ConstraintJS

Programming Interactive Behaviors for the Web by Integrating Constraints and States

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Constraints

- Relationships that are declared once & maintained automatically

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- “the toolbar is displayed above the workspace”

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- Relationships that are declared once & maintained automatically
- “the toolbar is displayed above the workspace”
- Can enable clearer, more concise code [Meyerovich, 2009; Myers, 1991]

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- Constraint solvers can be unpredictable and difficult to control [Myers, 2000]
- “the toolbar is displayed above the workspace”
    - change the workspace or toolbar location

- “when the toolbar is docked, it is displayed above the workspace”
- “when the toolbar is being dragged, it follows the mouse”

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🟦 constraint

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🟧 state 🟦 constraint

States & Constraints

- GUIs are state-oriented
    - Appearance & behavior

States & Constraints

- GUIs are state-oriented
    - Appearance & behavior
- Finite-state machines control when constraints are enabled/disabled

goal: reduce the complexity of programming interactive applications goal: reduce the complexity of programming interactive applications

hypothesis: interactive behaviors can be easier and more concisely expressed by combining states and constraints

Web development

- HTML (declarative) - content

Web development

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- CSS (declarative) - style

Web development

- HTML (declarative) - content
- CSS (declarative) - style
- Javascript (imperative) - interactivity

ConstraintJS

- Integrates constraints & states on Web

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- Integrates with HTML & CSS syntaxes

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- Integrates constraints & states on Web
- Integrates with HTML & CSS syntaxes
- Efficient implementation

ConstraintJS

- Motivating example
  - Tying FSMs with states
- Fitting in with Web languages
  - Styles (CSS)
  - Templates (HTML)
  - Asynchronous values

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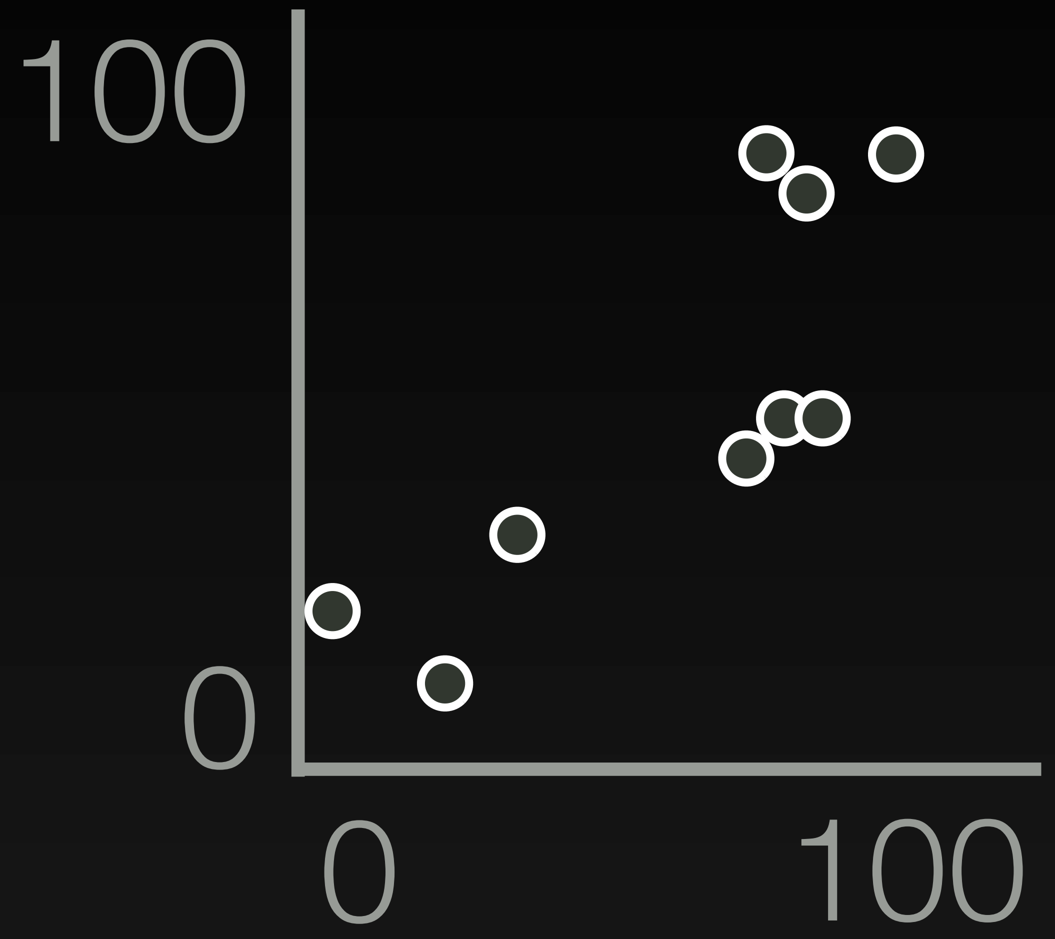
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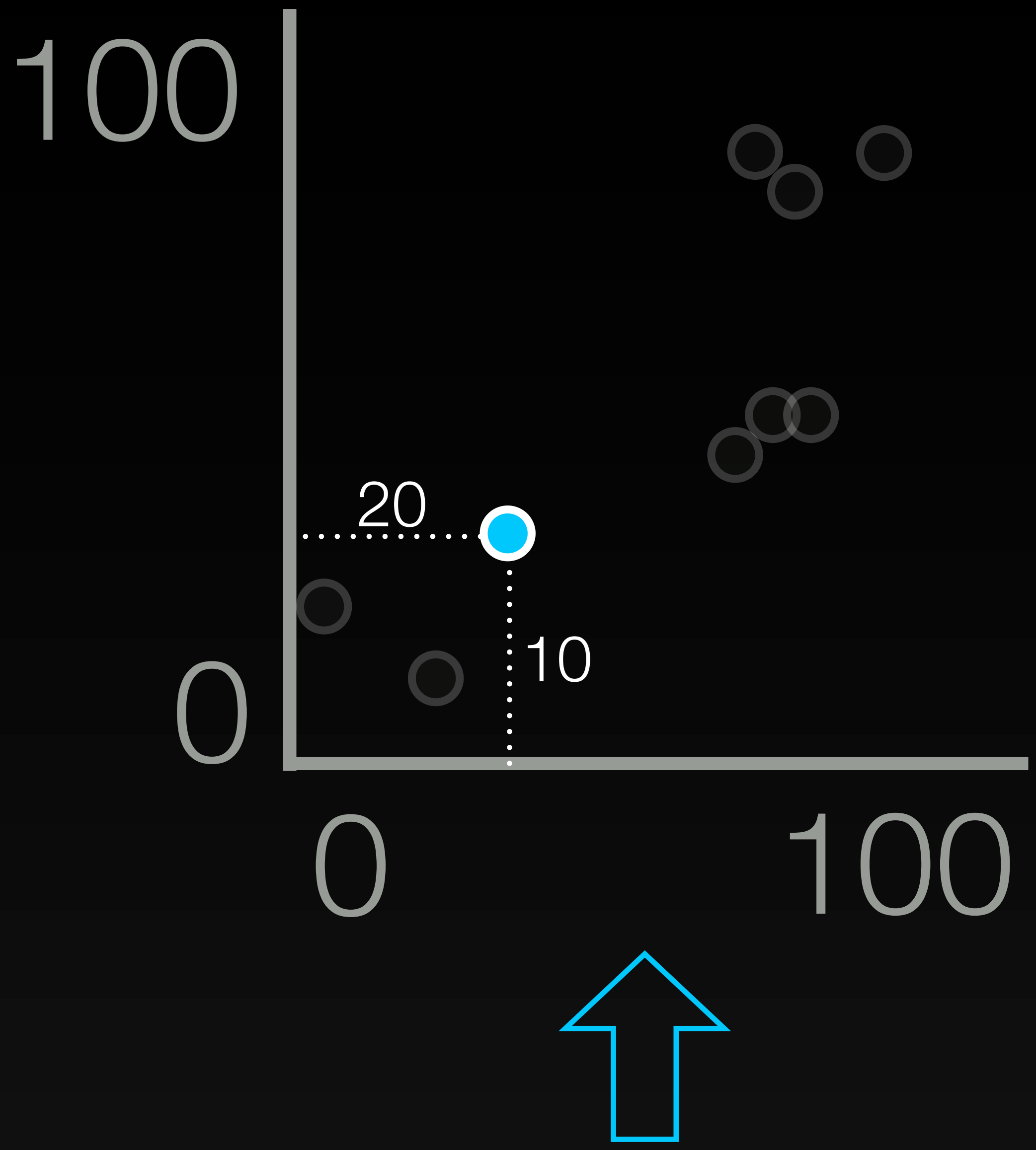

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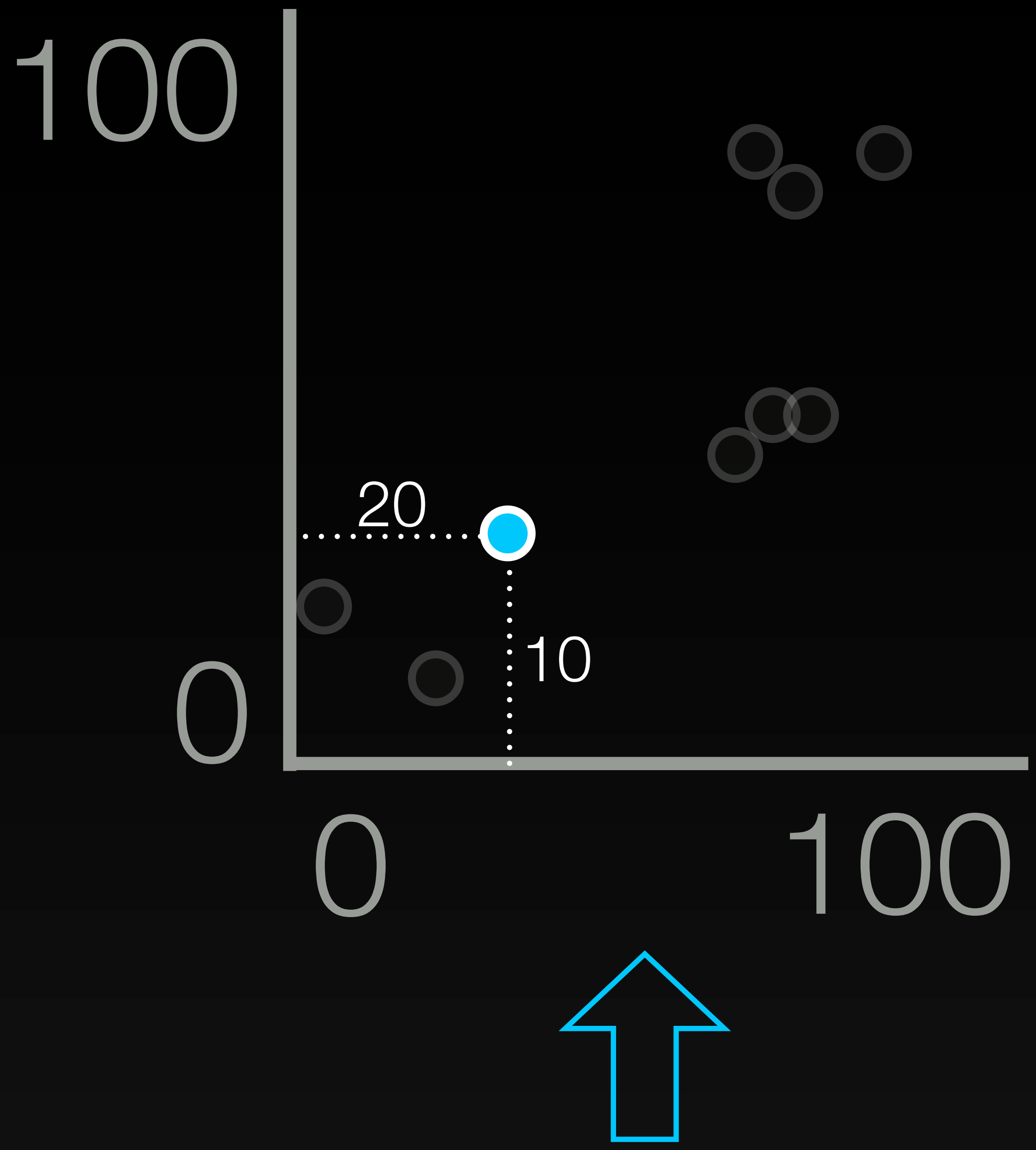
{x:60, y:40}, {x: 65, y: 45}, {x: 70, y: 45},
{x: 63, y: 80}, {x: 68, y: 75}, {x: 80, y: 80}



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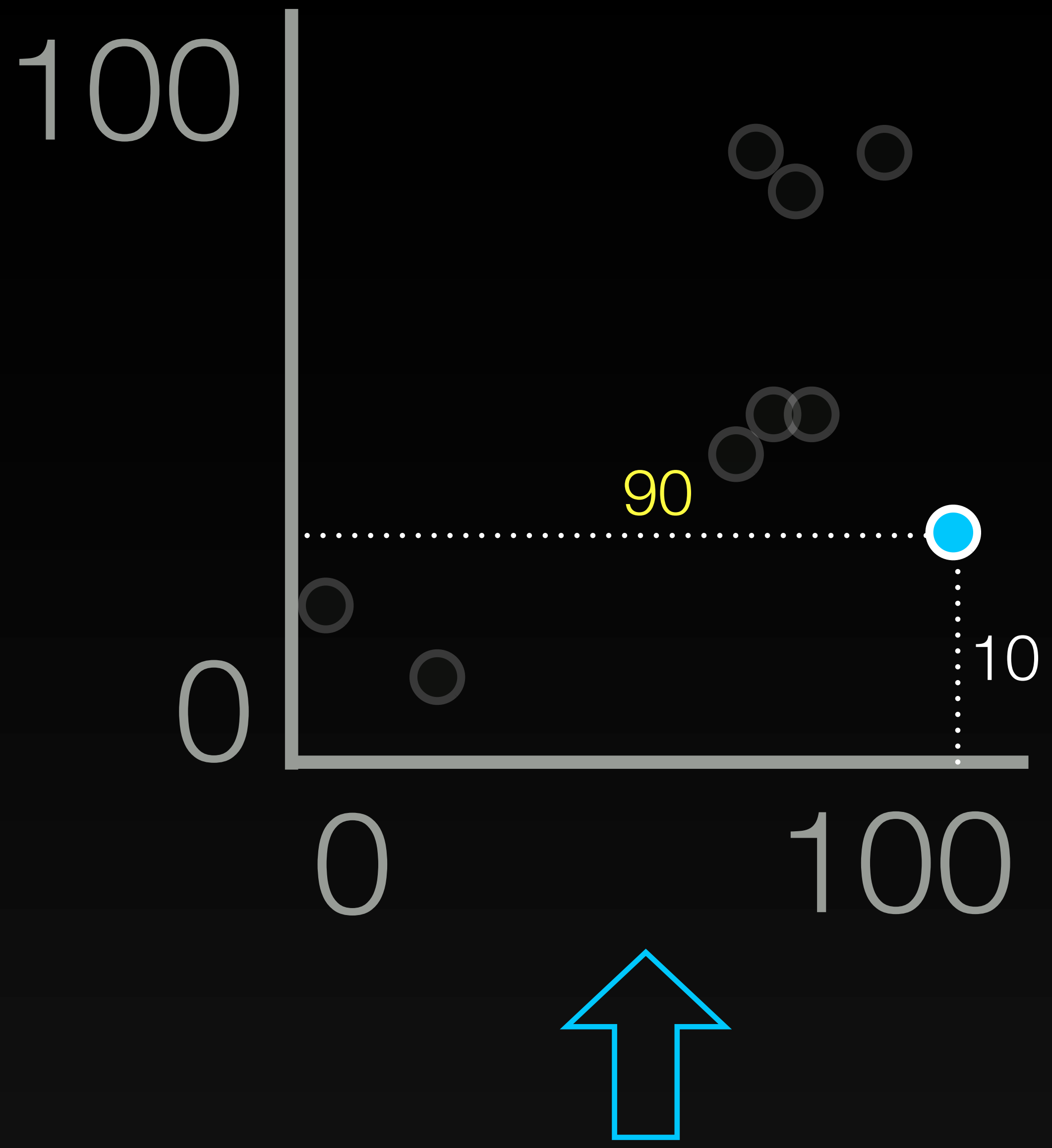

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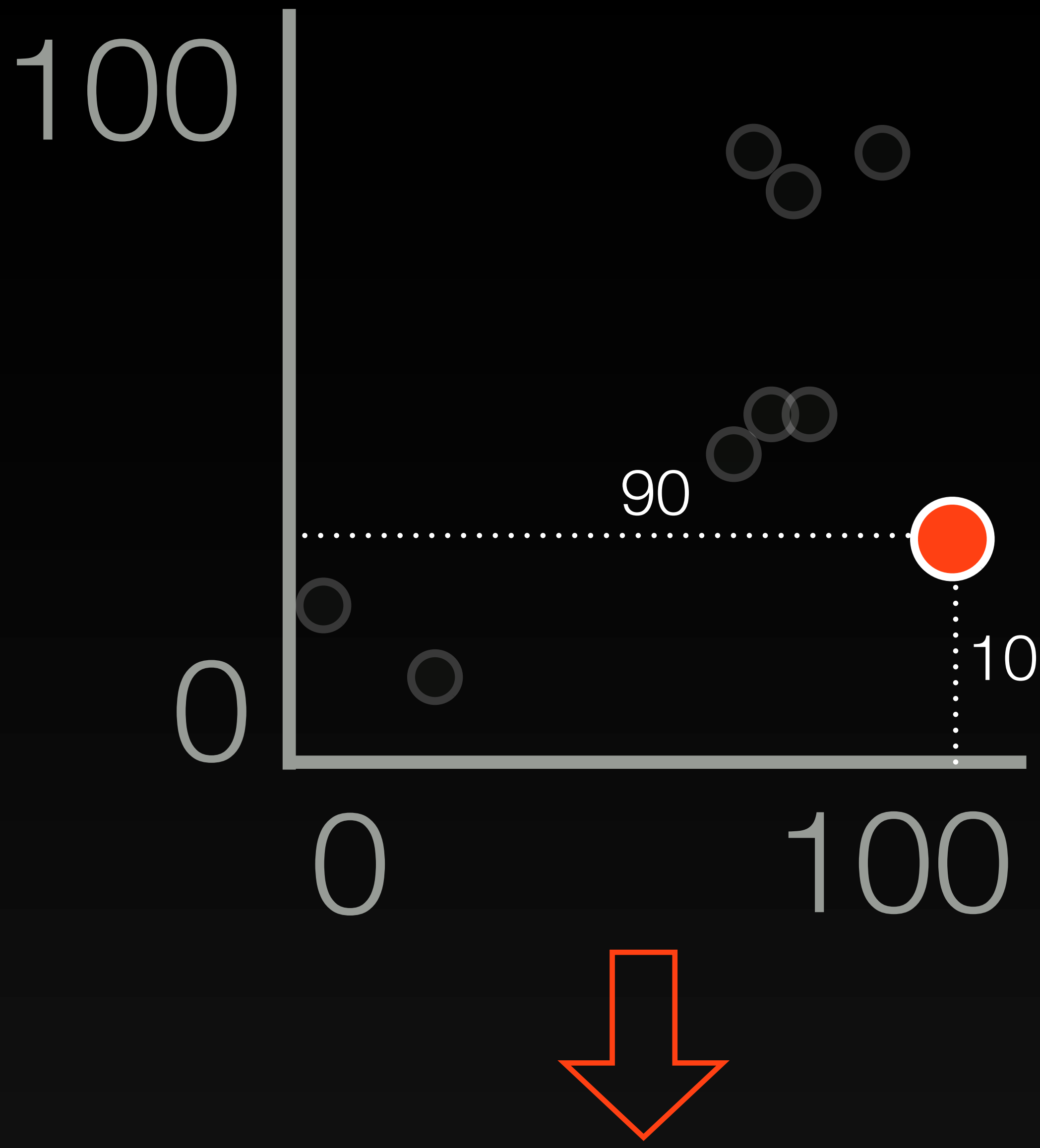

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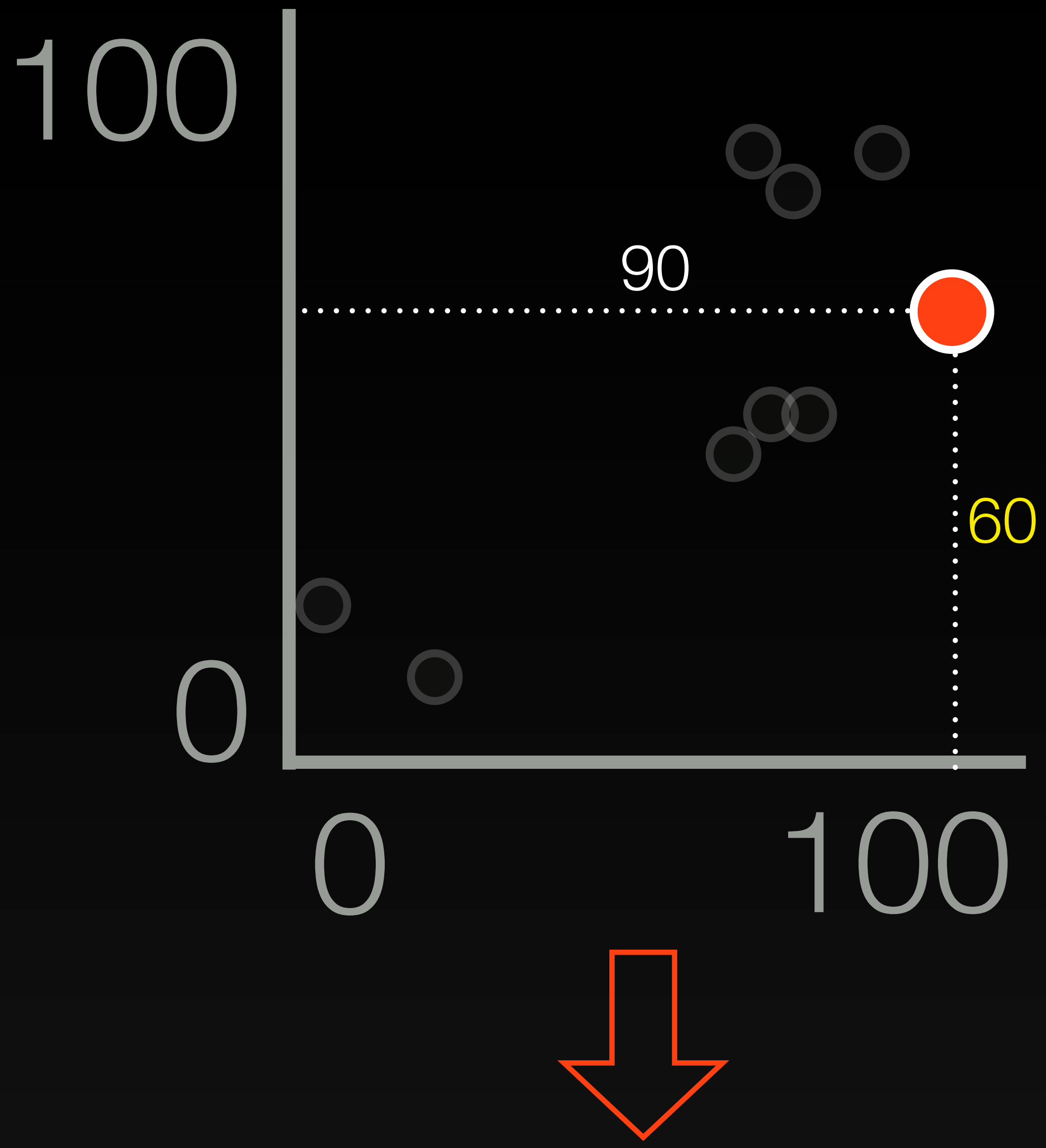

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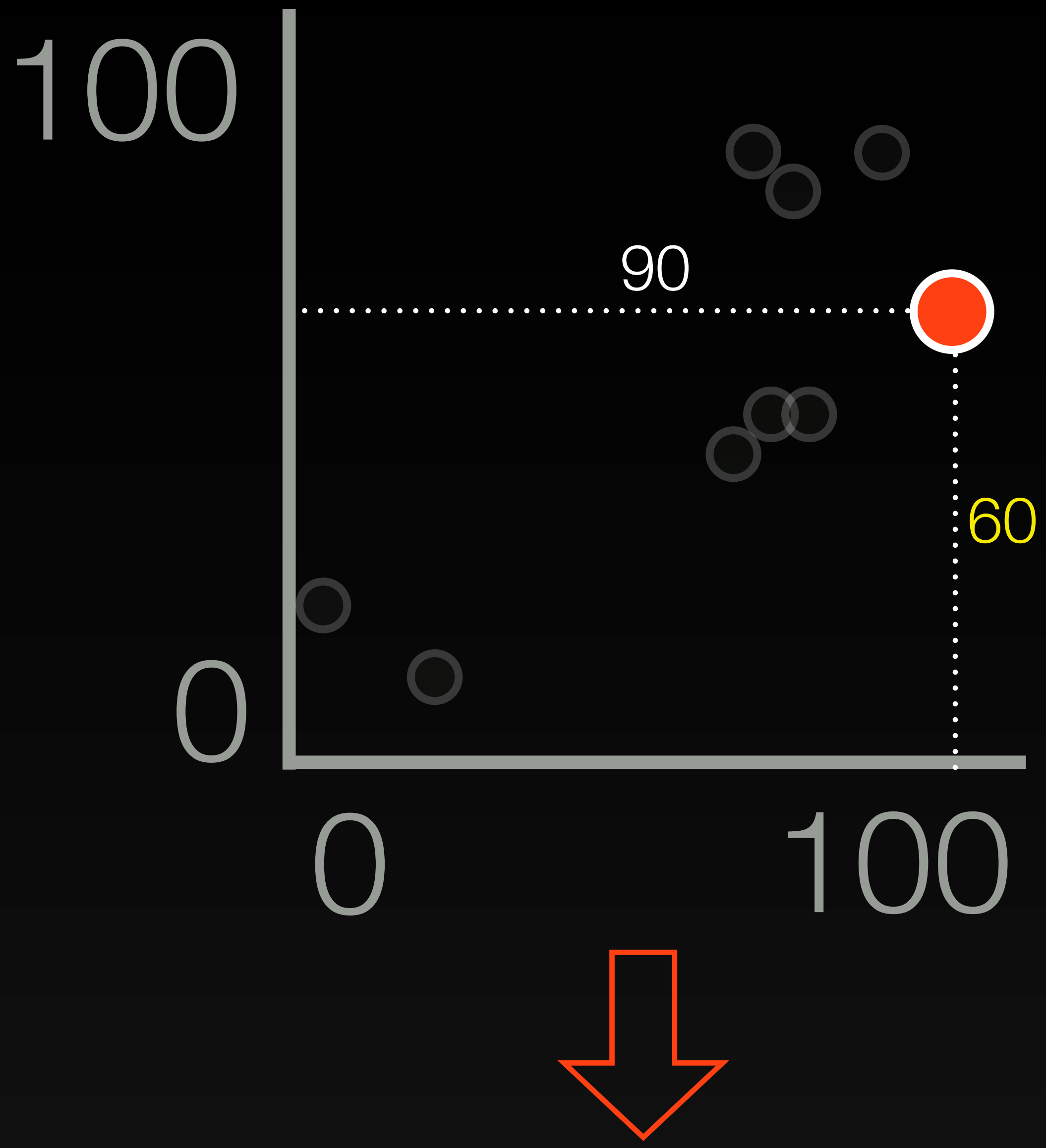

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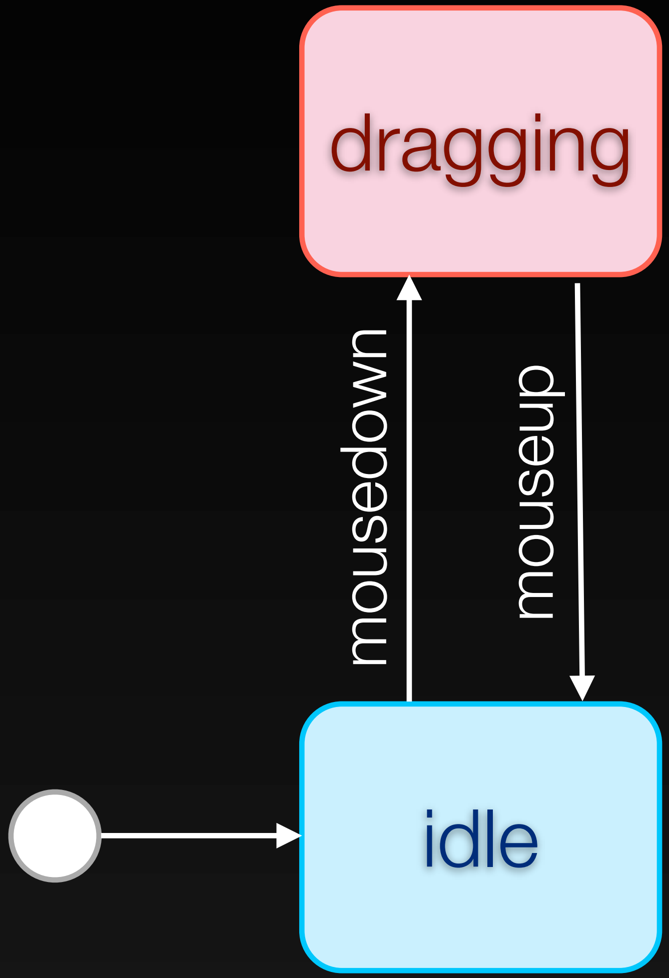
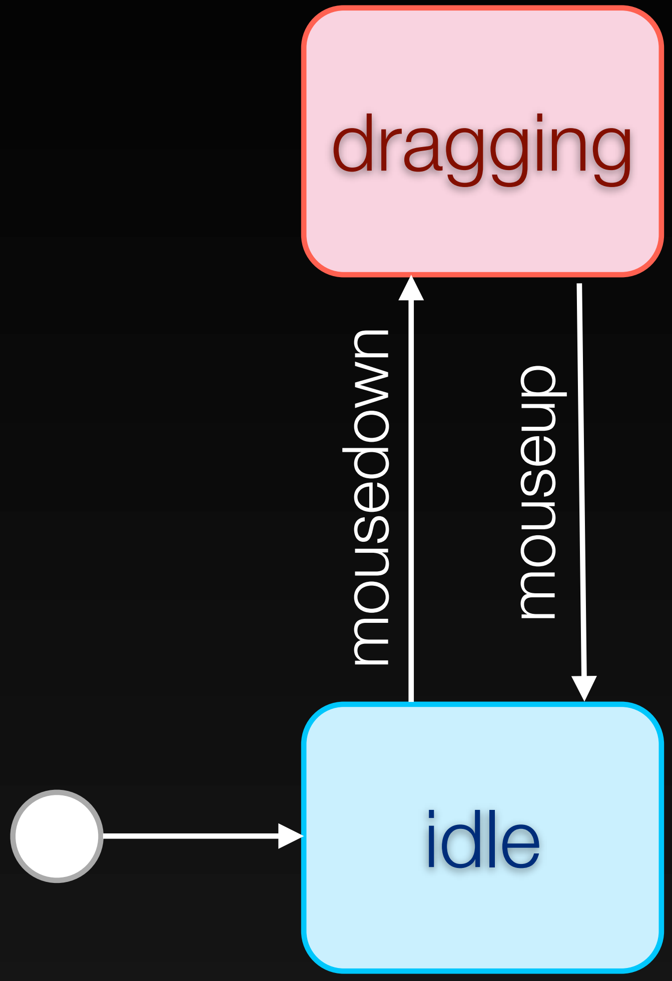
Multi-way Constraints

- Constraints where
  A depends on B & B depends on A
- Specify constraint hierarchy
- Difficult to control [Vander Zanden, 1994]

`fsm *for every point*`



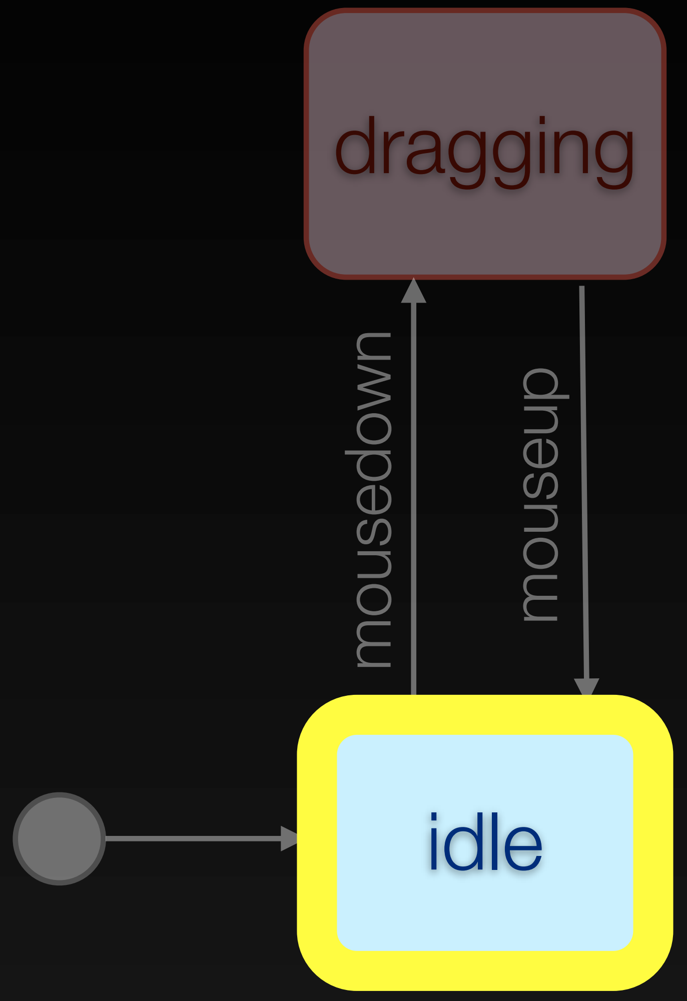
fsm:



```
view_x = cjs(fsm, {
   idle:      model_x,
   dragging: cjs.mouse.x
});


model_x = cjs(fsm, {
   init:      datum.x,
   dragging: view_x
});
```

fsm:



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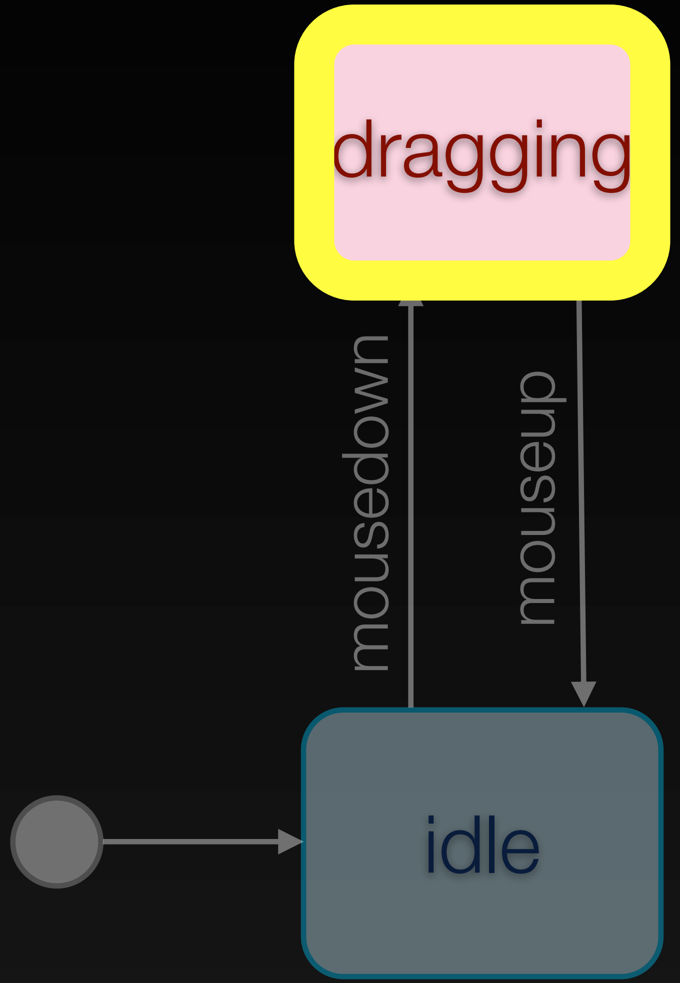

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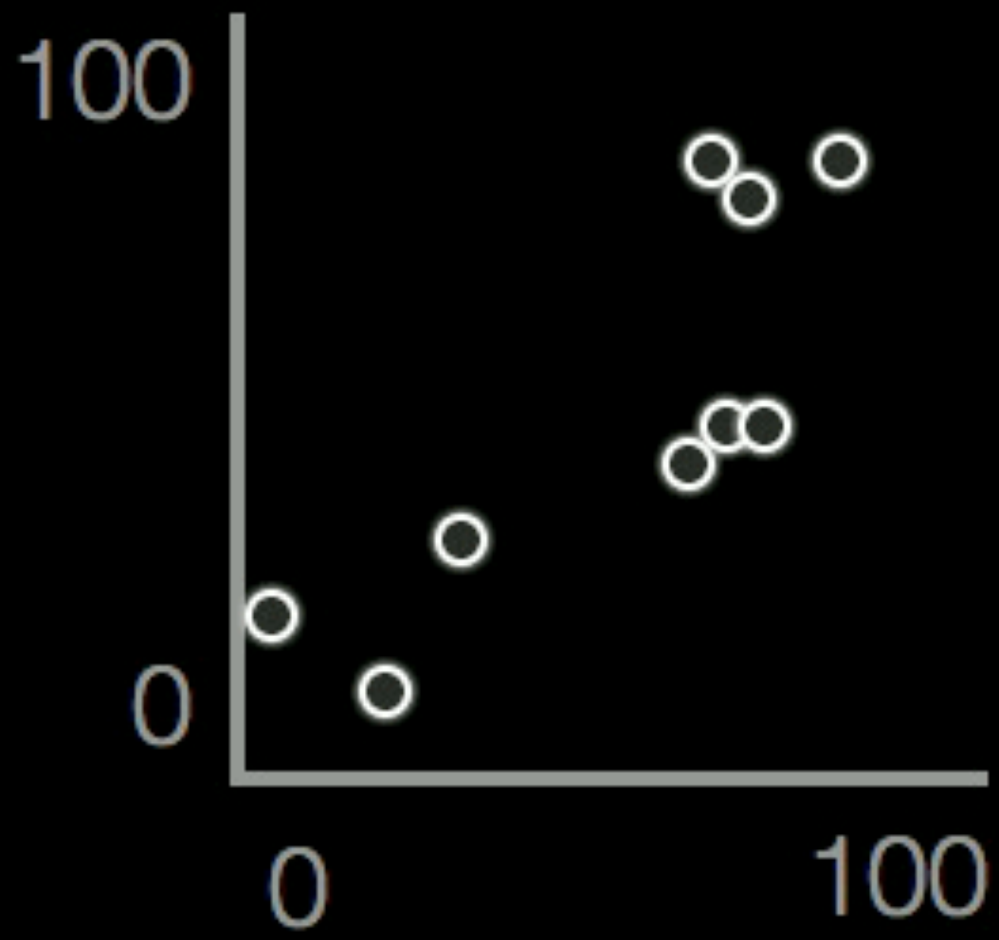
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ConstraintJS

- Motivating example
  - Tying FSMs with states
- Fitting in with Web languages
  - Styles (CSS)
  - Templates (HTML)
  - Asynchronous values

Styles

```
cjs.css(element,
“background-color”,
$selected_color);
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Templates

Templates

```
{{#if form_complete}}
<button>Submit</button>
{{#else}}
<div>Incomplete form...</div>
{{/if}}
```

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Asynchronous Values

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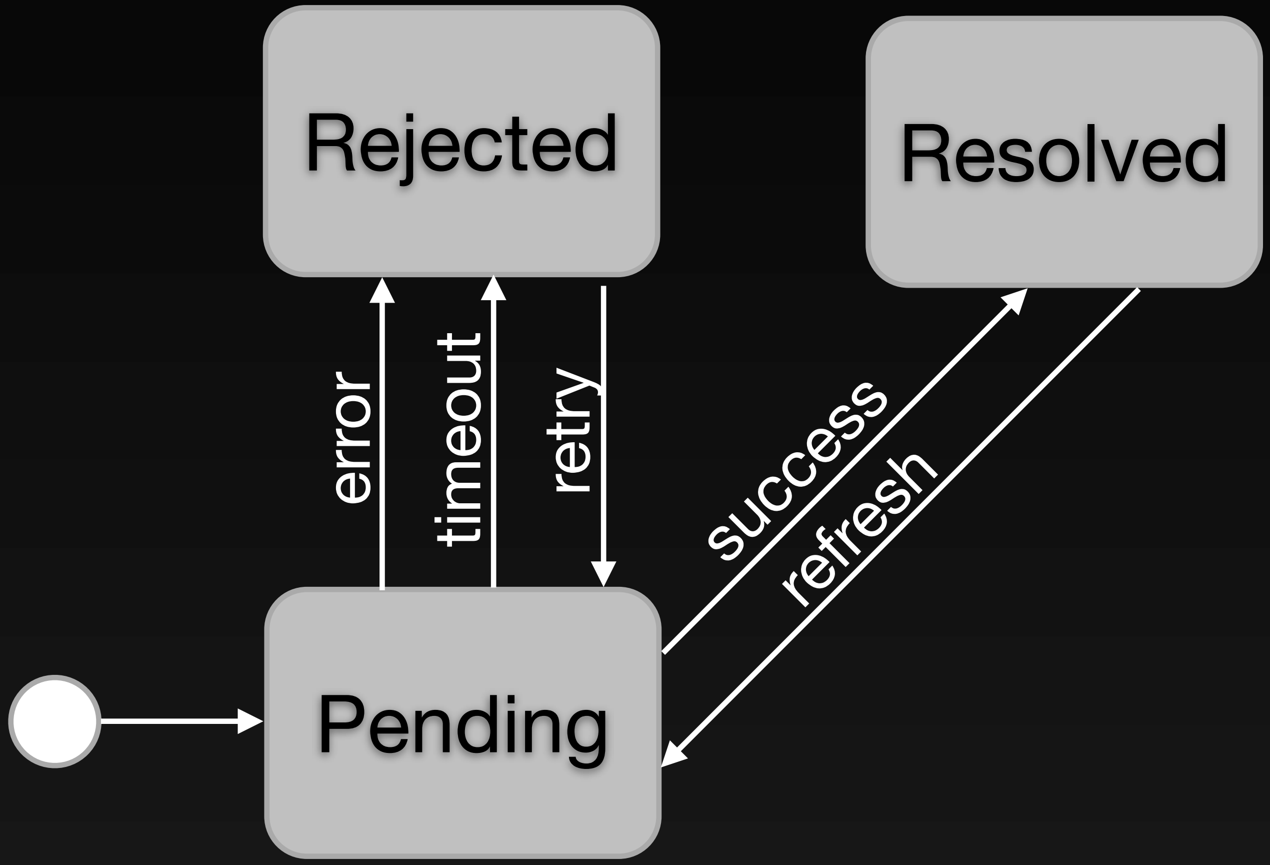
- Indeterminate wait before return
- Can greatly increase complexity of imperative code
    - Control timing
    - Propagation of values

Asynchronous Values



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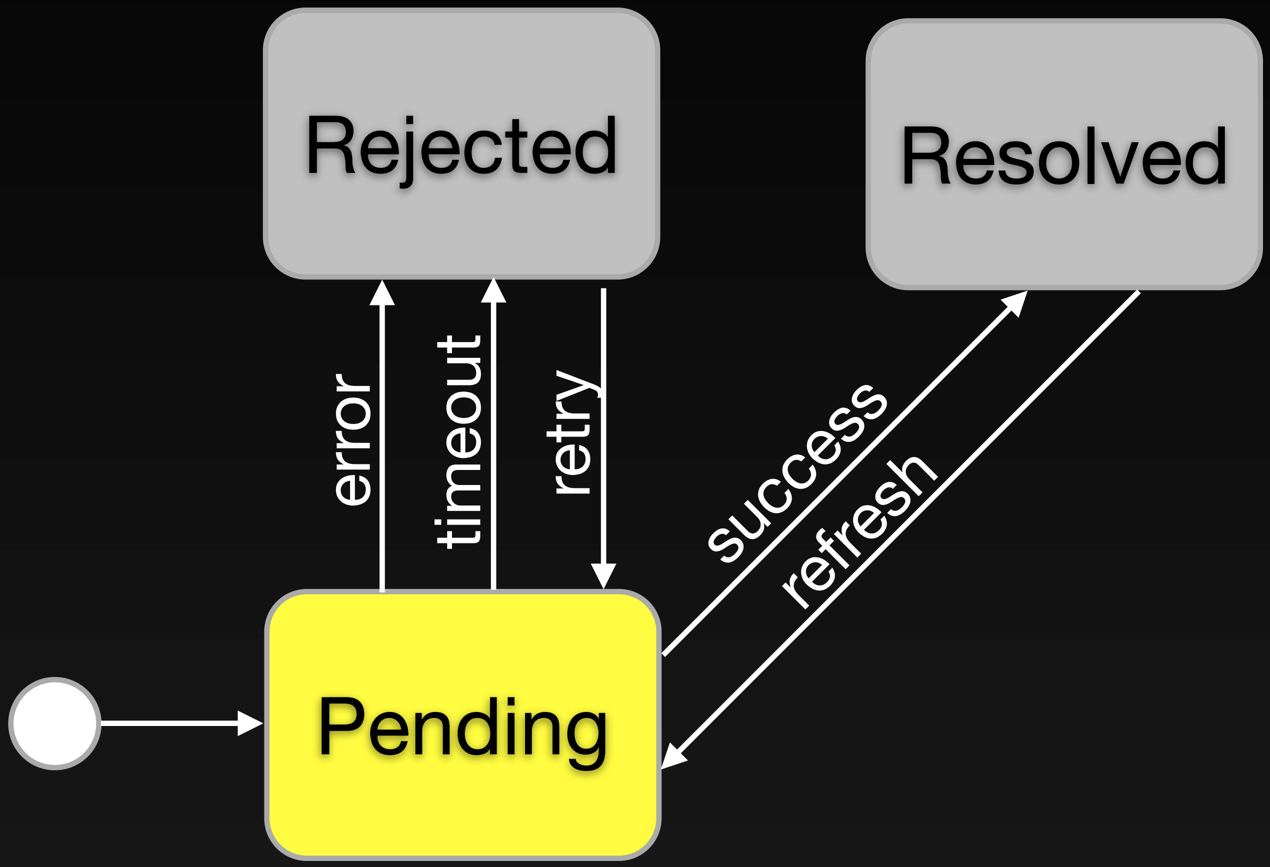
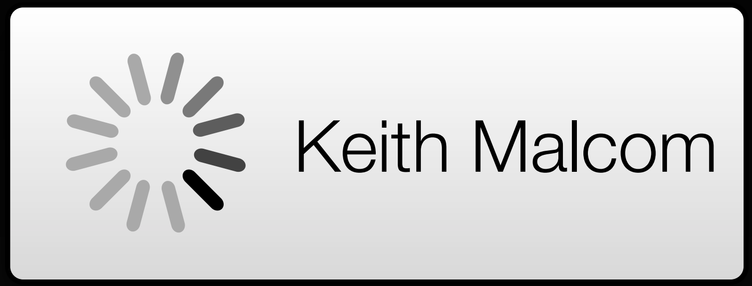
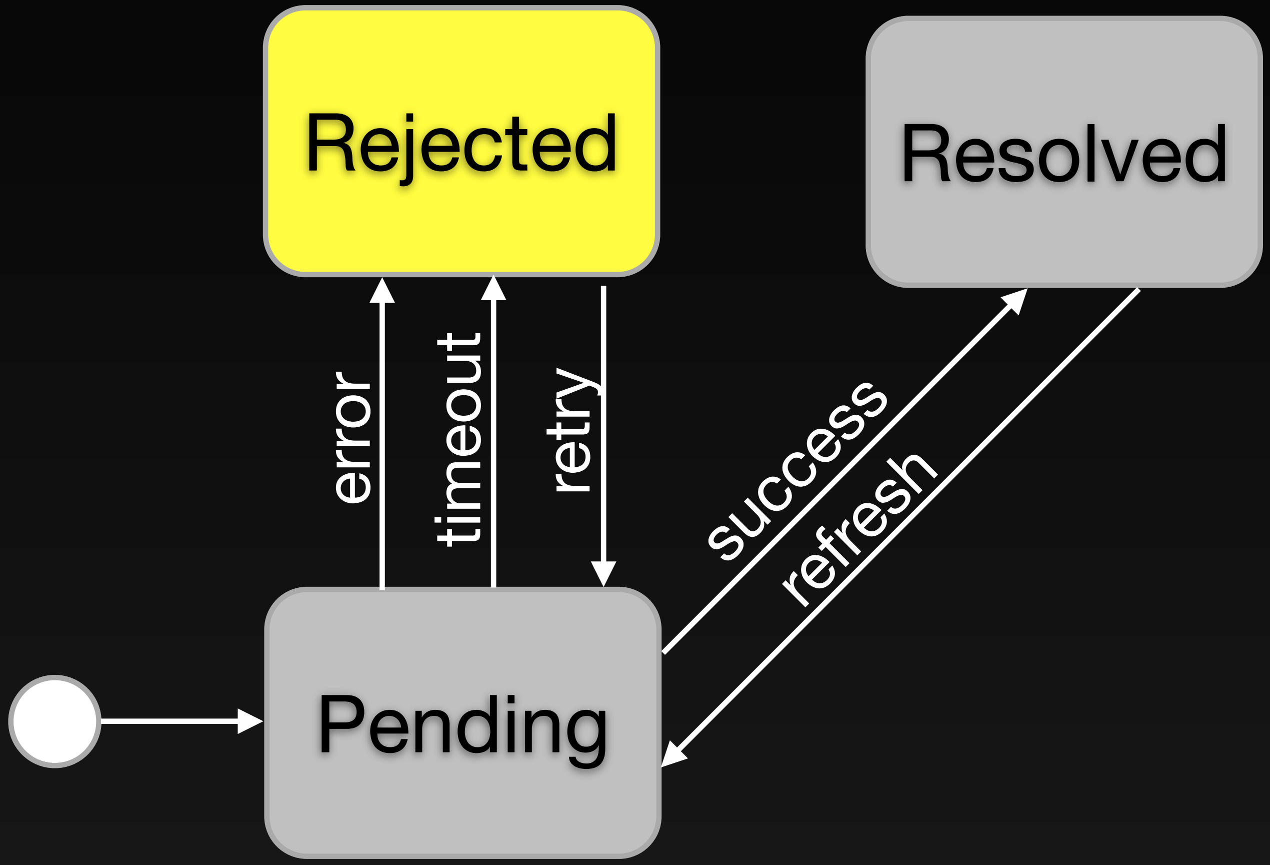
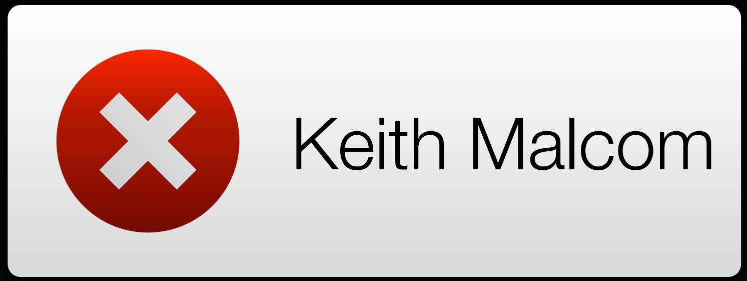




```
pending:  "loading.gif"
```

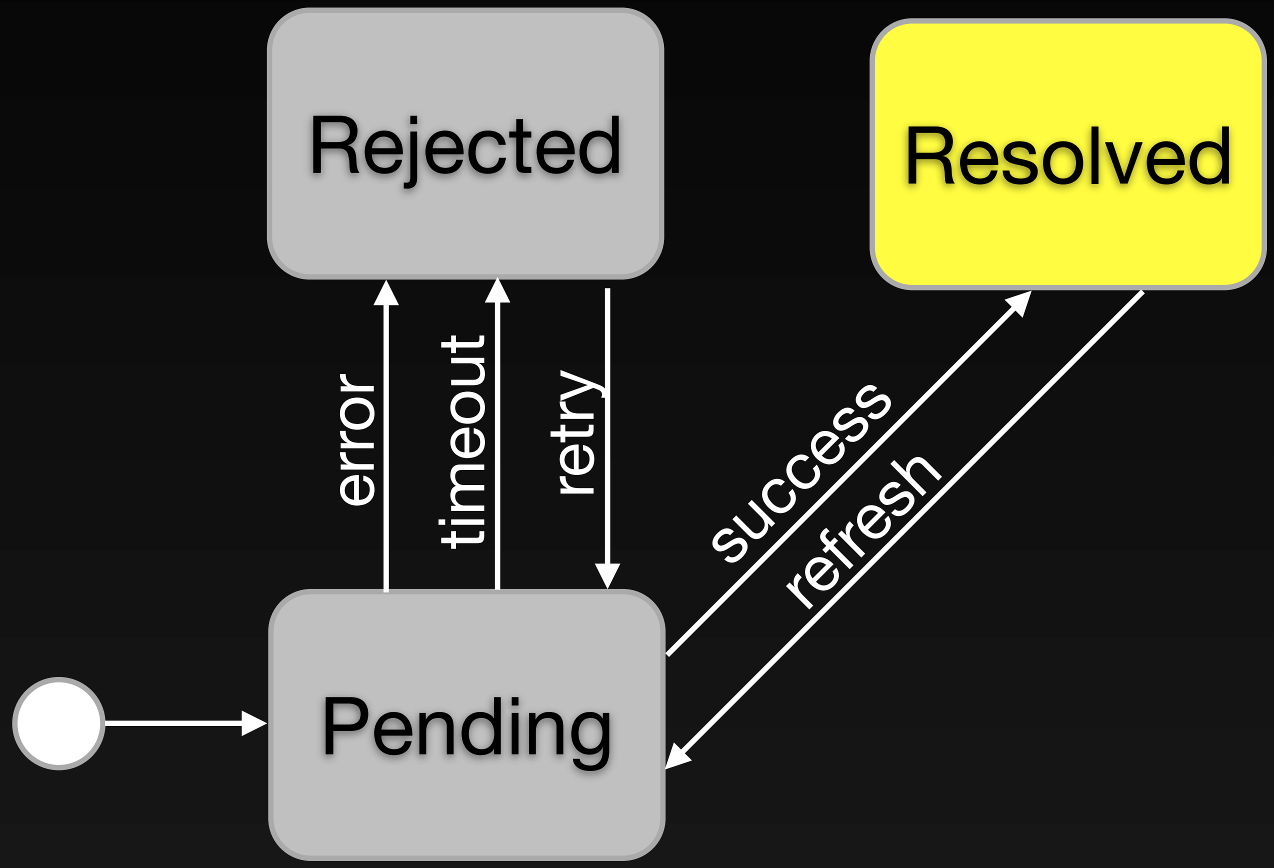
Asynchronous Values





```
pending:  "loading.gif",
rejected: "error.gif"
```

Asynchronous Values



Rejected

Resolved

Pending

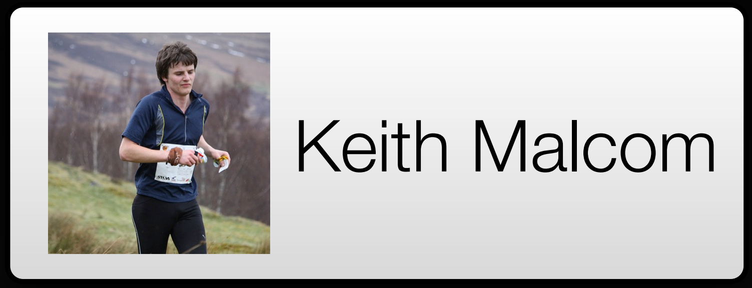
error

timeout

retry

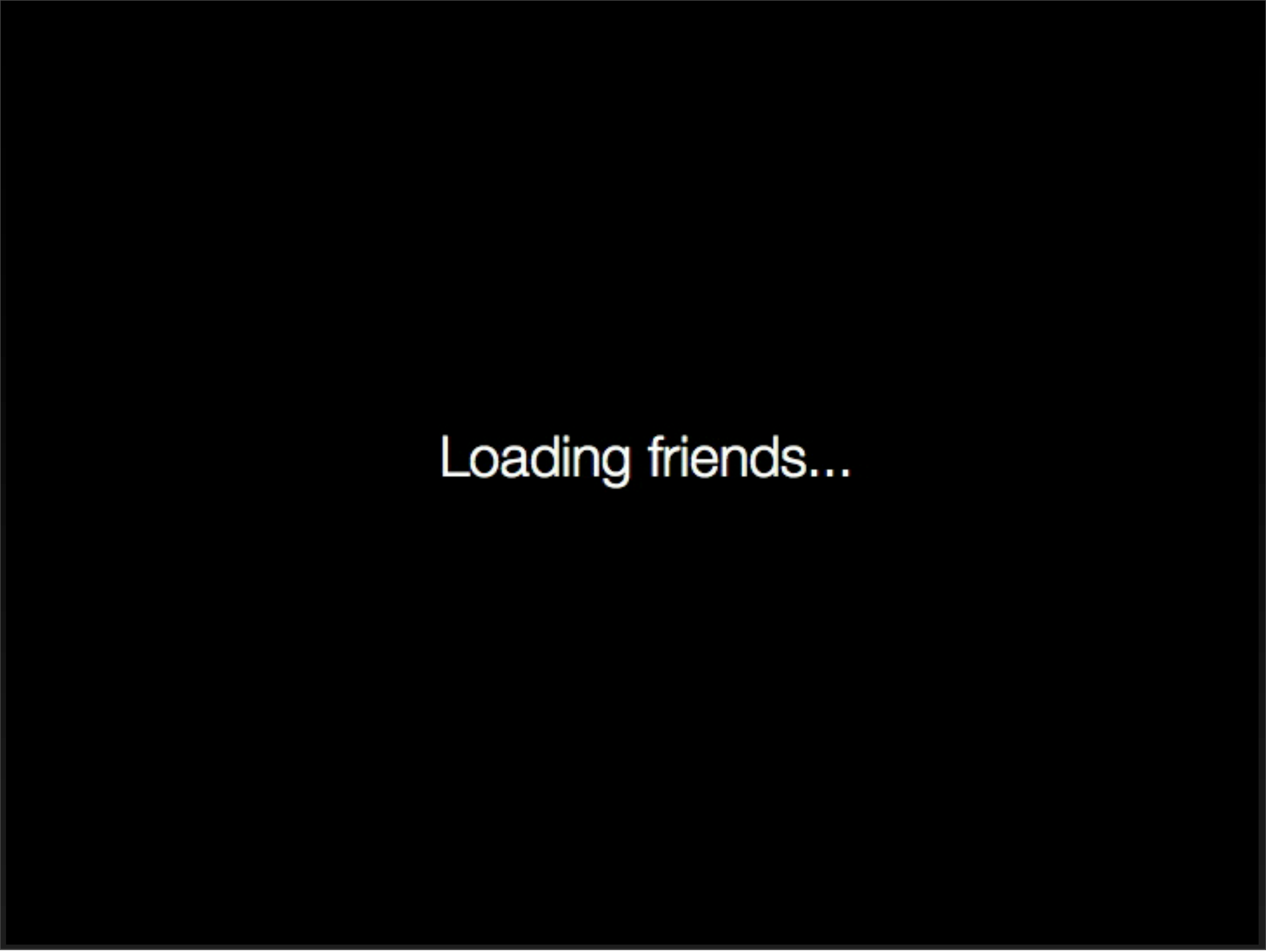
success

refresh



Keith Malcom

```
pending:  "loading.gif",
rejected: "error.gif",
resolved: {{picture}}
```



Loading friends...

```
friends = cjs.async(fb_request("/me/friends"));
pics    = friends.map(function(friend) {
              return cjs.async(fb_request( "/" + friend.id
                                               + "/picture"));
          });

//...

{{#diagram friends.state}}
   {{#state pending }} Loading friends...
   {{#state rejected}} Error
   {{#state resolved}}
      {{#each friends friend i}}
         {{#diagram pics[i].state}}
            {{#state pending }} <img src = "loading.gif" />
            {{#state resolved}} <img src = "{{pics[i]}}" />
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         {{/diagram}}
         {{friend.name}}
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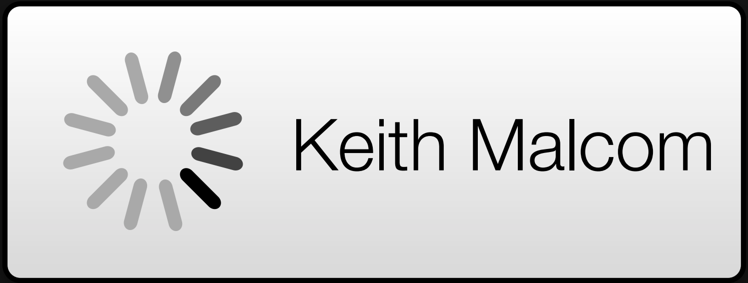

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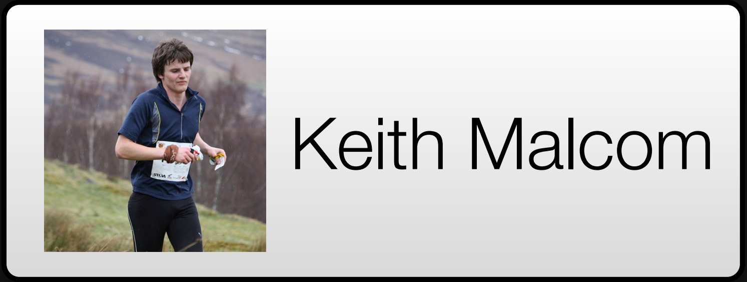

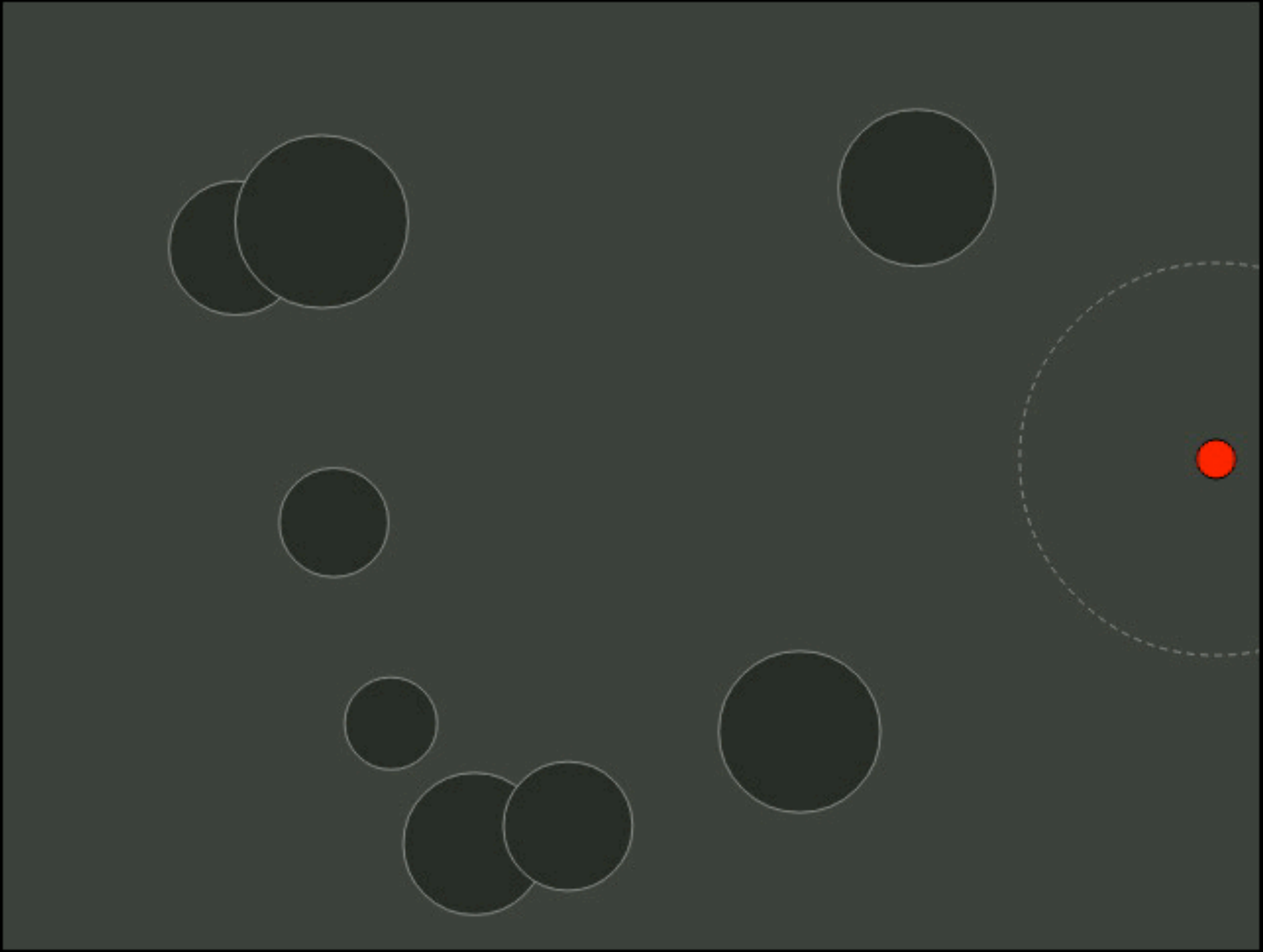

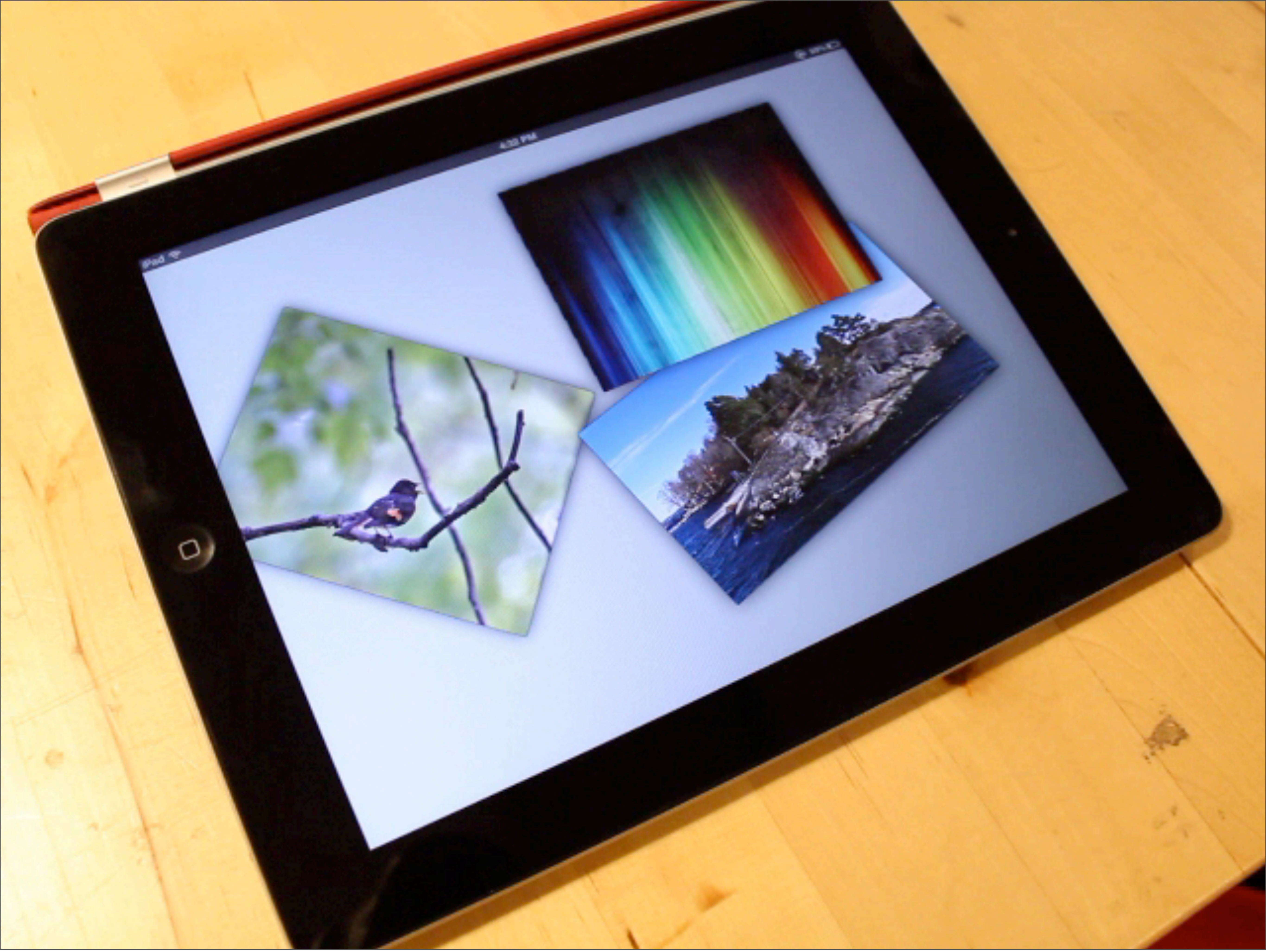
iPad
4:32 PM

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  - Enable more controllable constraints
- Integrates with Web languages
- Efficient implementation
- Demonstration through examples

ConstraintJS

http://cjs.from.so/

Stephen Oney (CMU)
Brad Myers (CMU)
Joel Brandt (Adobe)

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