

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

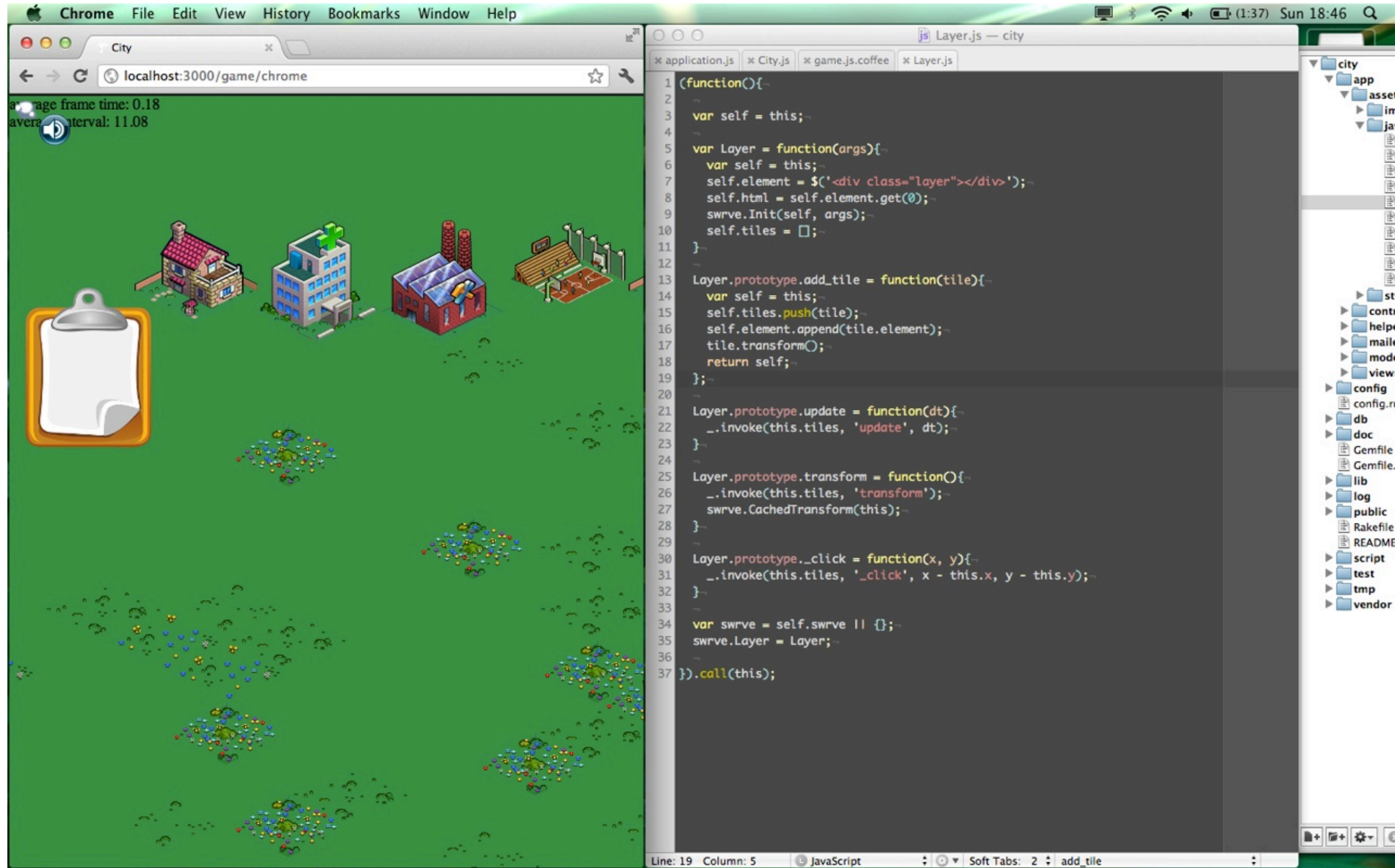
Why  ?

Why do people use Lua?

1. Fast Iteration

15 minutes to run the game!





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 `bold`.

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

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

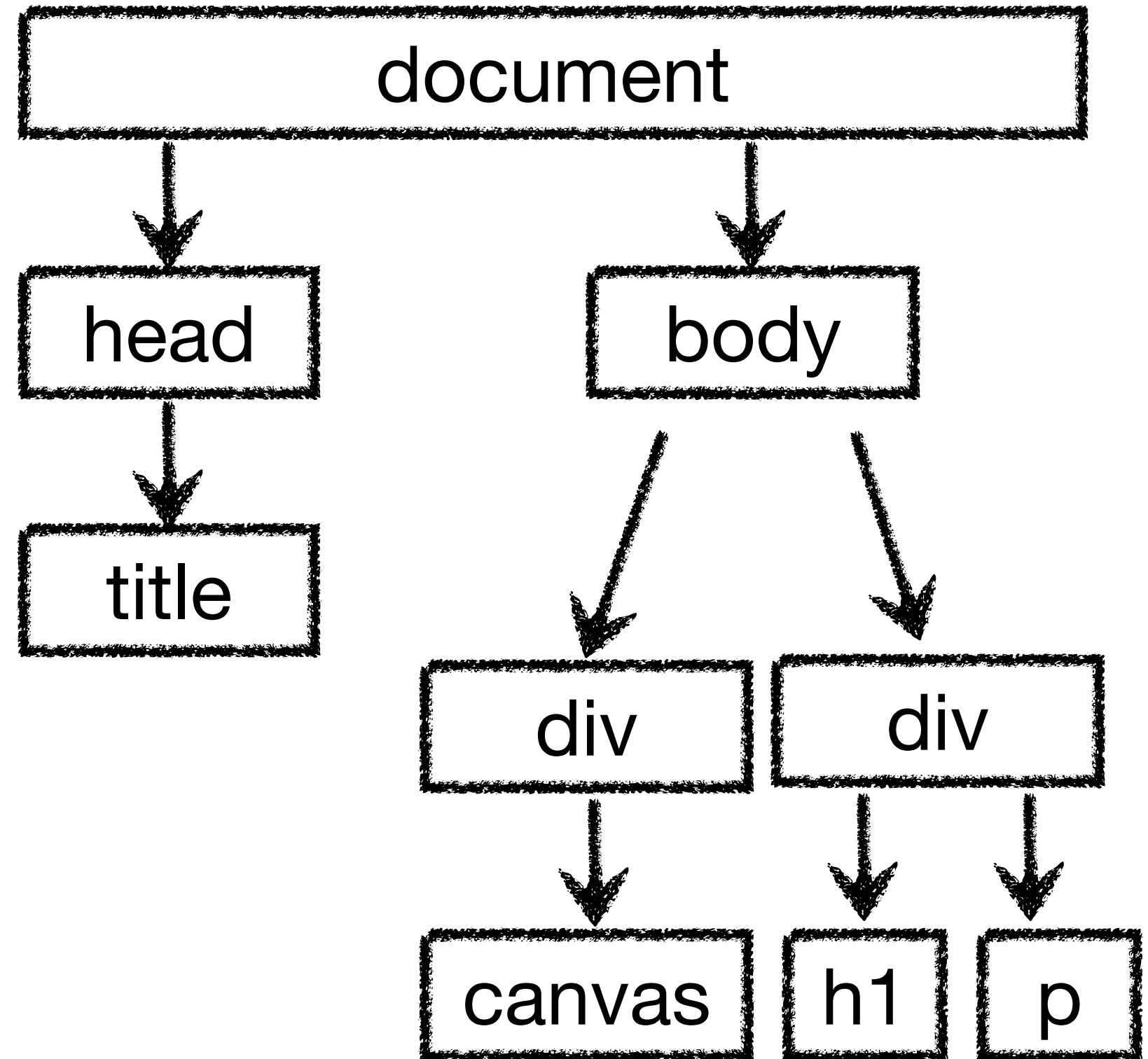
```
#include <stdio.h>
#include <stdlib.h>

// 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>
```

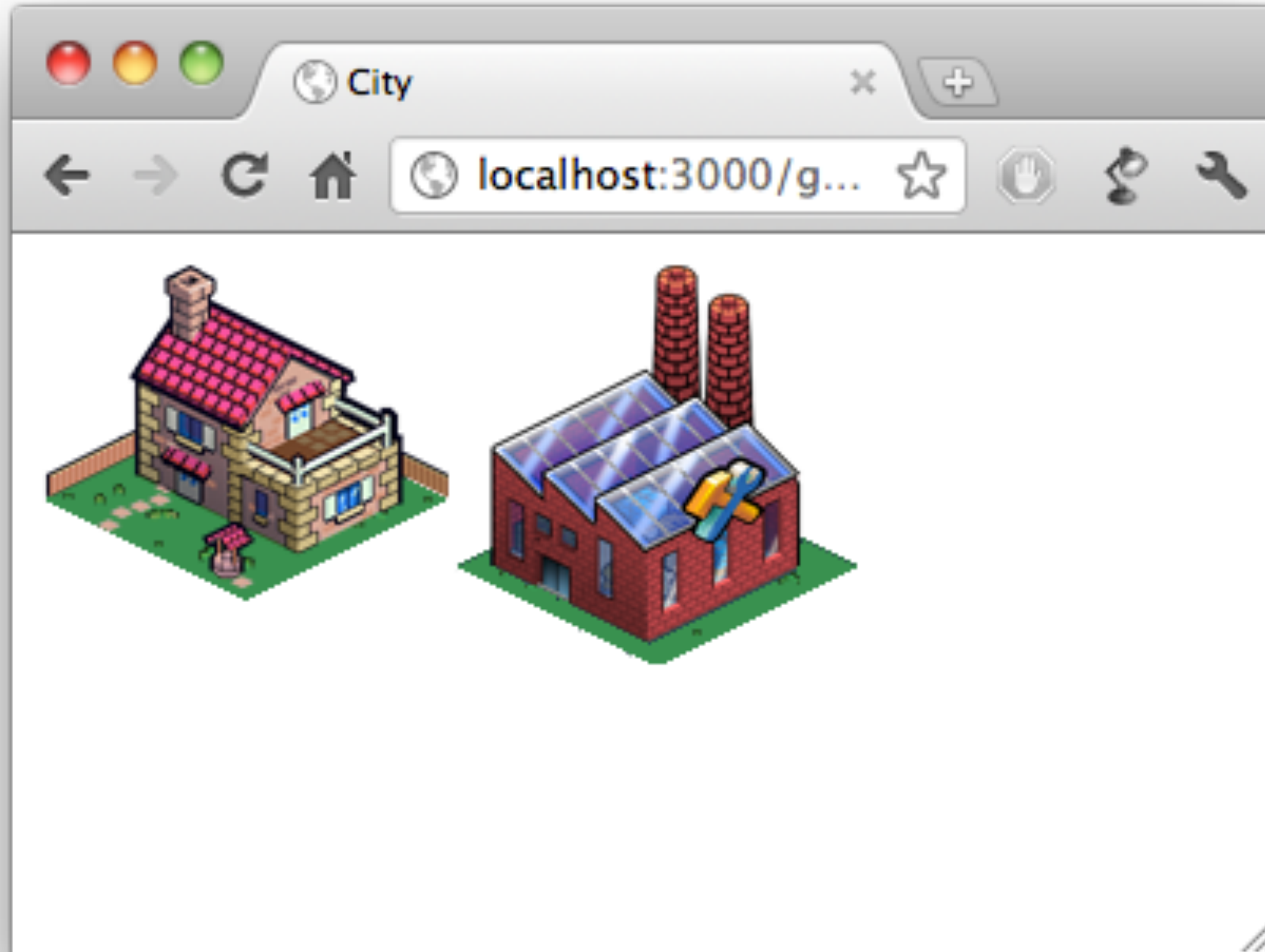
DOM

The DOM is a tree
exposed to
JavaScript



Rendering

<canvas>

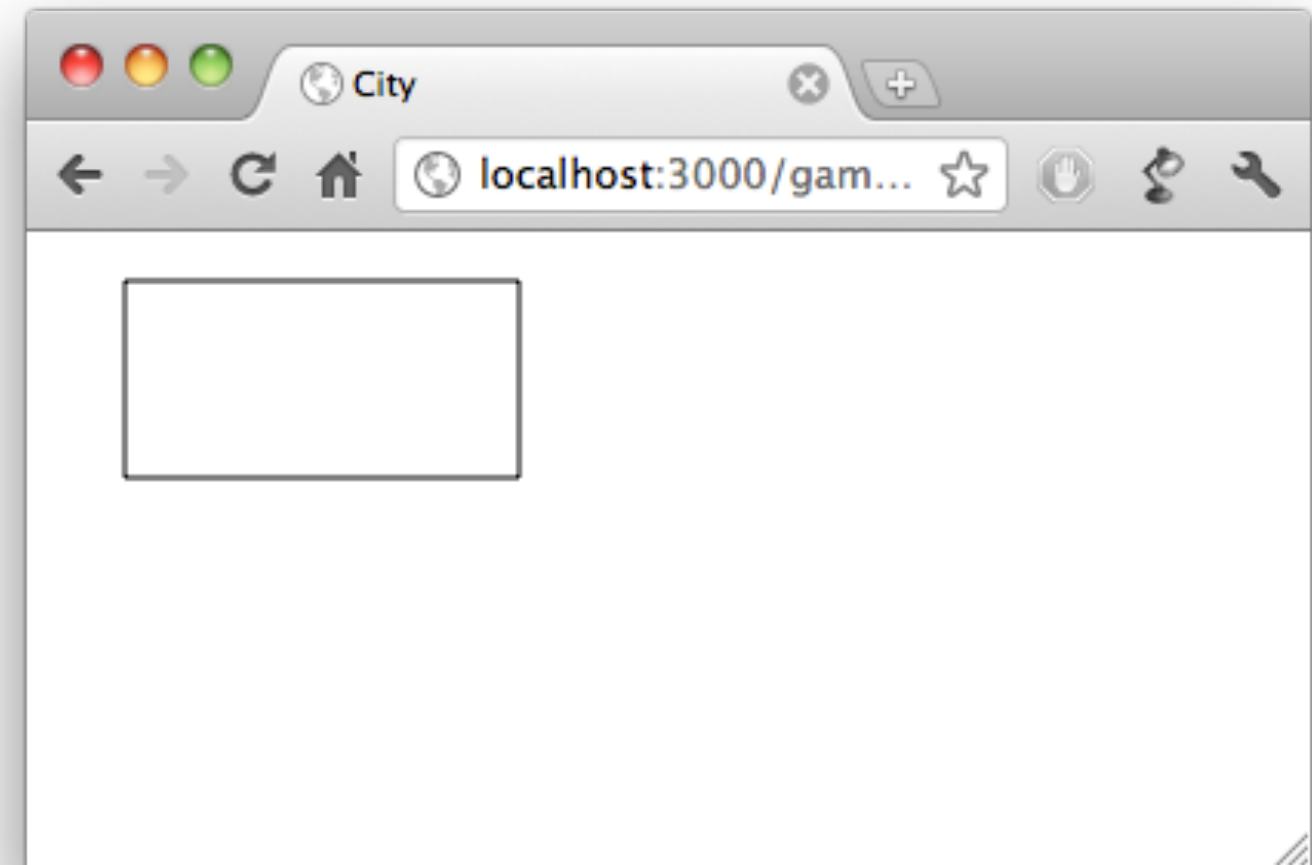


```
<html>
  <body>
    <canvas id="game"></canvas>
  </body>
</html>
```

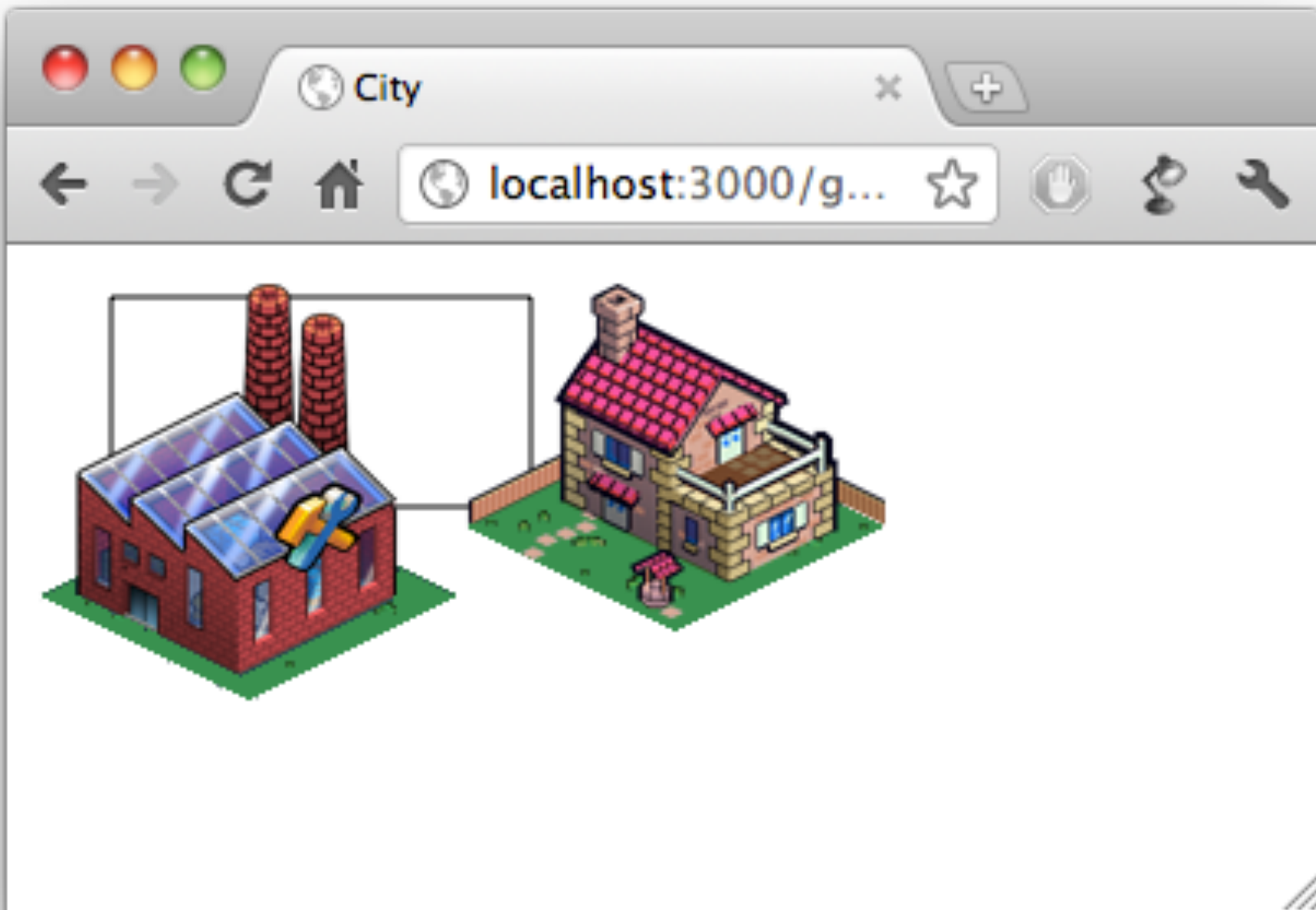
Make a canvas
element that fills the
screen

```
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

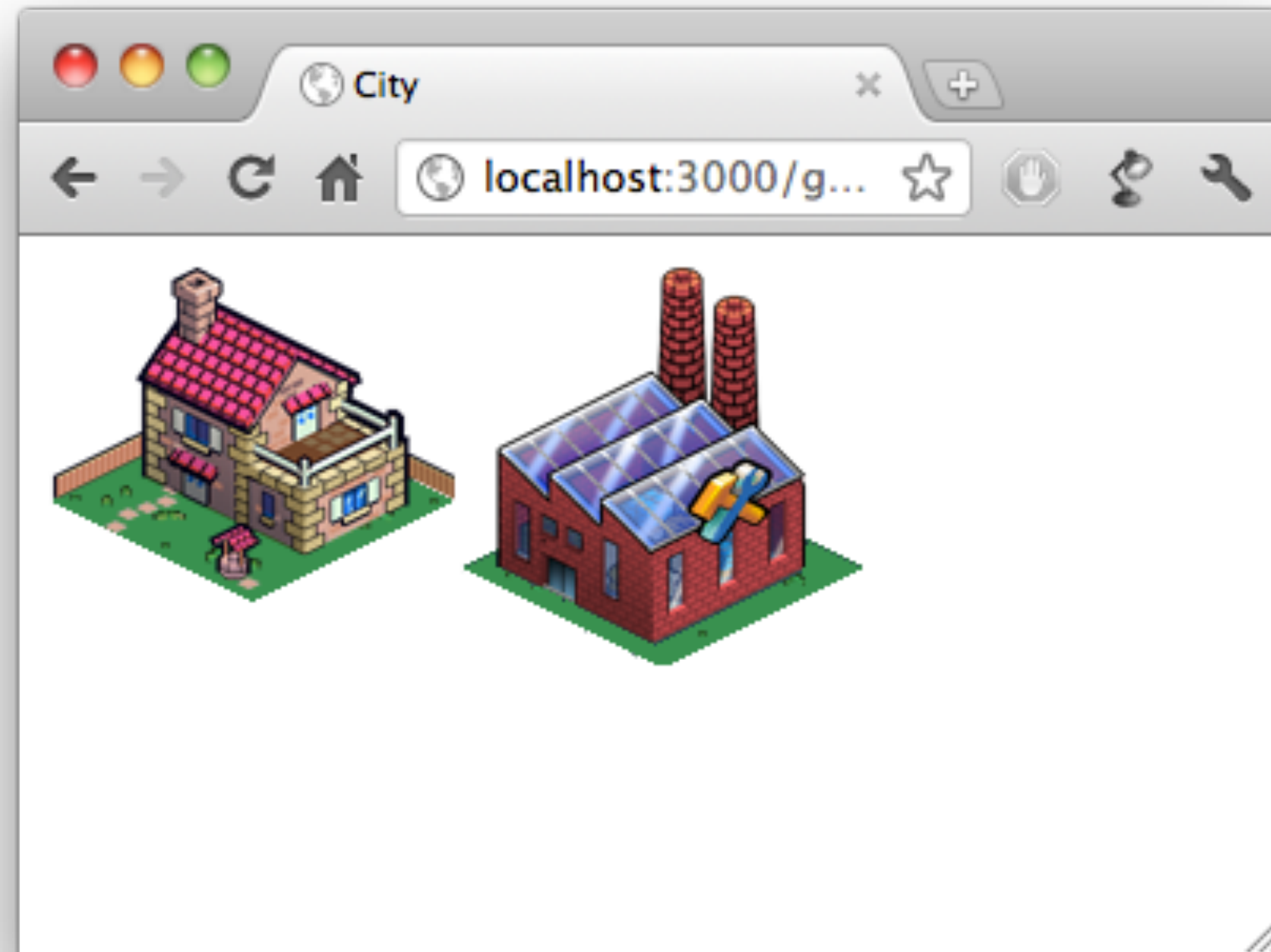


<canvas> text rendering

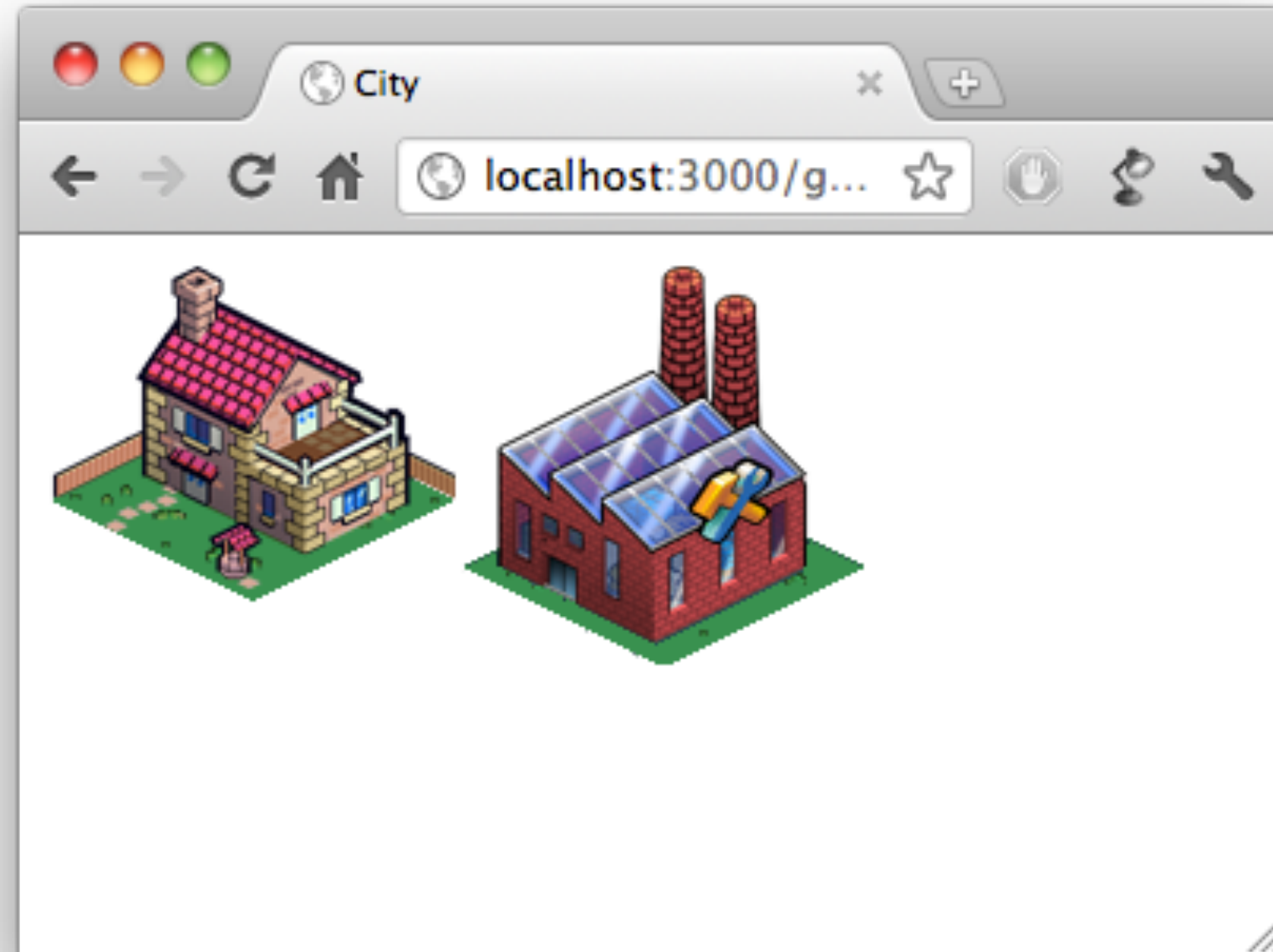
WebGL

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;  
}
```

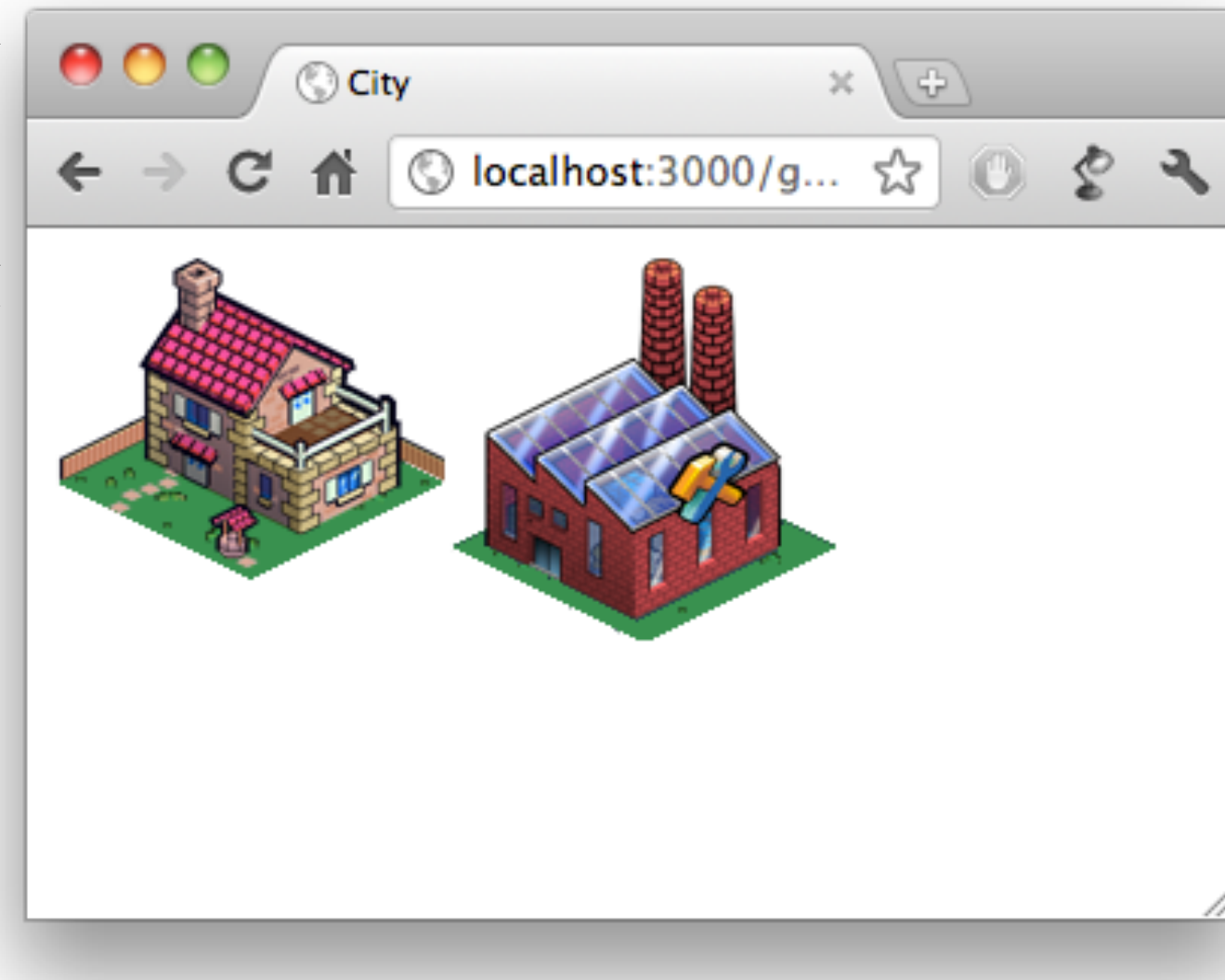


```
<html>
  <body>
    <div class="game" id="game"></div>
  </body>
</html>
```

```
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);
```

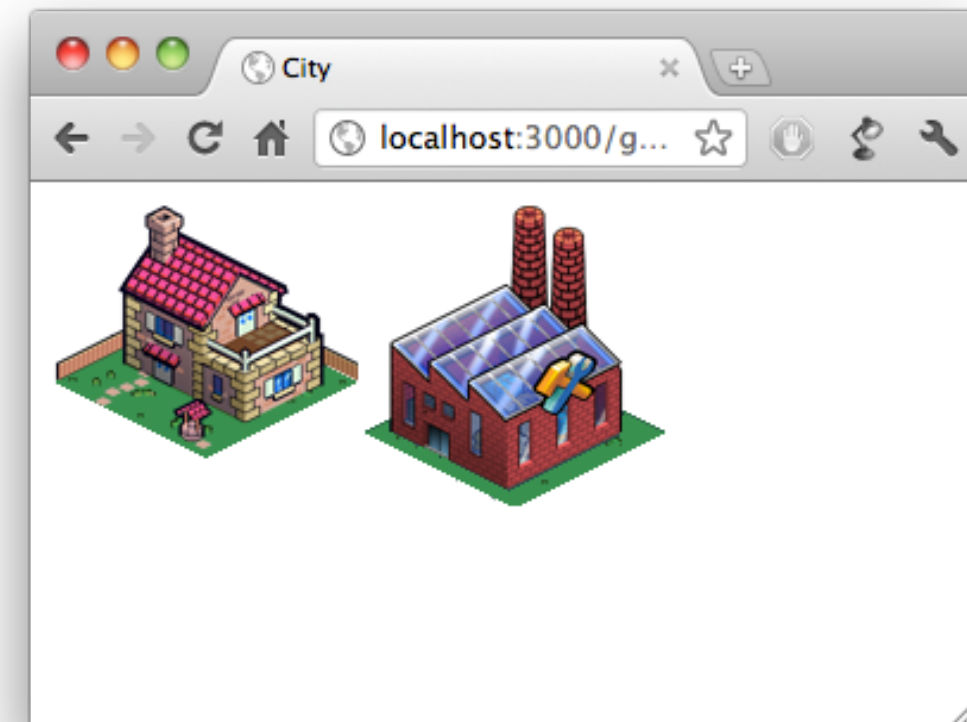



```
// Firefox
sprite.style.MozTransform = 'matrix(a, c, b, d, tx, ty)'
```

// 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

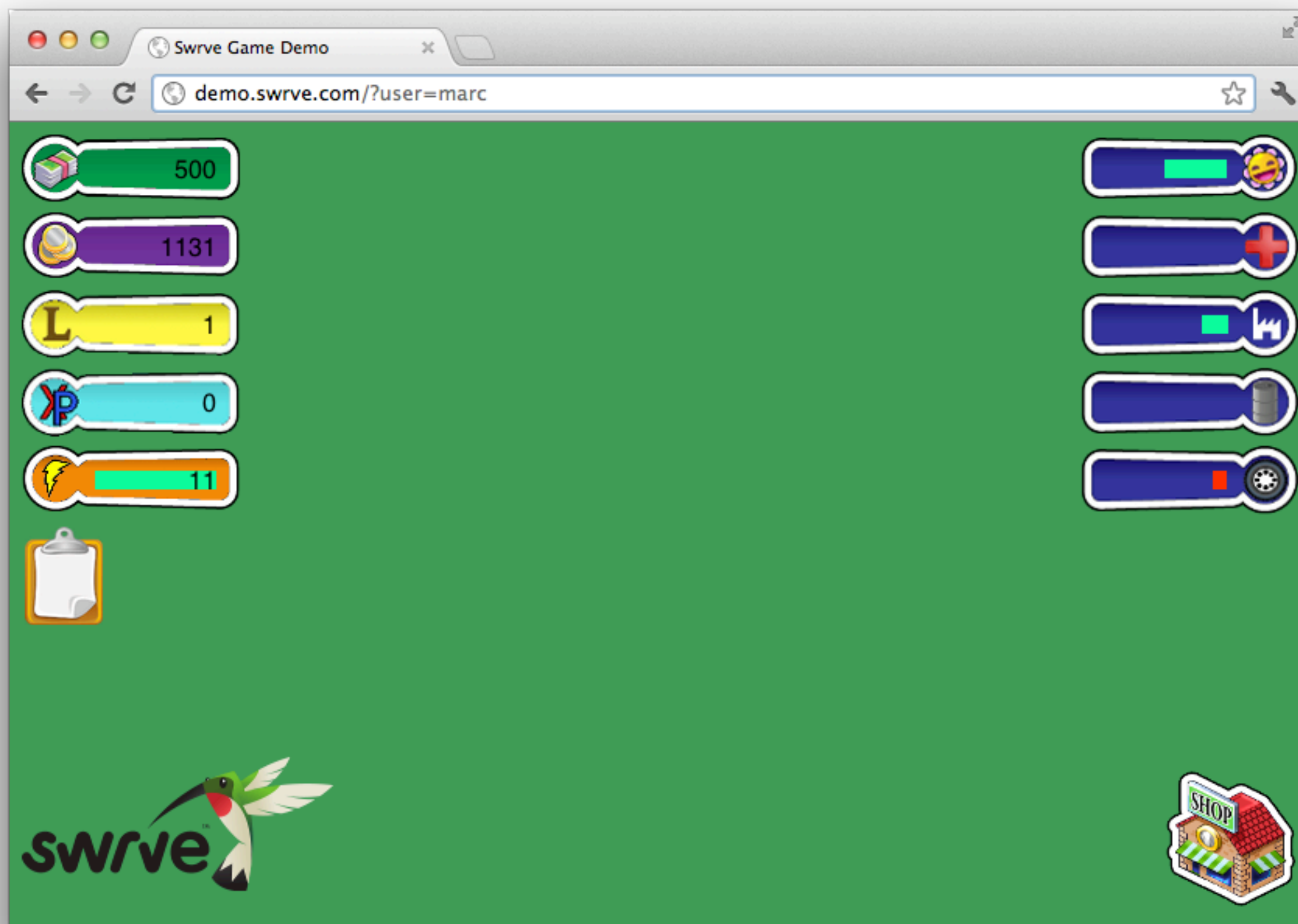
Mouse + Touch

Mouse

One click handler on the <canvas>

What did the user click on?



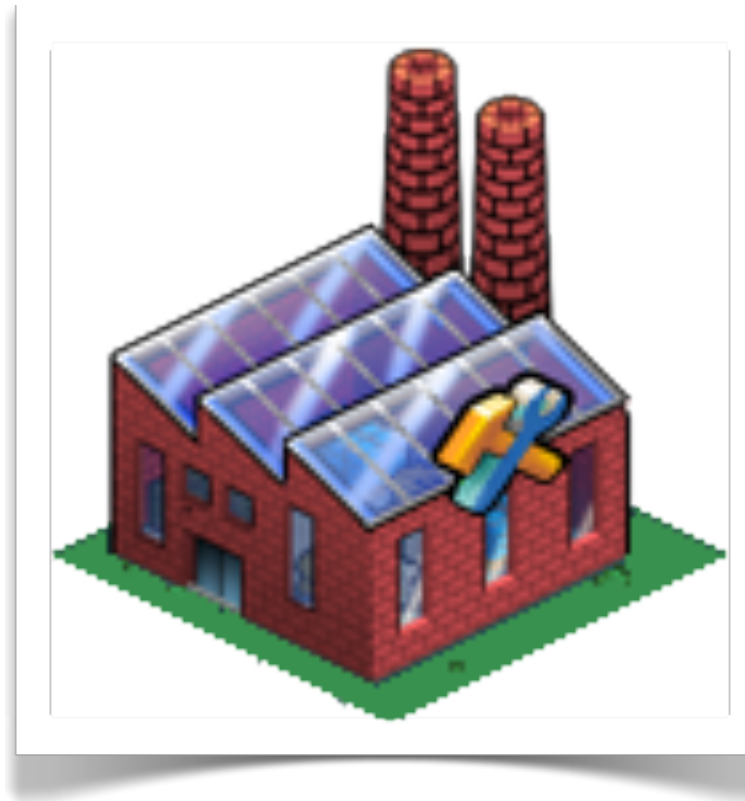




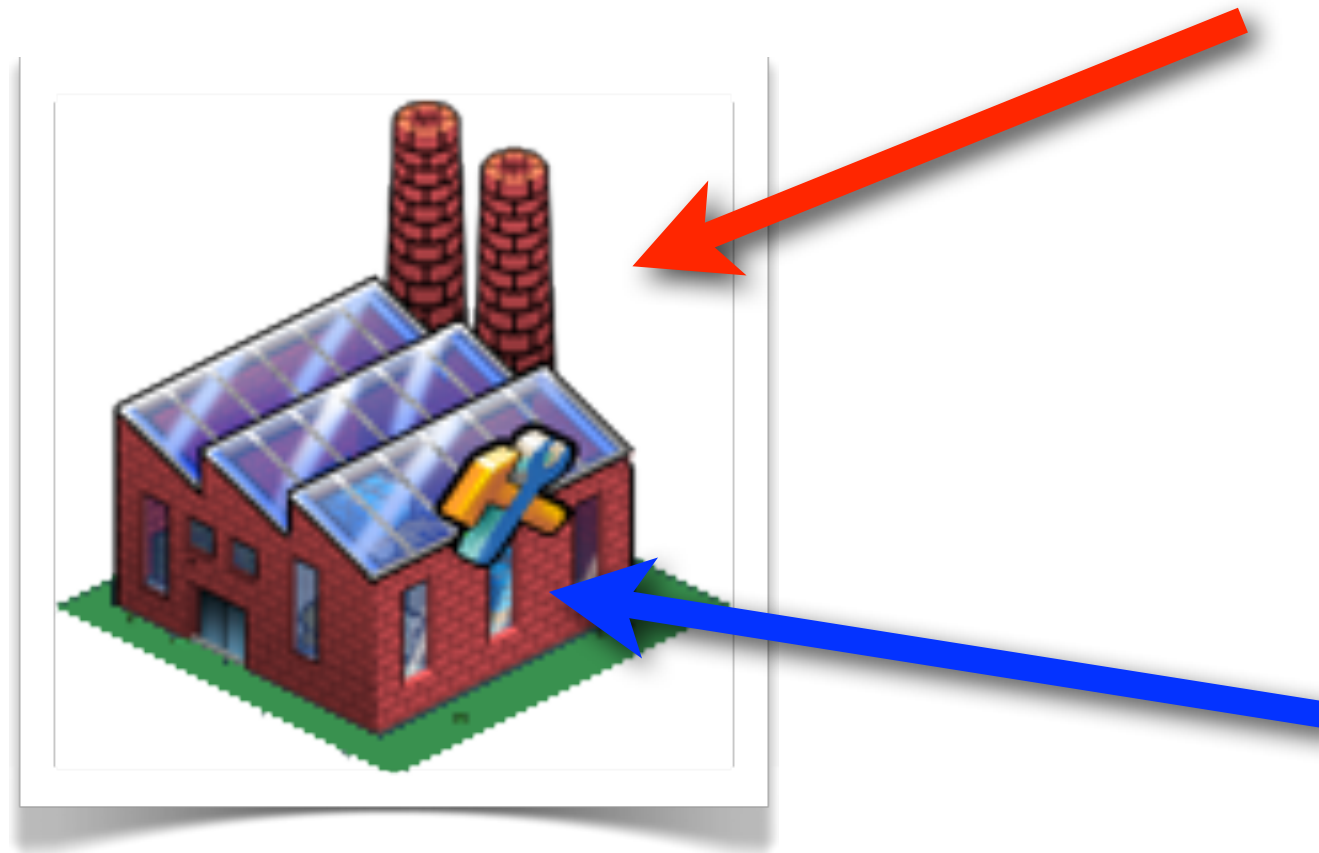
Build a tree of all clickable
objects in the scene

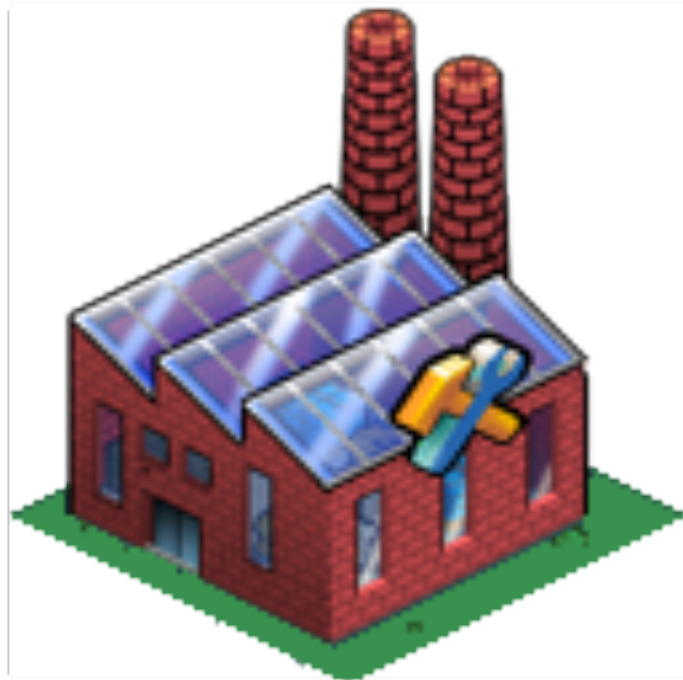
Click Maps

What happens player
clicks on a background
pixel?

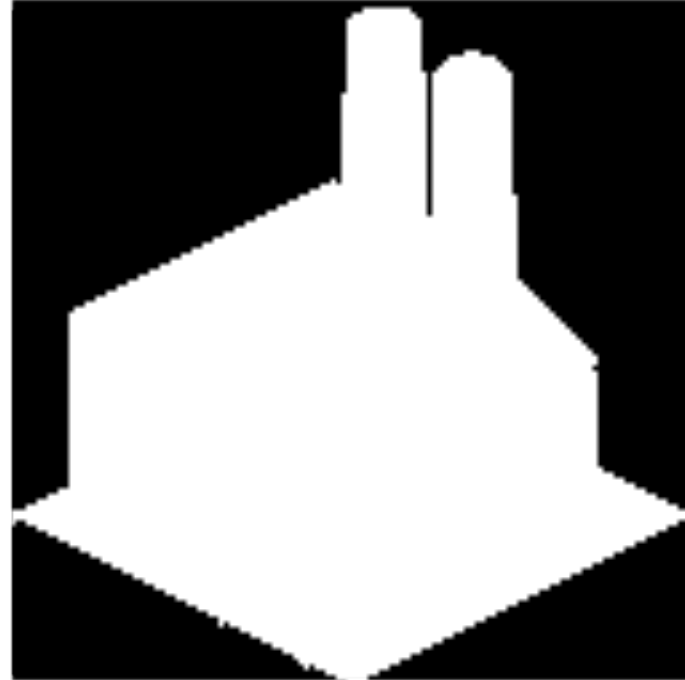


Need to be able to tell
when a click is on the
image





Original Image
128x128



Black and white
alpha channel



32x32 pixel
click map

```
0000000000000000001111000000000000
0000000000000000001111011000000000
0000000000000000001111111000000000
0000000000000000001111111000000000
00000000000000001111111100000000
000000000011111111111110000000
000000111111111111111110000000
001111111111111111111110000000
0011111111111111111111110000
00111111111111111111111110000
00111111111111111111111110000
00111111111111111111111110000
00111111111111111111111110000
001111111111111111111111100
0111111111111111111111111110
00000111111111111111111100000
00000000011111111111100000000
000000000000001111000000000000
```

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 };
```

✖ Uncaught Error: SECURITY_ERR: DOM Exception 18

✖ 2



Do the work once on the server

```
var click_map_data = {
```

```
'factory.png' : '000000000000000000000000111100000000000000' +
                  '000000000000000000000000111101100000000000' +
                  '000000000000000000000000111111111000000000' +
                  '000000000000000000000000111111111000000000' +
                  '00000000000000000000111111111111000000000' +
                  '00000000000011111111111111111000000000' +
                  '00000011111111111111111111111000000000' +
                  '00011111111111111111111111111110000000' +
                  '0001111111111111111111111111111110000' +
                  '0001111111111111111111111111111110000' +
                  '000111111111111111111111111111111110000' +
                  '000111111111111111111111111111111111100' +
                  '0011111111111111111111111111111111111110' +
                  '0000001111111111111111111111111111100000' +
                  '000000000000111111111111111110000000000' +
                  '000000000000000000001111000000000000000',
```

```
'burger.png' : '000000000000000011111100000000000000' +
                '00000000000000111111111110000000000000' +
                '00000000000000111111111111000000000000' +
```

[illegible]

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

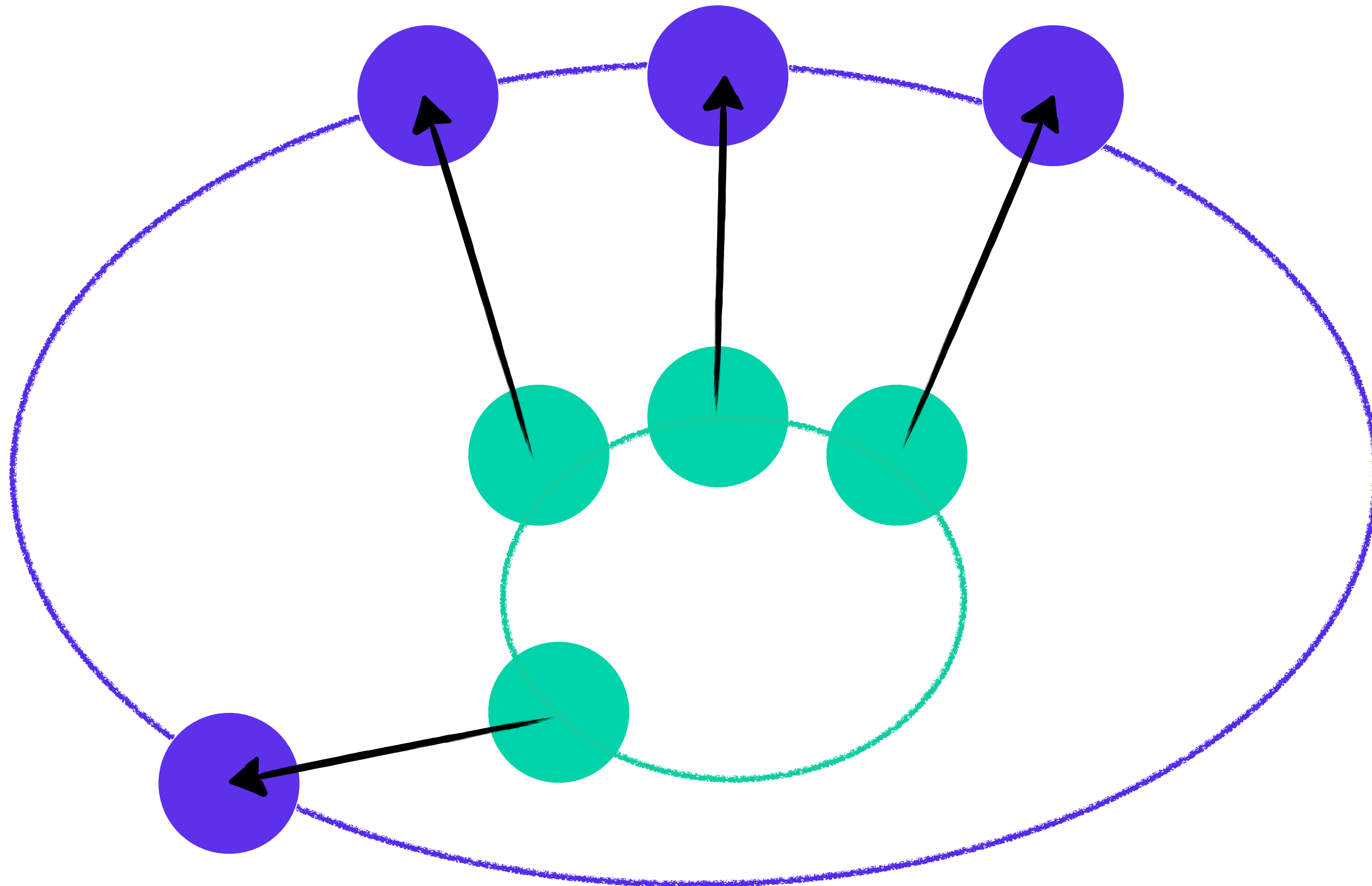


```
var pinch_distance = 0;

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

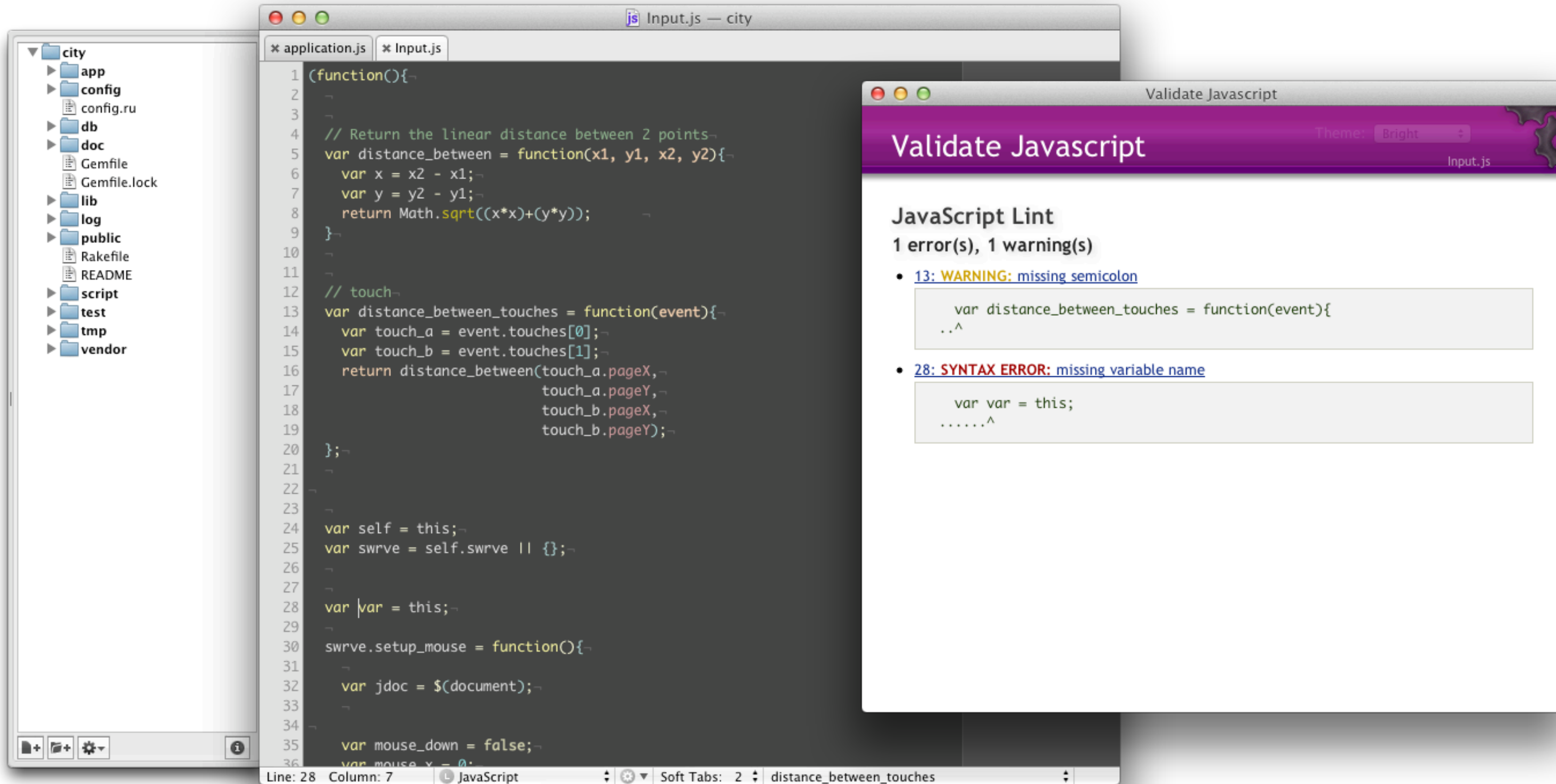
iOS Web Apps


```
<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



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 displaying a game demo titled "Swrve Game Demo" at the URL `demo.swrve.com/?user=steve`. The game interface features a top HUD with various stats: 500 (green bar), 1090 (purple bar), 1 (yellow bar), and a Swrve logo. The game world is an isometric view of a city with roads, buildings, a Ferris wheel, and a fountain. On the right side of the game area, there are several interactive buttons: a green bar, a red cross, a green bar with a key icon, a heart icon, and a shop icon.

Below the game area, a performance profiling tool is open, showing a table of CPU profiles. The table has three columns: "Self", "Total", and "Function". The "Function" column lists various JavaScript functions and their corresponding source files. The "Self" and "Total" columns show percentages.

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

The performance tool interface includes a sidebar with "Profiles" and "CPU PROFILES" sections. The "CPU PROFILES" section shows "Profile 1" and "Profile 2". The "Profiles" section shows a search bar and a list of profiles. The bottom of the tool shows a "Tree (Top Down)" view and a status bar with "1" error and "702" warnings.





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

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

★ Favorites ★ Suggested Sites Web Slice Gallery

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...
JSript - 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);

};
```

Swrve Game Demo

demo.swrve.com/?user=steve

500

2372

swrve

0

Elements Resources Network Scripts Timeline Profiles Audits Search Profiles

Profiles

CPU 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 % ? 1 782

Debugging





Hosting

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

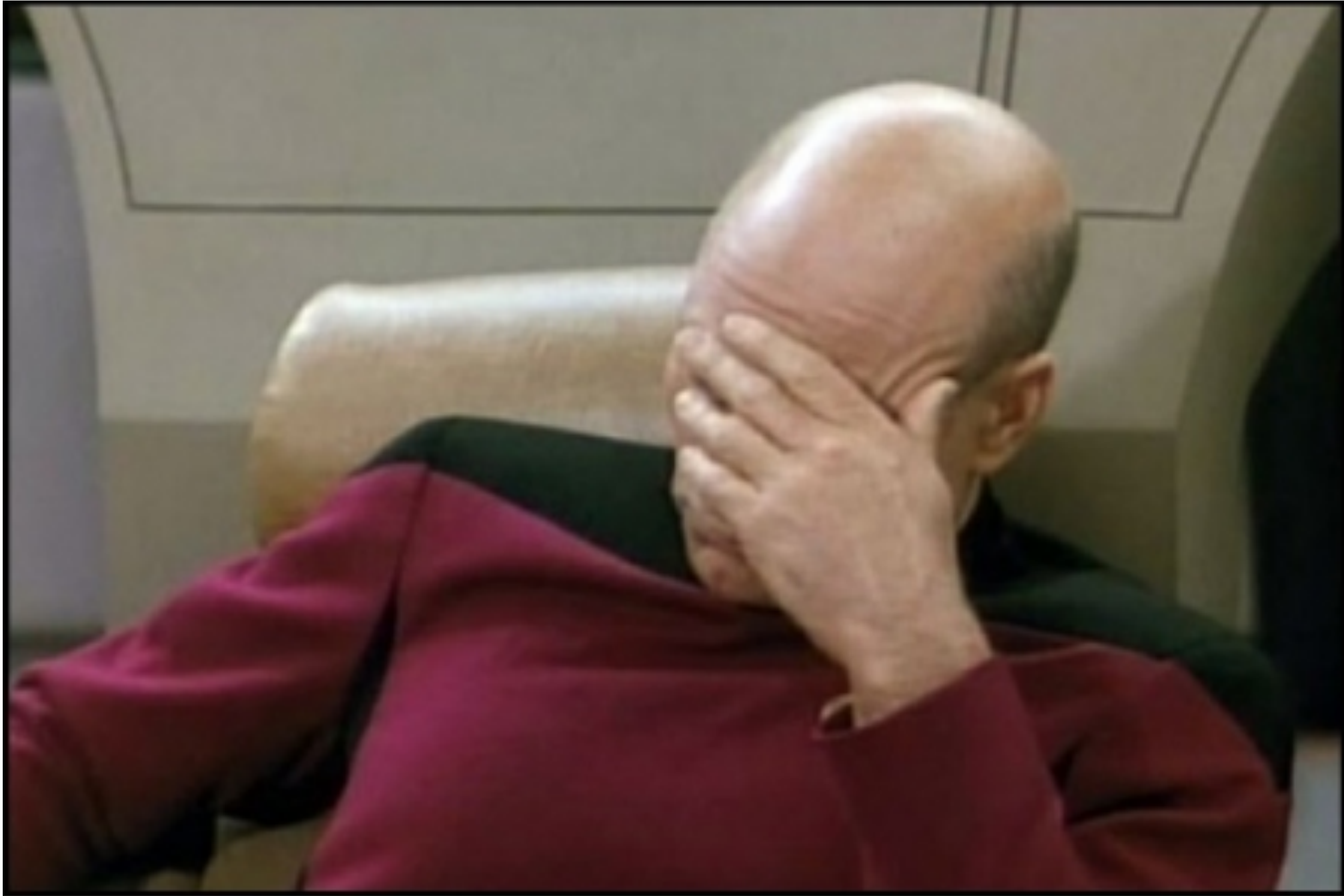


And you launch your game...



Browser Cache

HTML5 Audio



Use Flash



Questions?

(please use the microphone)

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