River Trail – Parallel Programming in JavaScript*

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In This Talk

1. Why parallel programming matters for the web
2. How best to add parallel programming to JavaScript*
3. What to do with it once you have it
4. How **You** can get involved

Why Parallel Programming in JavaScript*

The Web Is Evolving

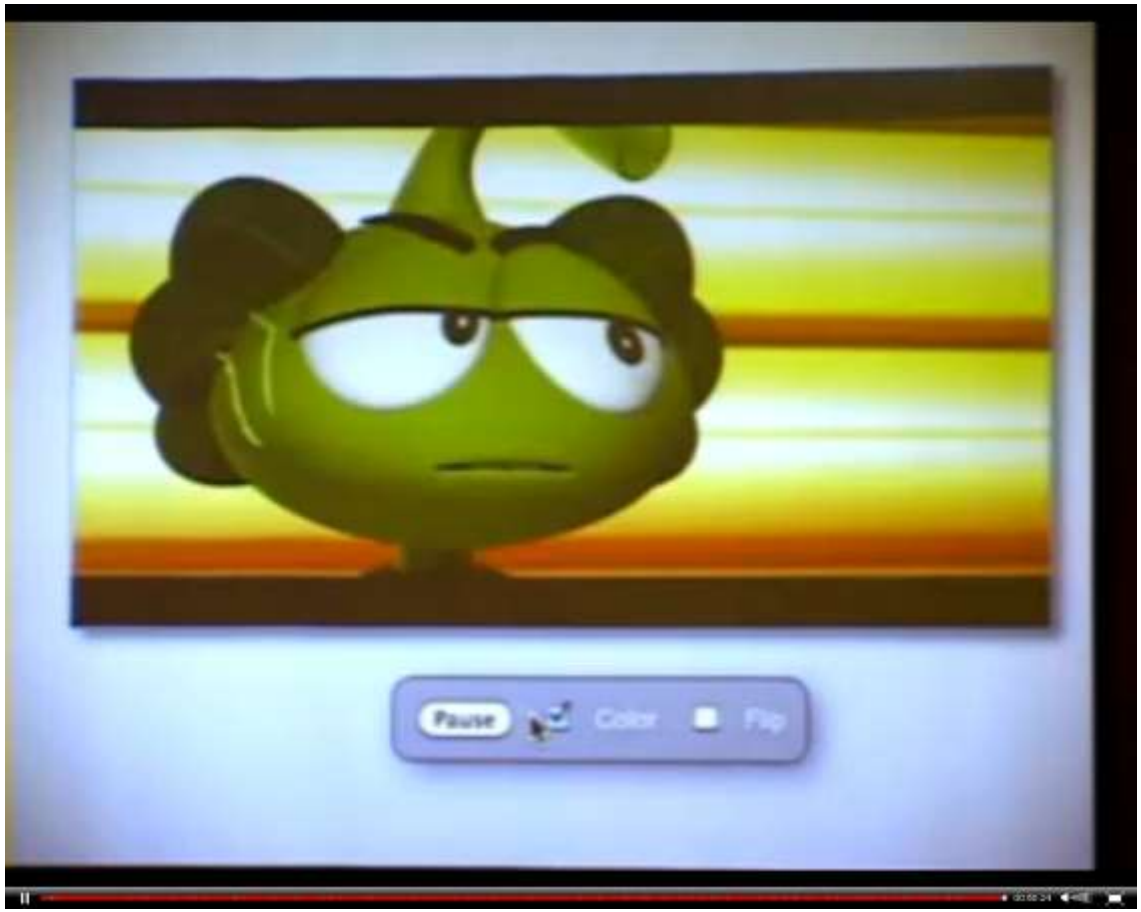
- Storage
- Multimedia
- 3D & Effects
- Device Access
- Connectivity

“very, very powerful stuff”

David Geary at TheStrangeLoop 2011
on <video> and <canvas>

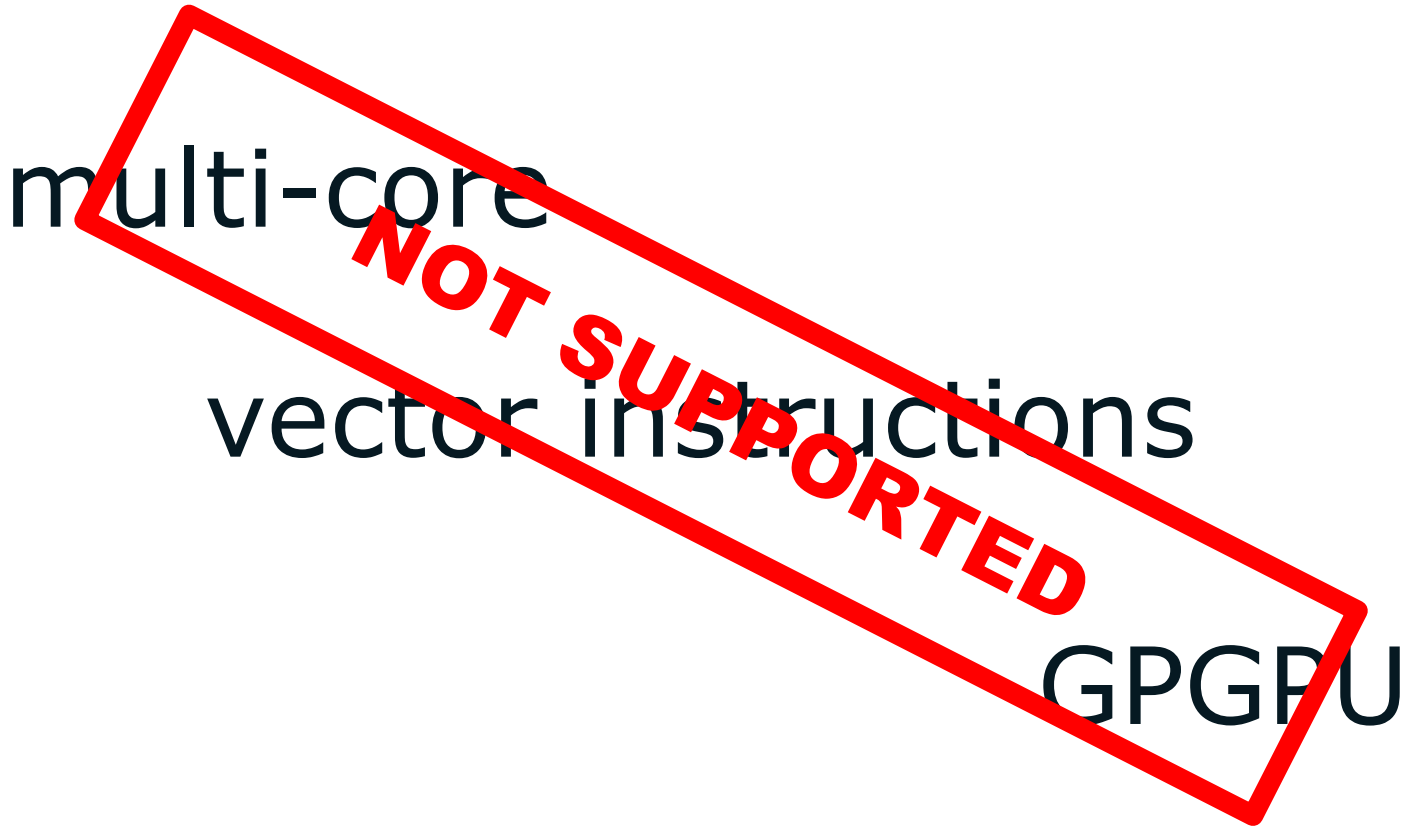
http://www.infoq.com/presentations/Core-HTML5-Canvas

David's <canvas> and <video> Demo



http://www.infoq.com/presentations/Core-HTML5-Canvas

Parallel Hardware Everywhere



Yet Another Programming API

"Meant to be a scripting language […] for the designer, the amateur programmer, the beginner programmer"

Brendan Eich at FluentConf 2012

https://www.youtube.com/watch?v=Rj49rmc01Hs

River Trail Design Goals

1. Ease of use

http://www.flickr.com/photos/jcestnik/5666428672

River Trail Design Goals

1. Ease of use

2. Code reuse and mash-up coding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River Trail Design Goals

1. Ease of use
2. Code reuse and mash-up coding
3. Performance portability

http://www.flickr.com/photos/carbonnyc/2294144289/

River Trail Design Goals

1. Ease of use
2. Code reuse and mash-up coding
3. Performance portability
4. Safety and Security

Challenge: meet these criteria and get good performance

The Design of River Trail

Concurrency in JavaScript* Today

- Cooperative multi-tasking
  - Scripts compete with the browser for computing resources
  - Event driven execution model
- Concurrent programming mindset
  - Asynchronous call-backs for latency hiding
- Fully deterministic
  - Run-to-completion semantics
  - No concurrent side effects
- **No support for concurrent execution**
  - Single threaded evaluation of JavaScript

Design Decisions

- Deterministic execution model
  - No race conditions, no dead lock (no live lock)
- Looks and behaves like JavaScript
  - All code still written purely in JavaScript
- Uses high-level parallel patterns
  - Express parallel code without tying it down to a specific implementation
- Maintains JavaScript's Safety and Security
  - Still use managed runtime, still no pointers

Three Pillar Approach

- Data structure: **`ParallelArray`**
  - Immutable, dense and homogeneous
- Six Methods: **`map`**, **`combine`**, **`reduce`**, **`scan`**, **`filter`**, **`scatter`**
  - Provide the basic skeletons for parallel computing
  - Typically creates a freshly minted ParallelArray object
- Elemental functions
  - Specify the actual workload
  - Written purely in JavaScript*
  - Side effect free

ParallelArray construction

```
new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


new ParallelArray(4, function (i) { return i+1; })

//-> [1, 2, 3, 4]


new ParallelArray([2,2],
  function (iv) { return iv[0] + iv[1]; })

//-> [0, 1, 1, 2]                  // [[0, 1], [1, 2]]
```

Map Method

```
var source = new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


source.map(function inc(v) { return v+1; })

//-> [2, 3, 4, 5]
```


http://rivertrail.github.com/interactive/

Combine Method

```
var source = new ParallelArray([1,2,3,4]);

source.combine(
  function inc(iv) { return this.get(iv)+1; }
)

//-> [2, 3, 4, 5]


source.combine(
  function rev(iv) {
    return this.get(this.length - iv[0] - 1); }
)

//-> [4, 3, 2, 1]
```

Combine Method in 2D

```
var source = new ParallelArray([2,2],
  function (iv) { return iv[0] + iv[1]; })

//-> [0, 1, 1, 2]                    [[0, 1], [1, 2]]


source.combine( 2,
  function rev(iv) {
    return this.get([this.getShape()[0]-iv[0]-1,
                     this.getShape()[1]-iv[1]-1]); }
)

//-> [2, 1, 1, 0]                    [[2, 1], [1, 0]]
```

Reduce Method

```
var source = new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


source.reduce(
  function plus(a, b) { return a + b; }
)

//-> 10
```


http://rivertrail.github.com/interactive/

Scan Method

```
var source = new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


source.scan(
  function plus(a, b) { return a + b; }
)

//-> [1, 3, 6, 10]
```


http://rivertrail.github.com/interactive/

Filter Method

```
var source = new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


source.filter(
  function isOdd(iv) { return this.get(iv) % 2; }
)

//-> [1, 3]
```

Scatter Method

```
var source = new ParallelArray([1,2,3,4]);
//-> [1, 2, 3, 4]

source.scatter([3,0,2,1]);
//-> [2, 4, 3, 1]

source.scatter([2,0,2,1]);
//-> RangeError : Duplicate indices in scatter
```

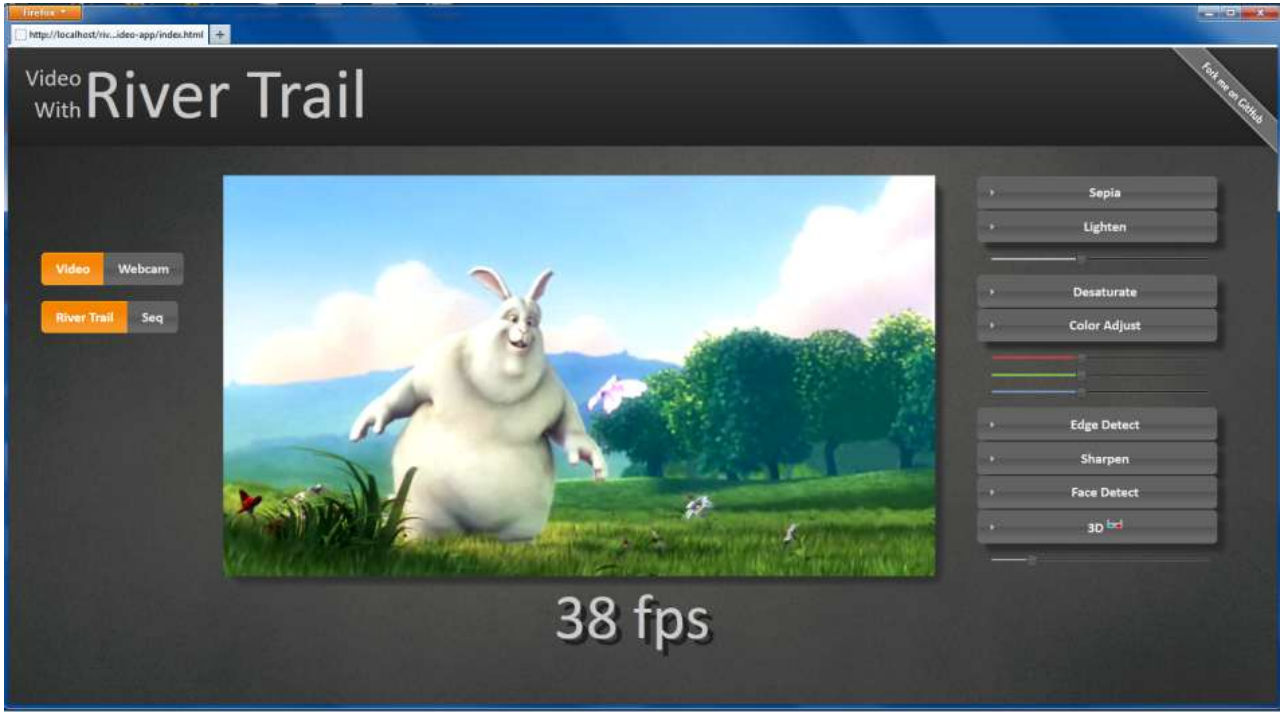
Scatter Method With Conflict

```
var source = new ParallelArray([1,2,3,4]);

//-> [1, 2, 3, 4]


source.scatter([2,0,2,1], 9,
               function plus (a, b) { return a+b; });

//-> [2, 4, 4, 9]


source.scatter([2,0,2,1], 9,
               function plus (a, b) { return a+b; },
               3);

//-> [2, 4, 4]
```


http://rivertrail.github.com/interactive/

River Trail in Action

Video With River Trail

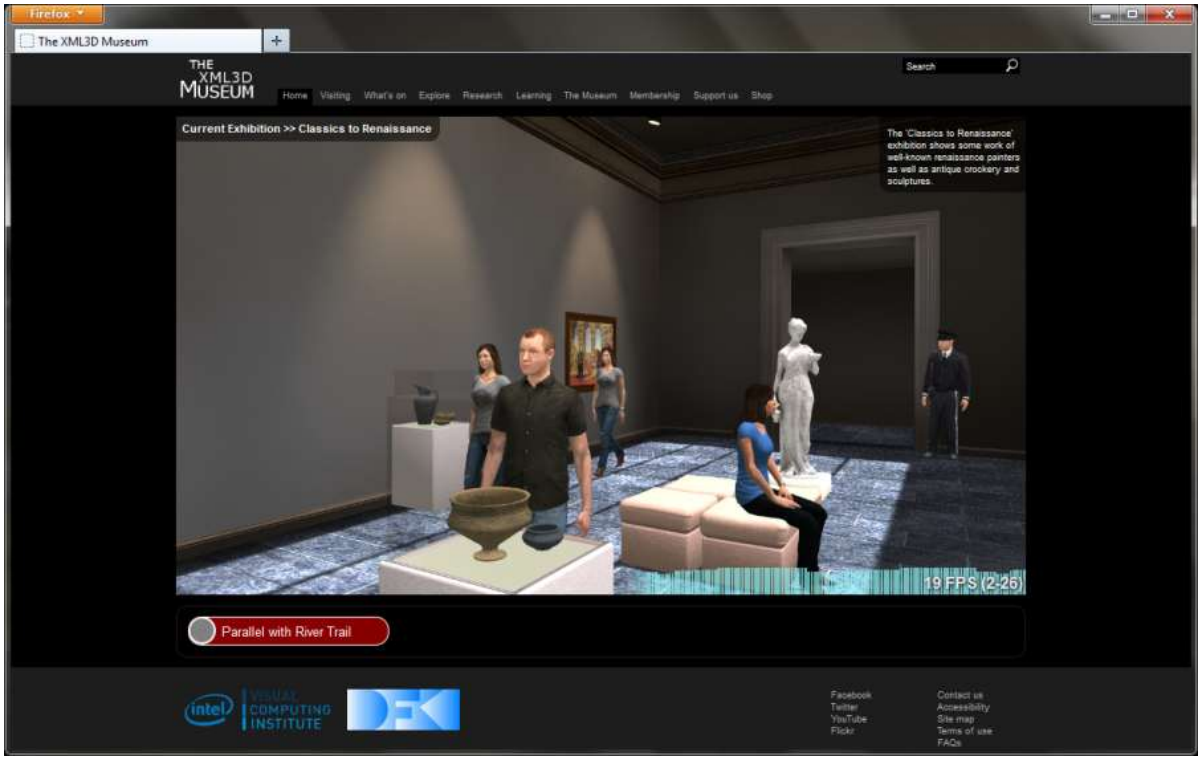


http://github.com/RiverTrail/RiverTrail/tree/master/tutorial

Physics Based Gaming in the Browser

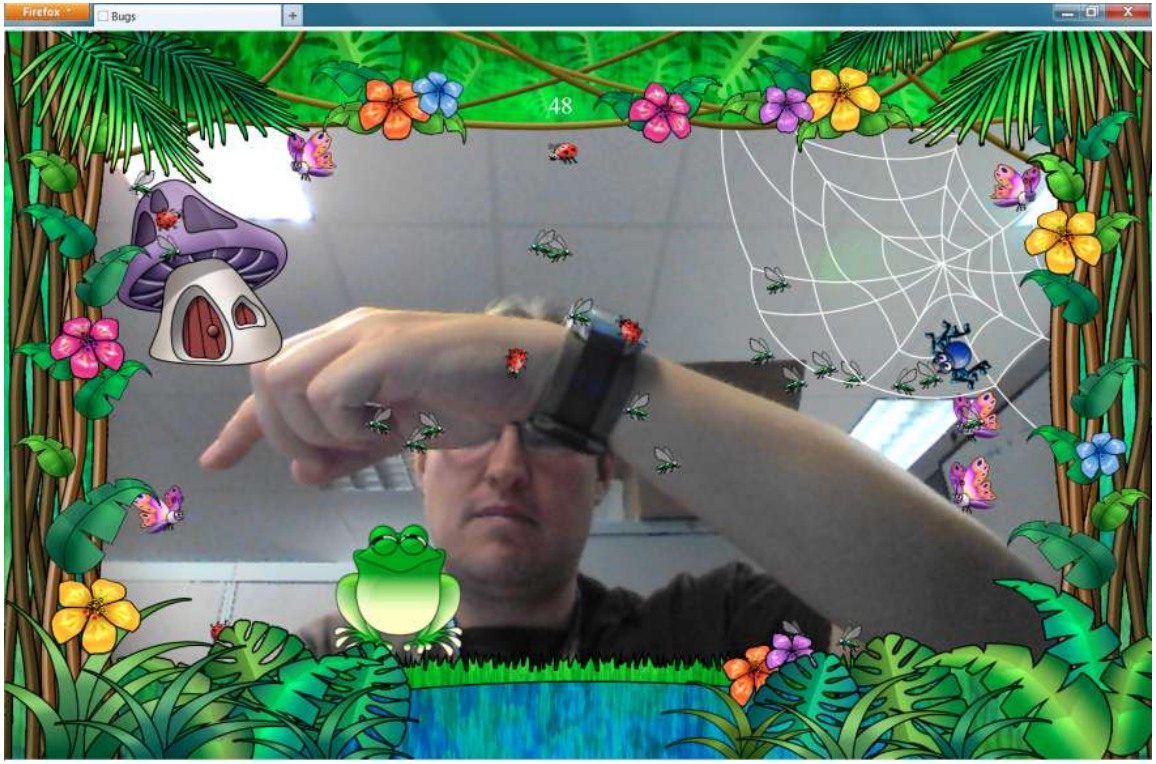
River Trail is used to **accelerate the physics computations** (collision detection)

3D Avatar Animation in the Browser



River Trail is used to **accelerate the animation of characters** (skinning)

Visual Computing in the Browser



River Trail **powers the computer vision algorithms** (optical flow) for motion tracking

Getting Involved

Try River Trail Today

- Open source Mozilla* Firefox* prototype available on GitHub*
  - Pre-built binary extension for current Firefox release
  - Sequential library fall back for other browsers

  http://github.com/RiverTrail/RiverTrail/wiki

- REPL to play with the API
  - Works in Chrome* and Firefox

  http://rivertrail.github.com/interactive/

- Full "Video with River Trail" tutorial
  - A fun way to learn River Trail

  http://rivertrail.github.com/RiverTrail/tutorial/

Help Shape The Future

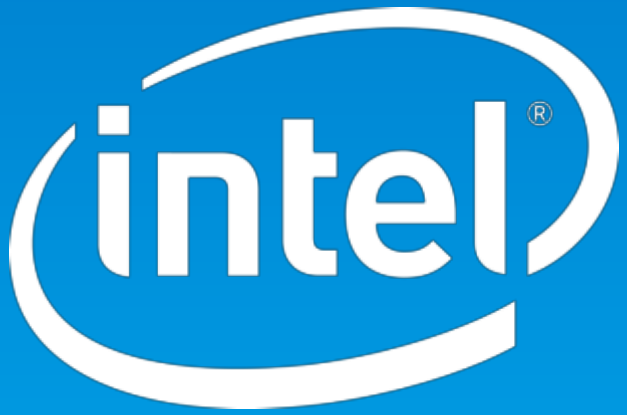
- ECMA proposal for Parallel JavaScript*
  - Full API specification published

  http://wiki.ecmascript.org/doku.php?id=strawman:data_parallelism

- First implementation in Firefox* Nightly
  - Implements full API
  - Work in progress

  http://nightly.mozilla.org/

- Join the discussion at es-discuss@mozilla.org
- Get in touch: here, @herhut, stephan.a.herhut@intel.com
- Go, Play, Create!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