cw = context.canvas.width;
96             var ch = context.canvas.height;
97             var tx = 0; // The initial distance to translate on the x-
98             var ty = 0; // The initial distance to translate on the y-
99             if (this.rx){
100                 that.assert(this.rx > 0);
101                 // Calculate the starting x position
102                 var dx = this.x % this.rx;
103                 if (dx < 0) {
104                     dx += this.rx;
105                     tx = -this.rx;
106             }
107         }
108     }
109 }

```

The right-hand side of the DevTools interface shows the "Watch Expressions" panel with the expression "window == document: false". Other panels like "Call Stack", "Scope Variables", and "Breakpoints" are also visible.



# Hosting

Local web server  
<http://localhost:8080>

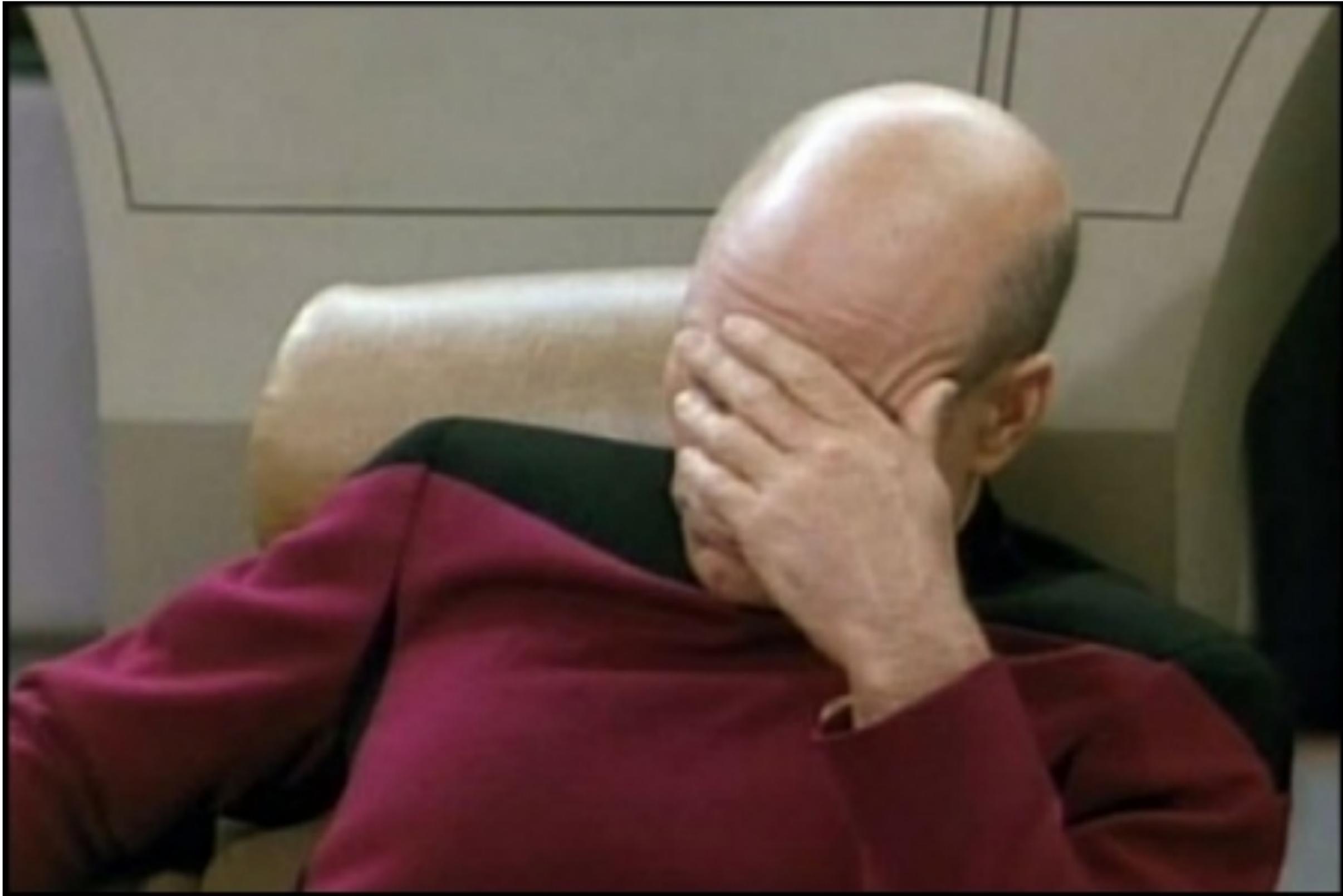


And you launch your game...



# Browser Cache

# HTML5 Audio



# Use Flash



# Questions?

(please use the microphone)

marc.omorain@swrve.com  
@atmarc