

# Building a Visualization Language

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# Topics

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- ◆ Canvas
- ◆ Processing
- ◆ Processing.js

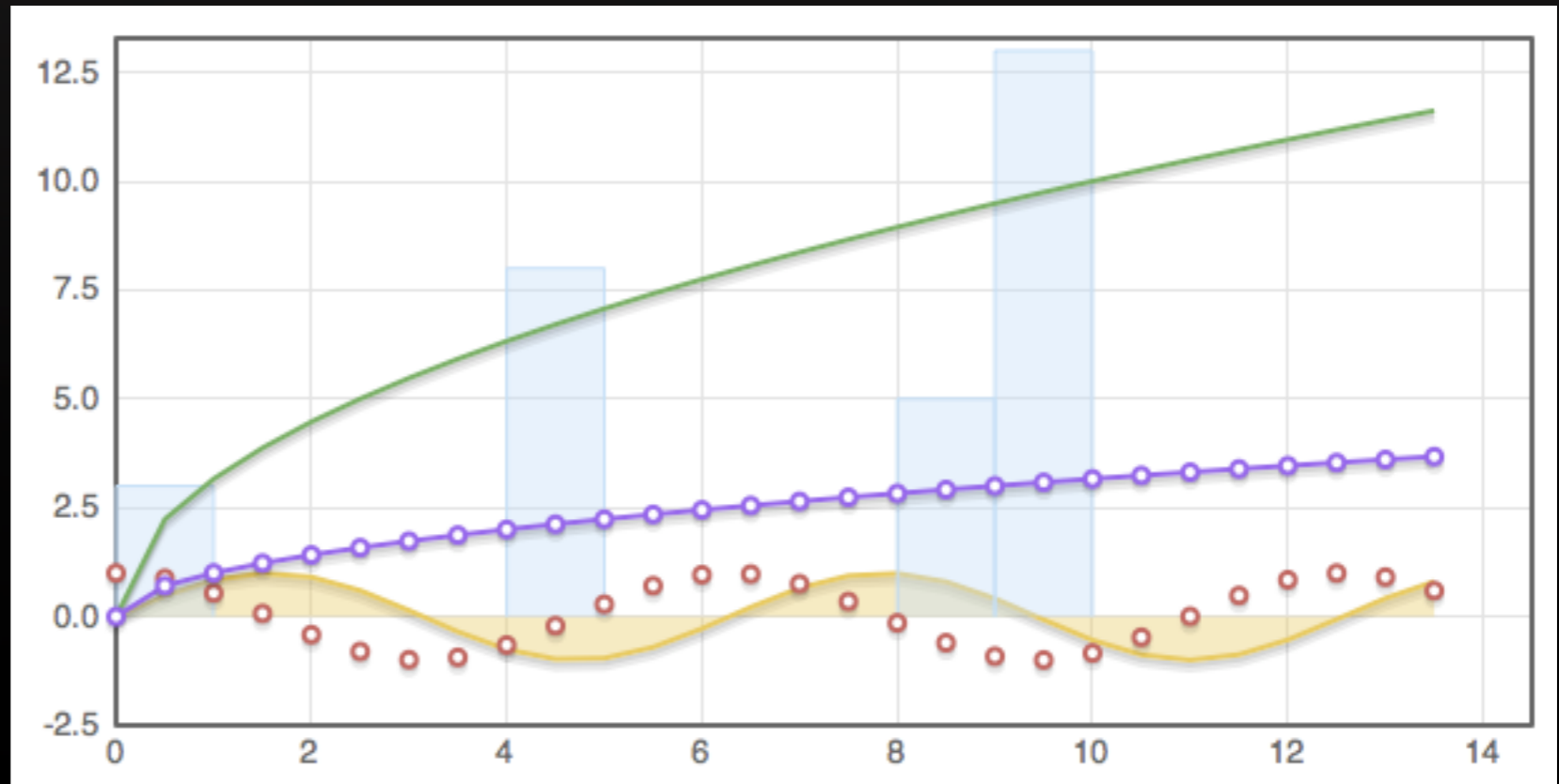
# Canvas

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- ◆ Proposed and first implemented by Apple in WebKit
- ◆ A 2d drawing layer
  - ◆ With possibilities for future expansion
- ◆ Embedded in web pages (looks and behaves like an img element)

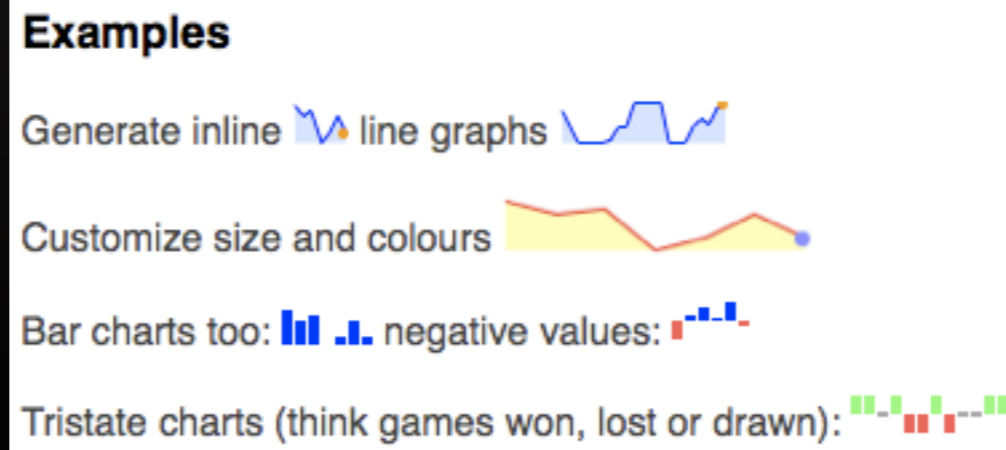
# Shapes and Paths

- ◆ NOT vectors (unlike SVG)
- ◆ Rectangles
- ◆ Arcs
- ◆ Lines
- ◆ Curves
- ◆ Charts:



# Fill and Stroke

- ◆ All can be styled (similar to CSS)
- ◆ Stroke styles the path (or outline)
- ◆ Fill is the color of the interior
- ◆ Sparklines:



# Canvas Demo

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# Canvas Embedding

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- ◆ Canvases can consume:
  - ◆ Images
  - ◆ Other Canvases
- ◆ Will be able to consume (Firefox 3.1):
  - ◆ Video
- ◆ In an extension:
  - ◆ Web Pages

# Processing

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- ◆ Data Visualization programming language
- ◆ Built on top of Java
- ◆ Can do 2d and 3d
- ◆ Many libraries (manipulate video, images, audio)



# The Language

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- ◆ Strictly typed
- ◆ Has classes, inheritance
- ◆ A bunch of globally-accessible functions
  - ◆ (Very flat API)
- ◆ `setup()` and `draw()` methods
  - ◆ Very OpenGL-like
  - ◆ `draw()` is called continually at a specific framerate

# Draw A Line w/ Mouse

- ◆ While you hold the mouse down, draw a line from the previous mouse point

- ◆ Topics > Drawing > Continuous Line

- ◆ 

```
void setup() {  
    size(200, 200);  
    background(102);  
}
```

```
void draw() {  
    stroke(255);  
    if(mousePressed) {  
        line(mouseX, mouseY, pmouseX, pmouseY);  
    }  
}
```

# Initialization

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- ◆ `setup()` is called initially
- ◆ `size(...)` set the width/height of the drawing area
- ◆ Call any other number of methods, such as:
  - ◆ `background(...)` - draw and fill a background
- ◆ 

```
void setup() {  
    size(200, 200);  
    background(102);  
}
```

# draw() loop

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- ◆ draw() gets called as fast as possible, unless a frameRate is specified
- ◆ stroke() sets color of drawing outline
- ◆ fill() sets inside color of drawing
- ◆ mousePressed is true if mouse is down
- ◆ mouseX, mouseY - mouse position
- ◆ 

```
void draw() {  
  stroke(255);  
  if(mousePressed) {  
    line(mouseX, mouseY, pmouseX, pmouseY);  
  }  
}
```

# Drawing

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- ◆ Different drawing methods:
  - ◆ `line()`
  - ◆ `rect()`
  - ◆ `arc()`
  - ◆ `ellipse()`
  - ◆ `point()`
  - ◆ `quad()`
  - ◆ `triangle()`
  - ◆ `bezier()`
- ◆ All use `stroke()`, `strokeWeight()`, `fill()`

# The Drawing Area

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- ◆ Just like Canvas!
- ◆ Mutate the canvas rendering:
  - ◆ `translate()`
  - ◆ `scale()`
  - ◆ `rotate()`
- ◆ Save and Restore the state of the canvas:
  - ◆ `pushMatrix()`
  - ◆ `popMatrix()`
- ◆ Demo: Basics > Transform > Arm

# Shapes

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- ◆ A series of vertices, built into a shape

- ◆ 

```
fill(127);
beginShape();
for (int i=0; i<segments; i++){
    vertex(ground[i].x1, ground[i].y1);
    vertex(ground[i].x2, ground[i].y2);
}
vertex(ground[segments-1].x2, height);
vertex(ground[0].x1, height);
endShape(CLOSE);
```

# Classes

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- ◆ Hold data, do inheritance
- ◆ Demo: Topics > Motion > Reflection 2
- ◆

```
class Ground {
    float x1, y1, x2, y2, x, y, len, rot;
    Ground() { }
    Ground(float x1, float y1, float x2, float y2) {
        this.x1 = x1; this.y1 = y1; this.x2 = x2; this.y2 = y2;
        x = (x1+x2)/2;
        y = (y1+y2)/2;
        len = dist(x1, y1, x2, y2);
        rot = atan2((y2-y1), (x2-x1));
    }
}
```



# Math functions

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- ◆ `dist()`, `map()`, `constrain()`, `abs()`,  
`floor()`, `ceil()`
- ◆ `random()`, `noise()`
- ◆ `atan2()`, `cos()`, `sin()`, `pow()`, `sqrt()`
- ◆ `radians()`

# Images

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- ◆ Load in external images

- ◆ Demo: Topics > Animation > Sequential

- ◆ 

```
int numFrames = 12; // The number of frames in the animation
int frame = 0;
PImage[] images = new PImage[numFrames];
void setup(){
    size(200, 200);
    frameRate(30);
    for(int i=0; i<numFrames; i++) {
        String imageName = "PT_anim" + nf(i, 4) + ".gif";
        images[i] = loadImage(imageName);
    }
}
void draw() {
    frame = (frame+1)%numFrames;
    image(images[frame], 0, 0);
}
```

# Processing Demos

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- ◆ <http://acg.media.mit.edu/people/fry/zipdecode/>
- ◆ <http://complexification.net/gallery/machines/substrate/>
- ◆ [http://sublimeguile.com/processing/tree\\_071017b/](http://sublimeguile.com/processing/tree_071017b/)
- ◆ <http://vimeo.com/311550>

# Processing.js

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- ◆ How do we run Processing on web pages?
- ◆ Applets suck
- ◆ Processing: Convert Processing to JavaScript and run on Canvas
- ◆ Two stages:
  - ◆ Language Conversion
  - ◆ Processing API

# Ported to JS

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- ◆ Released in May:  
<http://ejohn.org/apps/processing.js/>
- ◆ Port of the Processing Language +  
the 2d Processing API
- ◆ All runs in JavaScript on top of HTML 5  
Canvas
- ◆ Works in all browsers (IE with excanvas)

# Porting

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- ◆ The API
  - ◆ Rather straight-forward
  - ◆ 1-to-1 mapping of Processing to Canvas
- ◆ The Language
  - ◆ Much more complicated
  - ◆ Parse the full language
  - ◆ (lots of Regular Expressions)

# Previous Demos

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- ◆ <http://ejohn.org/apps/processing.js/examples/topics/continuouslines.html>
- ◆ <http://ejohn.org/apps/processing.js/examples/basic/arm.html>
- ◆ <http://ejohn.org/apps/processing.js/examples/topics/reflection2.html>
- ◆ <http://ejohn.org/apps/processing.js/examples/topics/sequential.html>

# Processing.js Demos

- ◆ <http://ejohn.org/apps/processing.js/examples/custom/snake.html>
- ◆ <http://ejohn.org/apps/processing.js/examples/custom/molten.html>
- ◆ <http://ejohn.org/apps/processing.js/examples/basic/>
  - ◆ Recursion
  - ◆ Distance 2D
  - ◆ Random
- ◆ <http://ejohn.org/apps/processing.js/examples/topics/>
  - ◆ Soft Body
  - ◆ Flocking
  - ◆ Tree
- ◆ <http://ejohn.org/apps/hero/>