Computational Fabrication

CS 491 and 591, Special Topics in Computer Science
Professor: Leah Buechley
https://handandmachine.org/classes/computational_fabrication

WordPress FYI & Introduction

Create an account
use your full name and UNM email
add your full name to your account if you haven't

FERPA
All student activity is private
including all course work and comments

Syllabus, Schedule, Assignments, Resources are public

WordPress Creating a Post

Posts

Categories

Inserting images & other files

HTML

Small Assignment

Due Tuesday

Small Assignment 1: Introduce yourself

Find and share and example of computational design work you love

Put in “Small Assignment - Introductions” subcategory under “Student Work 2023” category

Due Thursday

Comment on at least three peer posts

questions?

Processing

Processing + P5JS

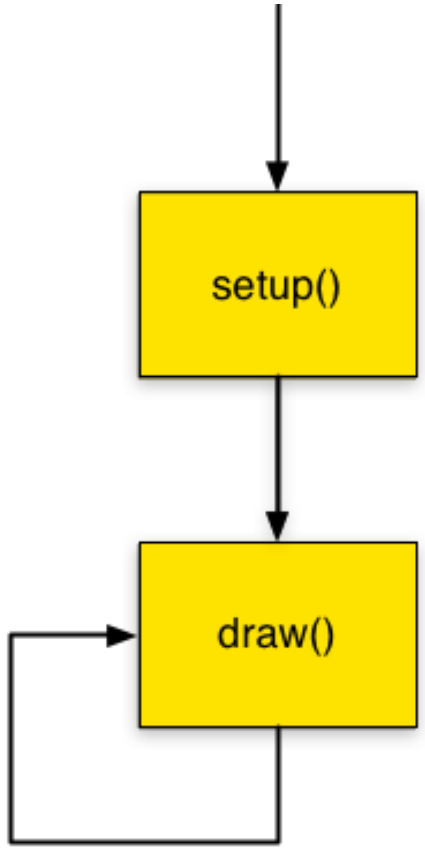
- Java based programming environment +
- Javascript based programming environment
- Lots of built in libraries
- Excellent documentation
- Vibrant community of artists and designers
- Makes programming of visual and interactive elements quick an easy
- Open Processing: https://openprocessing.org/

open up Processing &
Processing reference

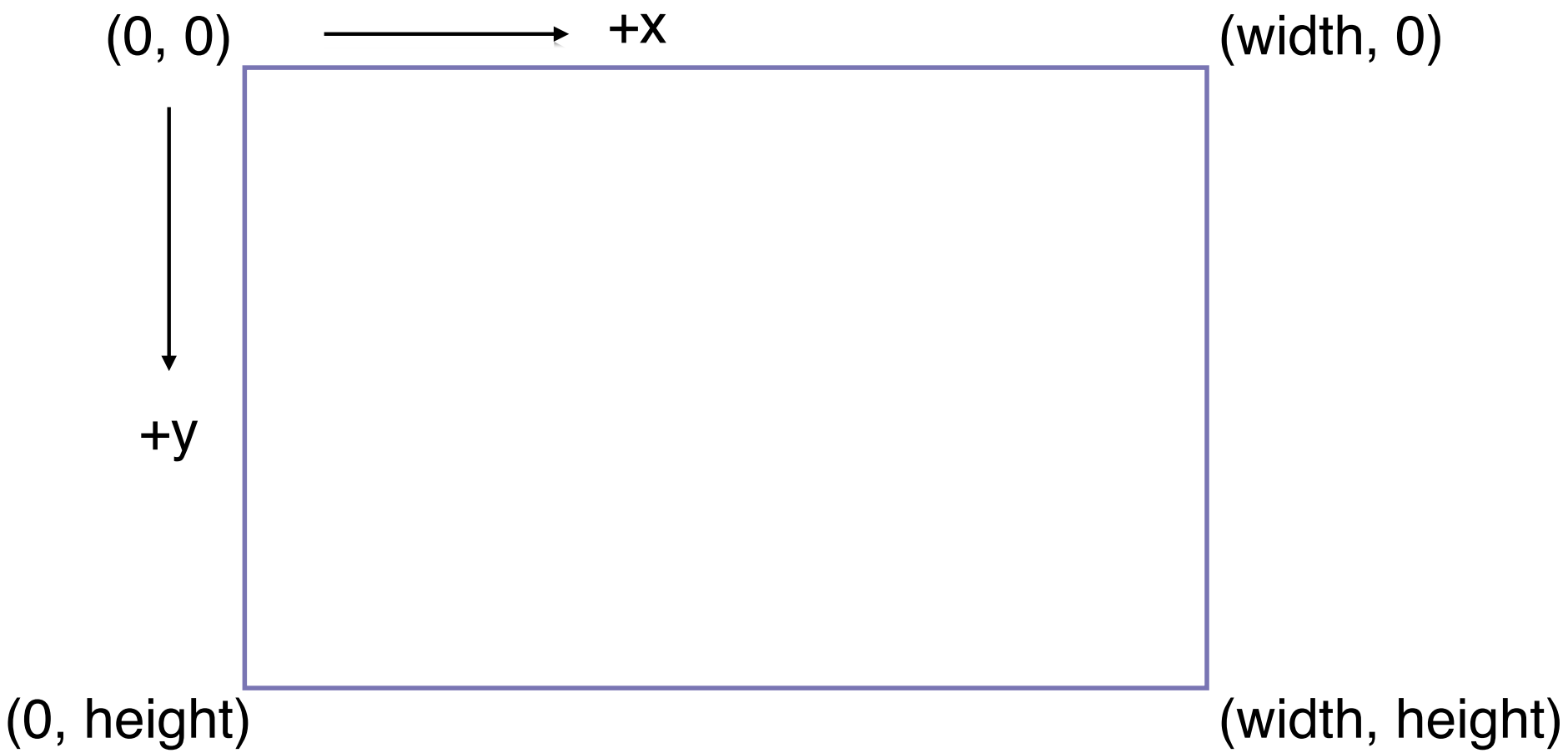
Program Structure

```
//this runs once
void setup () {
}

//this loops forever
void draw () {
}
```



Coordinate System



Simple Program

```
void setup() {
    size(700,500);
    background(255);
}

void draw() {
    line(0,0,100,100);
}
```

Save your “Sketch”

Built-in Variables

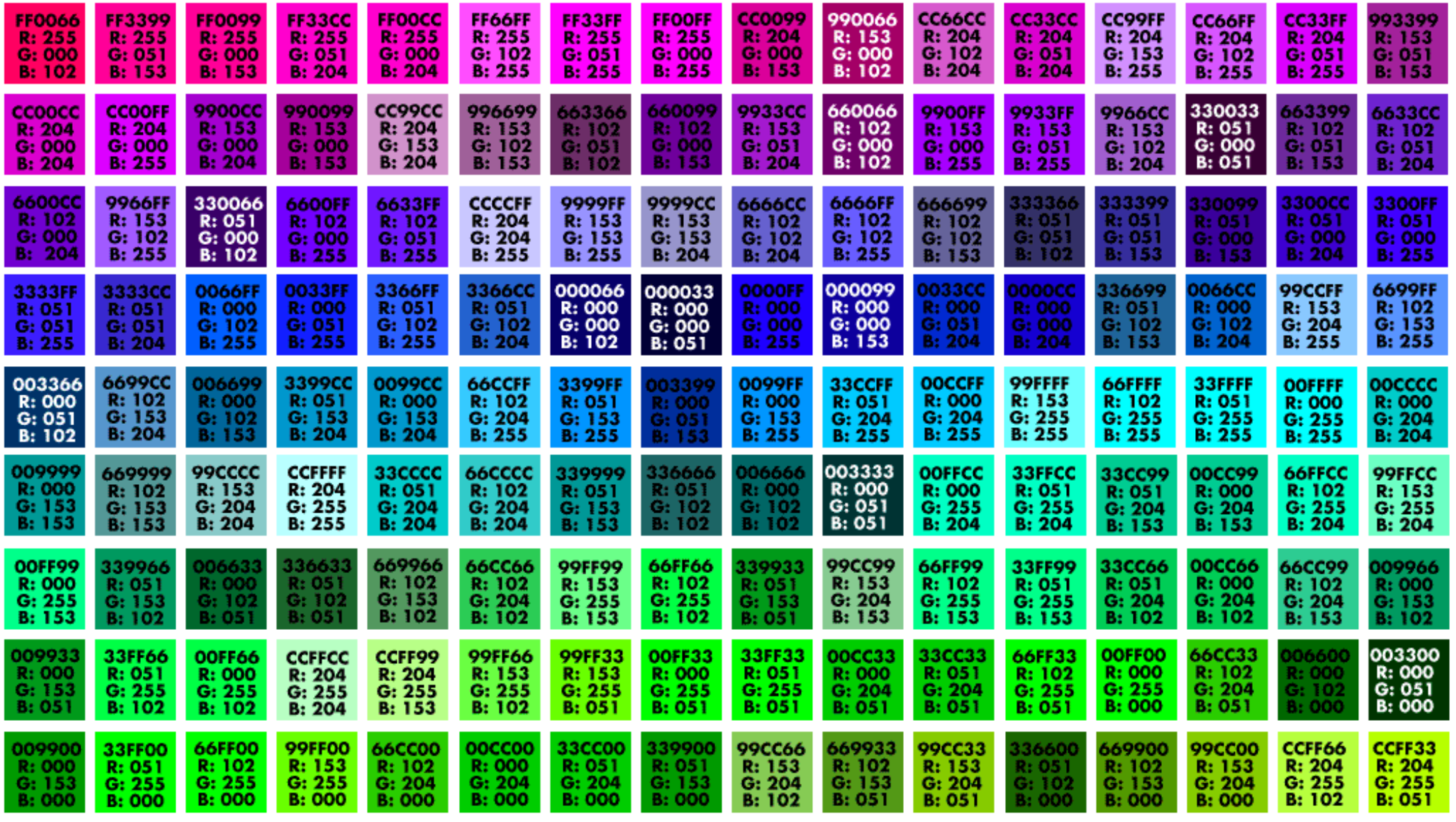
```
void setup() {
    size(700,500);
    background(255);
}


void draw() {
    line(width/2,height/2,width,height);
}
```

Built-in Variables, Interactivity

```
void setup() {
    size(700,500);
    background(255);
}

void draw() {
    line(0,0,mouseX,mouseY);
}
```


FF0066 R: 255 G: 000 B: 102
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CC66CC R: 204 G: 102 B: 204
CC33CC R: 204 G: 051 B: 204
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669999 R: 102 G: 153 B: 153
99CCCC R: 153 G: 204 B: 204
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CCFFCC R: 204 G: 255 B: 204
CCFF99 R: 204 G: 255 B: 153
99FF66 R: 153 G: 255 B: 102
99FF33 R: 153 G: 255 B: 051
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66CC33 R: 102 G: 204 B: 051
006600 R: 000 G: 102 B: 000
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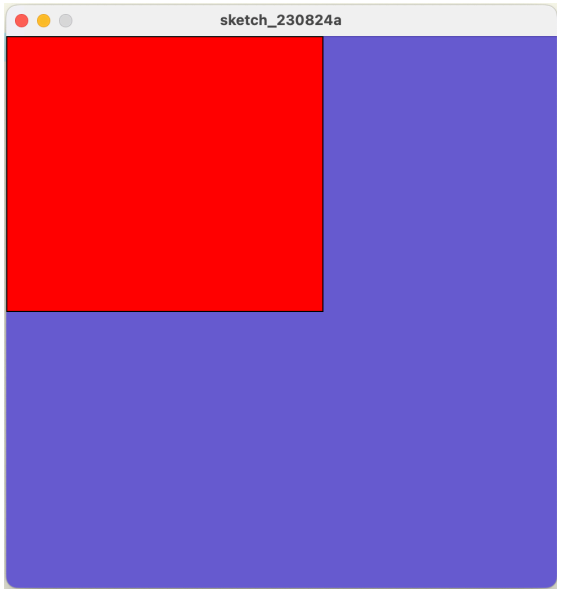
669900 R: 102 G: 153 B: 000
99CC00 R: 153 G: 204 B: 000
CCFF66 R: 204 G: 255 B: 102
CCFF33 R: 204 G: 255 B: 051

Color

```
void setup() {
    size(700,500);
}

void draw() {
    background(100,90,200);
    line(0,0,mouseX,mouseY);
}
```

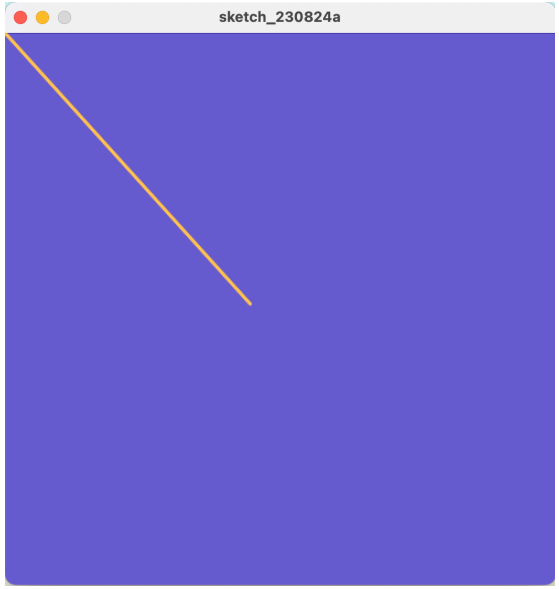
Color, Fill

```
void setup() {
    size(700,500);
    fill(255,0,0);
}

void draw() {
    background(100,90,200);
    rect(0,0,mouseX,mouseY);
}
```



Color, Stroke, Stroke Weight

```
void setup() {
    size(700,500);
    fill(255,0,0);
    stroke(255,200,100);
    strokeWeight(3);
}

void draw() {
    background(100,90,200);
    line(0,0,mouseX,mouseY);
}
```



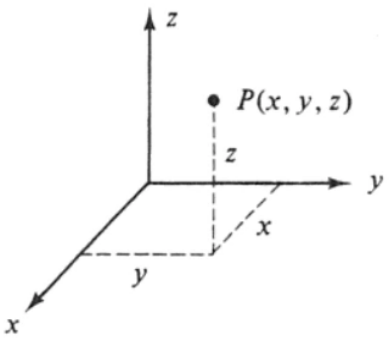
questions?

Math Review
trigonometry & coordinate systems

Coordinate systems

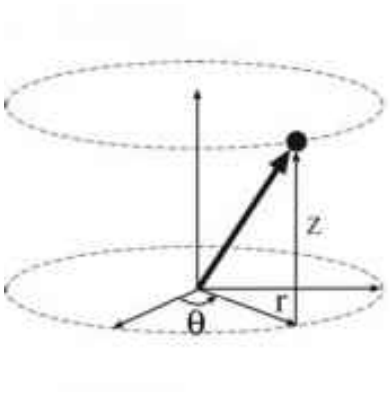
Cartesian

x,y,z



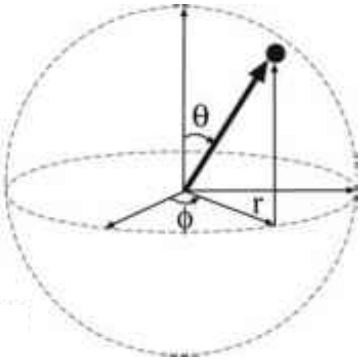
Polar/Cylindrical

r,θ,z



Spherical

r,θ,ϕ



Create a new Sketch

Line: Cartesian coordinate system

```
void setup() {
  size (300,300);
  background(220,200,100);
}

void draw() {
   line(width/2,height/2,mouseX,mouseY);
}
```

Line

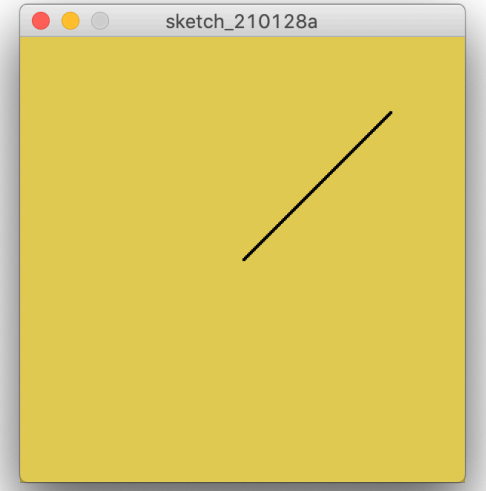
```
void setup() {
  size (300,300);
  background(220,200,100);
}

void draw() {
  line(width/2,height/2,width/2+100,height/2-100);
}
```

Line

```
void setup() {
  size (300,300);
  background(220,200,100);
}

void draw() {
  int x0,y0,x1,y1;
  x0 = width/2;
  y0 = height/2;
  x1 = x0+100;
  y1 = y0-100;
  line(x0,y0,x1,y1);
}
```

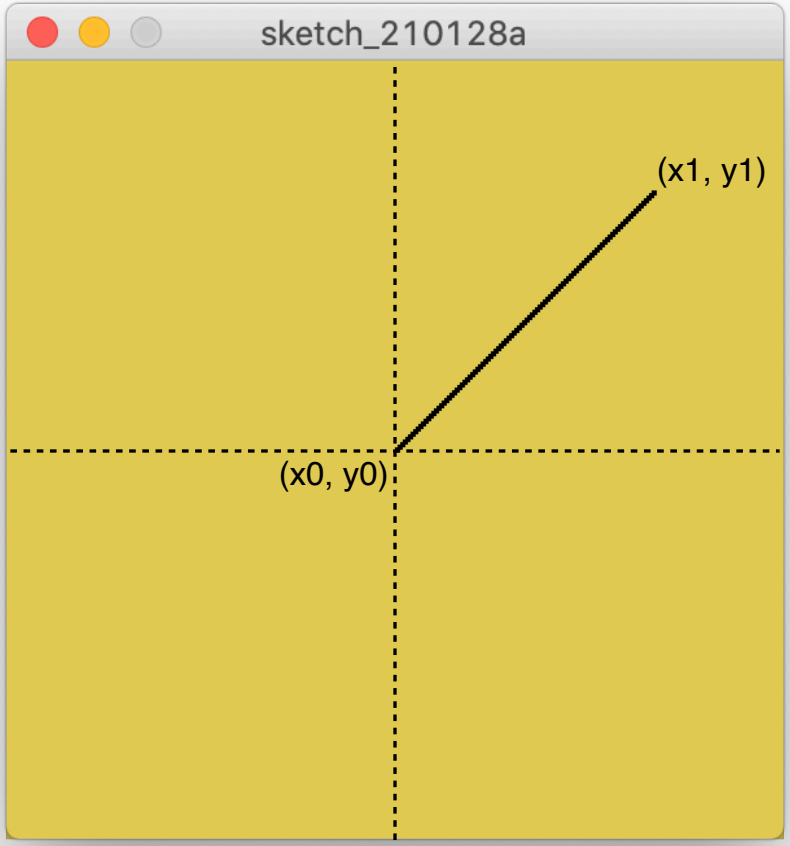
Line from x and y

```
void cartesianLine(float x0, float y0, float x1, float y1) {
  line(x0,y0,x1,y1);
}
```

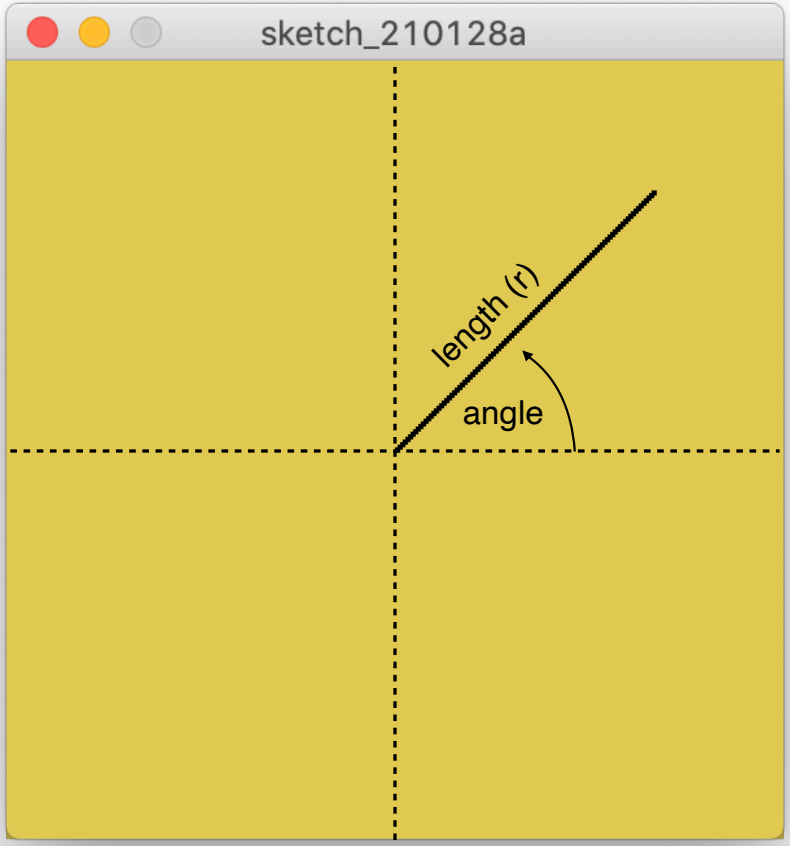


Line: Polar coordinate system?

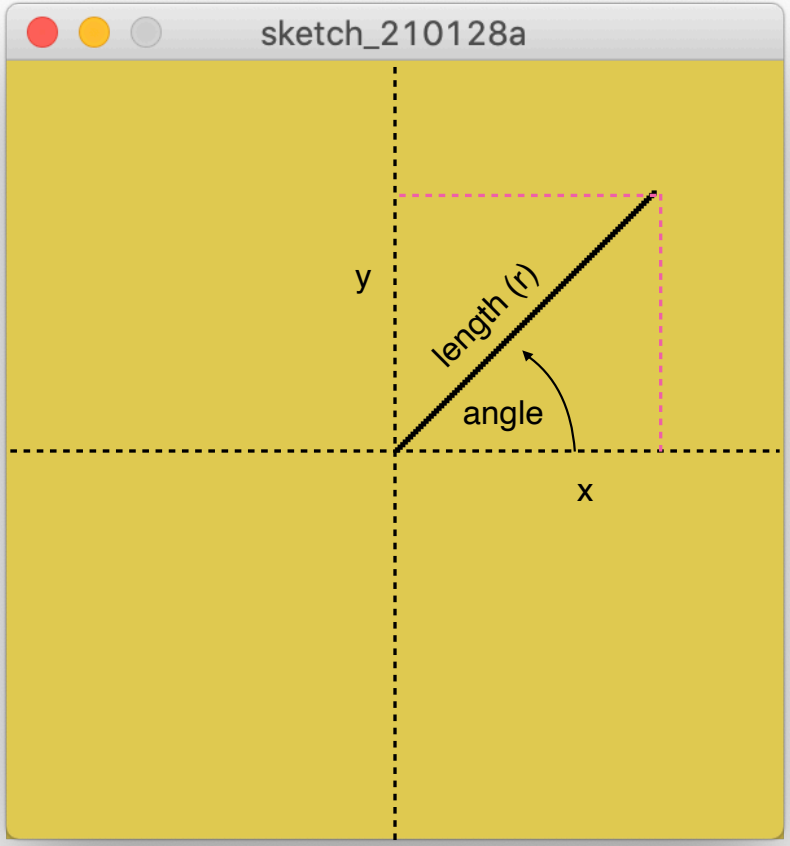
Line



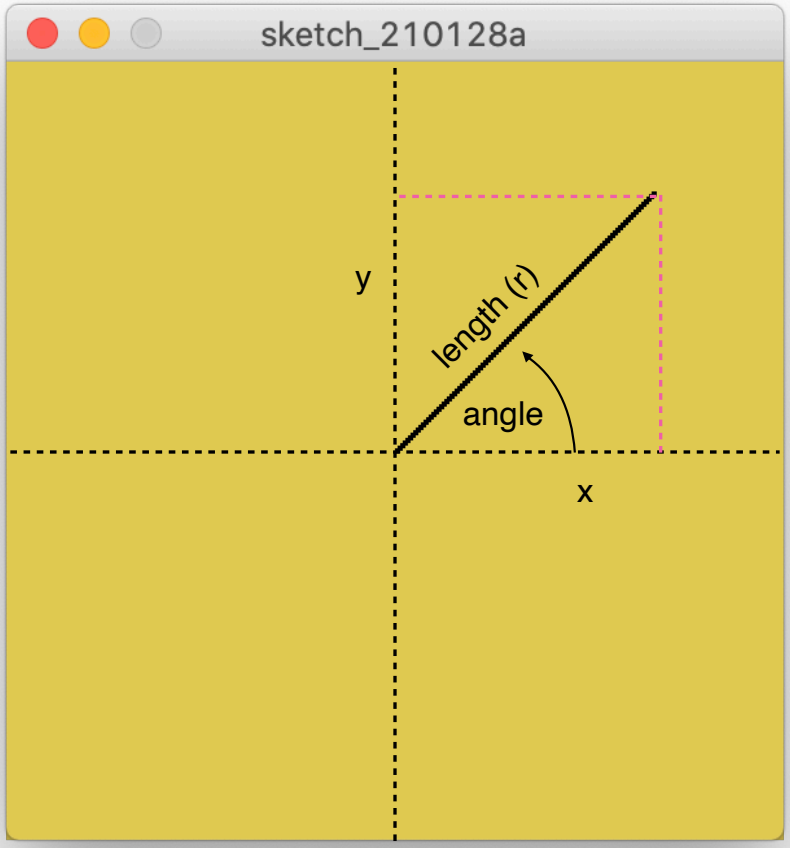
Line



Line



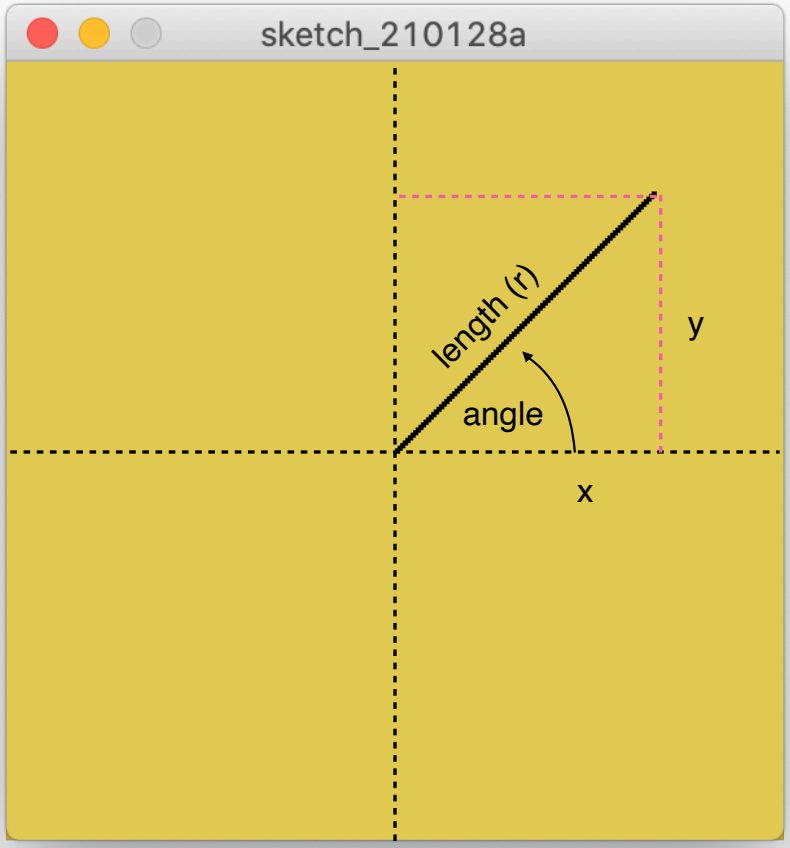
Line



length ?

r ?

Line

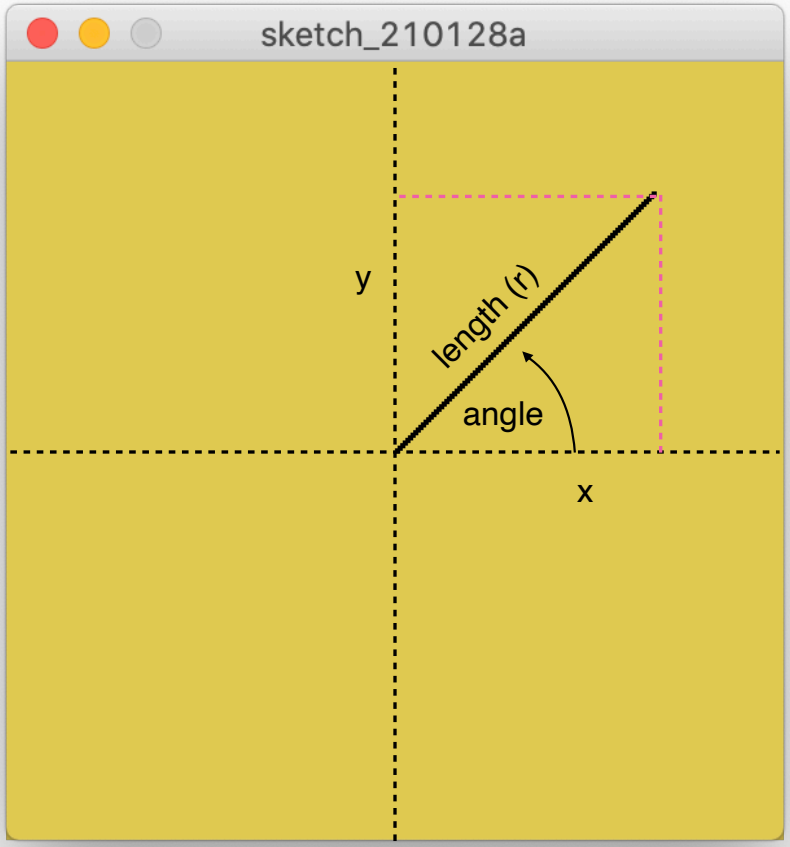


$$c^2 = a^2 + b^2$$

$$r^2 = x^2 + y^2$$

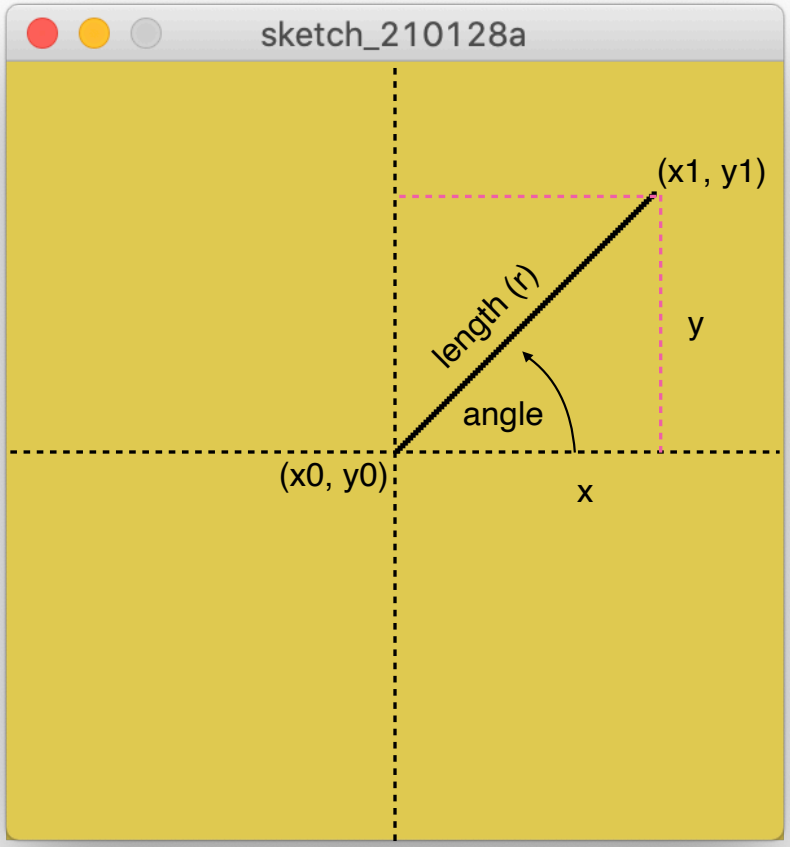
$$r = \sqrt{(x^2 + y^2)}$$

Line



angle ?

Line

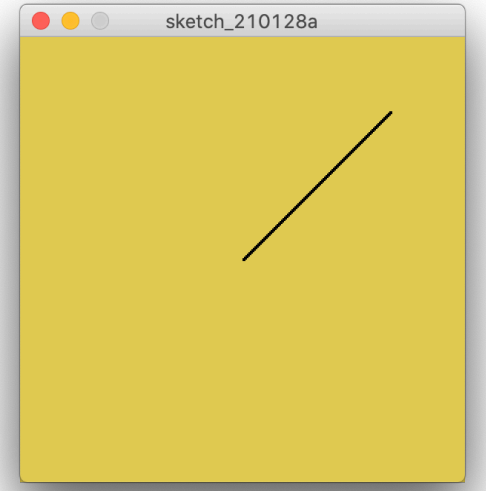


$$x = r * cos(angle)$$
$$y = r * sin(angle)$$

$$x1 = x0 + r * cos(angle)$$
$$y1 = y0 + r * sin(angle)$$

Line from r and θ

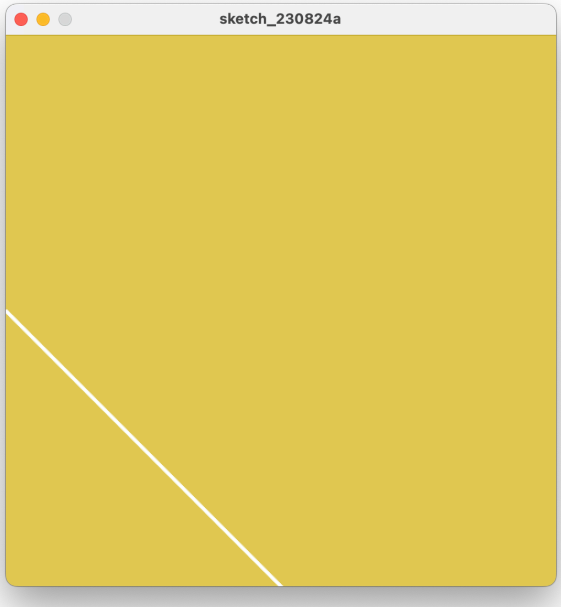
```
void polarLine(float x0, float y0, float r, float angle) {
  float x1 = x0 + r*cos(radians(angle));
  float y1 = y0 - r*sin(radians(angle));
  line(x0,y0,x1,y1);
}
```



questions?

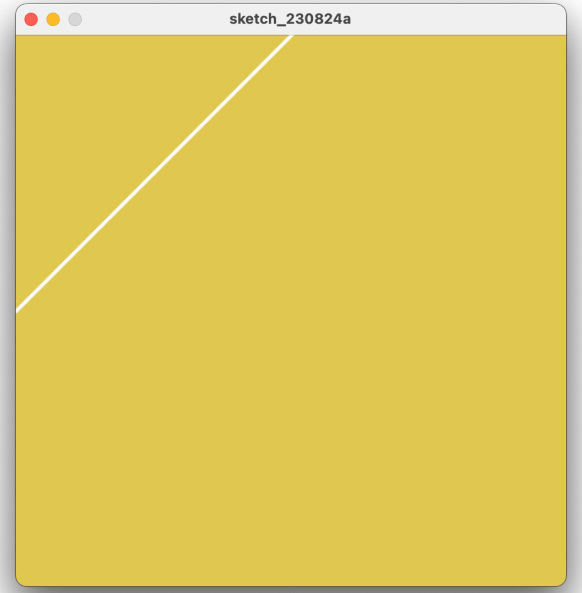
Cartesian Plots

```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 = x1;     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



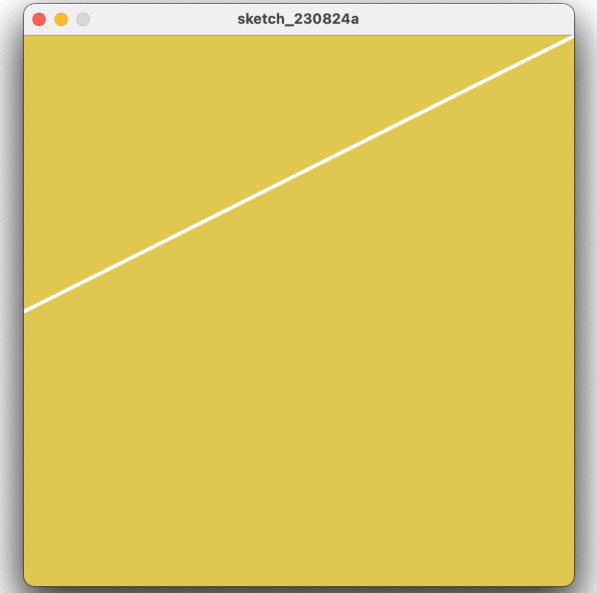
Cartesian Plots

```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 = -x1;     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



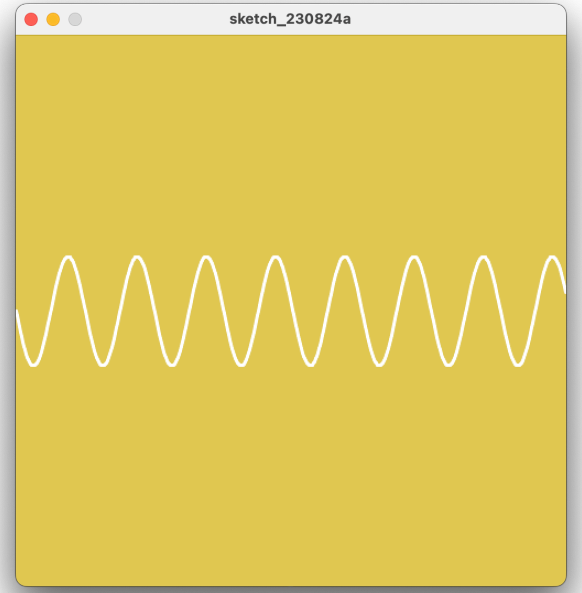
Cartesian Plots

```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 = -x1/2;     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



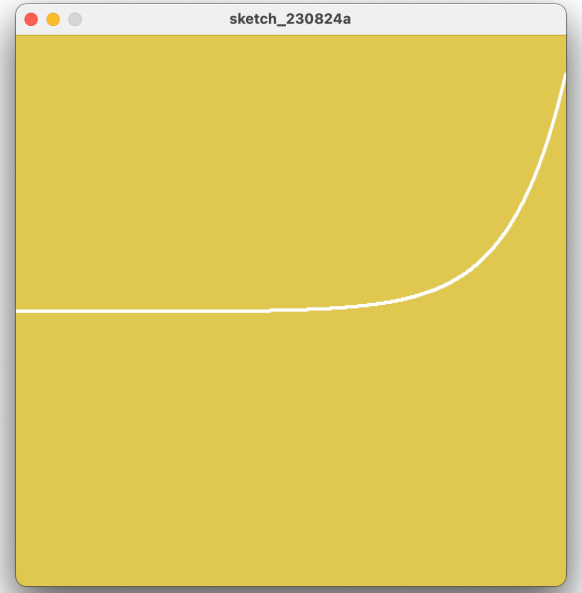
Cartesian Plots

```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 =(int)(sin(x1/10.0)*50);     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



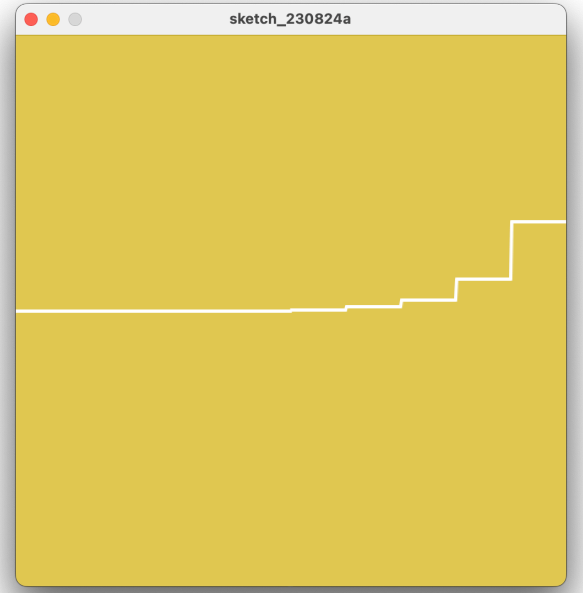
Cartesian Plots

```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 =-(int)(exp(x1/50.0)/100);     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



ints & floats, Be careful!

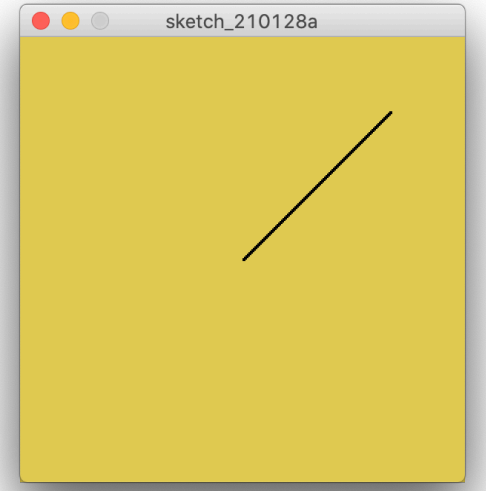
```
void cartesian_plot() {
  int x0,y0,x1,y1,y_offset;
  x0 = 0;
  y0 = 0;
  y_offset = width/2;
  for (x1=0;x1<width;x1++) {
    y1 =-(int)(exp(x1/50)/100);     //y = f(x)
    cartesianLine(x0,y0+y_offset,x1,y1+y_offset);
    x0 = x1;
    y0 = y1;
  }
}
```



questions?

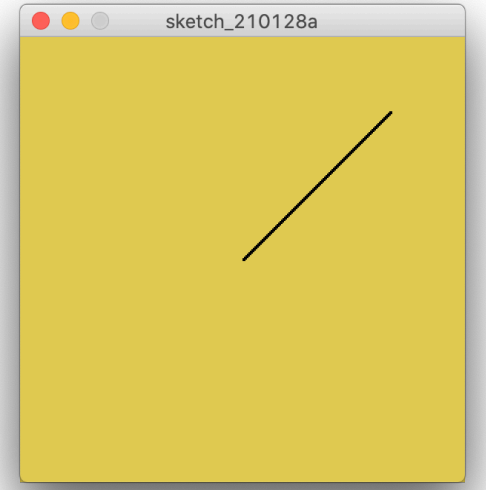
Polar Plots

```
void polarLine(float x0, float y0, float r, float angle) {
  float x1 = x0 + r*cos(radians(angle));
  float y1 = y0 - r*sin(radians(angle));
  line(x0,y0,x1,y1);
}
```



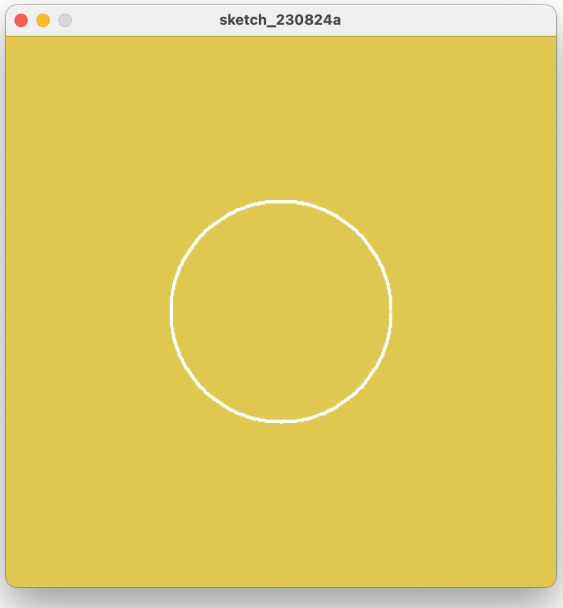
Point from from r and θ

```
float[] polarPoint(float r, float theta) {
  float [] point = new float[2];
  point[0] = width/2+r*cos(radians(theta));
  point[1] = height/2+r*sin(radians(theta));
  return point;
}
```



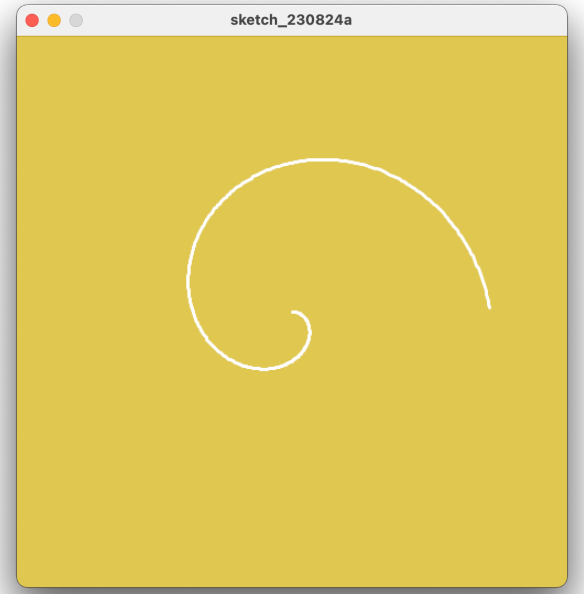
Polar Plots

```
void polar_plot () {
  float r;
  beginShape();
  for (int i=0; i<361; i++) {
    r = 100;    // r = f(theta)
    float[] point = polarPoint(r, i);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```

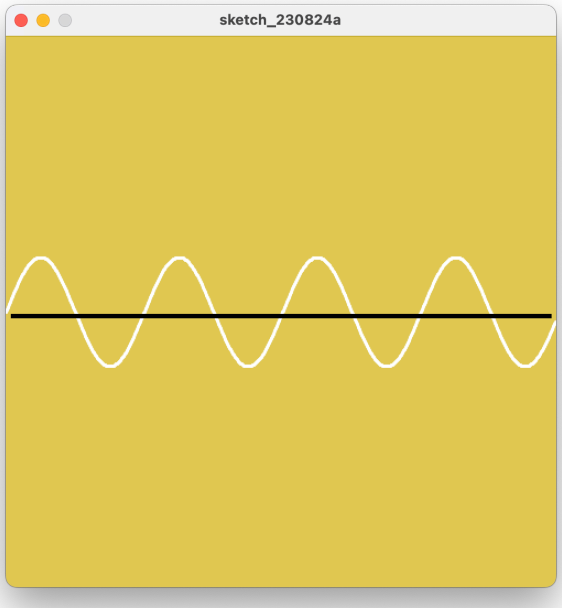


Polar Plots

```
void polar_plot () {
  float r;
  beginShape();
  for (int i=0; i<361; i++) {
    r = theta/2;     // r = f(theta)
    float[] point = polarPoint(r, i);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```

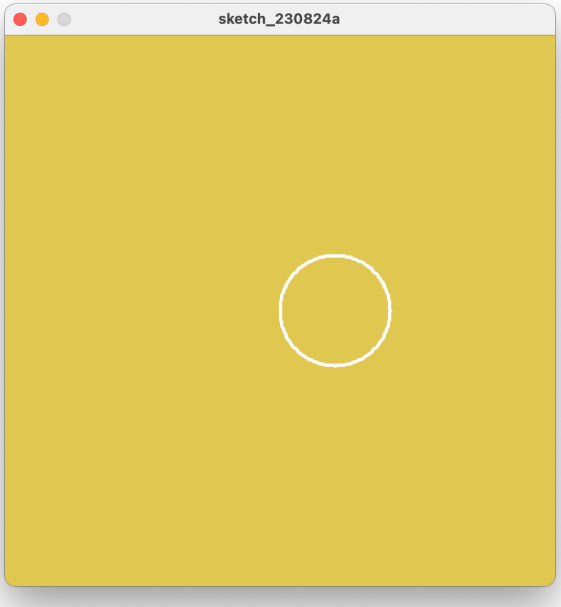


sin or cosine in polar coordinates?



Polar Plots

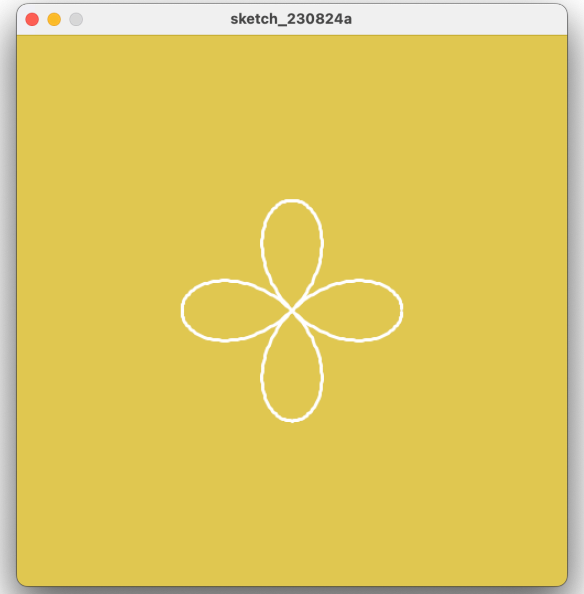
```
void polar_plot () {
  float r;
  float theta;
  beginShape();
  for (theta=0; theta<361; theta++) {
    r = cos(radians(theta))*100;    // r = f(theta)
    float[] point = polarPoint(r, theta);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```



one period, 0-2π, 0-360°

Polar Plots

```
void polar_plot () {
  float r;
  float theta;
  beginShape();
  for (theta=0; theta<361; theta++) {
    r = cos(radians(theta*2.0))*100;     // r = f(theta)
    float[] point = polarPoint(r, theta);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```

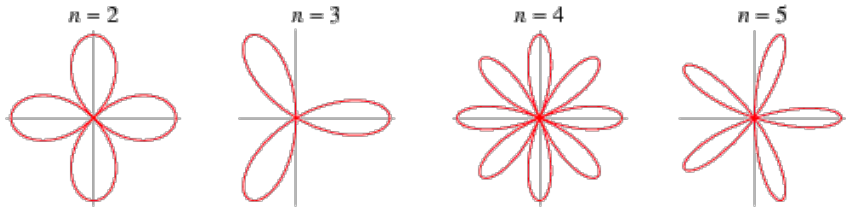


two periods, 0-4π, 0-720°

questions?

Polar Rose Equations

$$r = a\cos(n\theta)$$



a = amplitude of oscillation around circle

n = number of oscillations

Polar Rose Equation Extension

$$r = c + a\cos(n\theta)$$

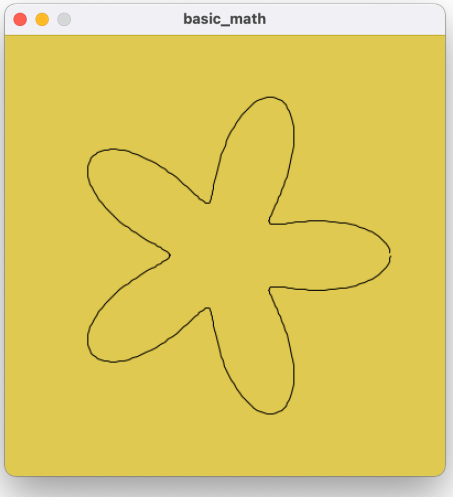
c = starting radius (opens up the shape if c > a)

a = amplitude of oscillation around circle

n = number of oscillations

Polar Plots

```
void plot () {
  float r;
  beginShape();
  for (int i=0; i<360; i++) {
    r = 100+50*cos(radians(i*5));
    float[] point = polarPoint(r, i);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```



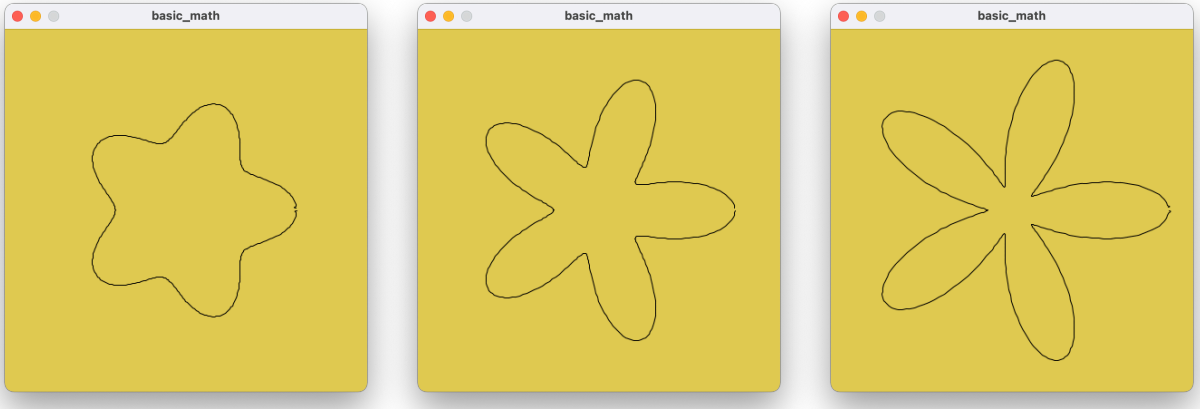
c = 100

a = 50

n = 5

Interactive Polar Plot

```
void plot () {
  float r;
  beginShape();
  for (int i=0; i<360; i++) {
    r = 100+mouseX/5*cos(radians(i*5));
    float[] point = polarPoint(r, i);
    curveVertex(point[0],point[1]);
  }
  endShape();
}
```



c = 100

a = mouseX/5

n = 5

questions?

For Next Class

First Small Assignment

Reading: Turtle Geometry

Install Turtle Library

Order your 3D printers

questions?

Thank you!

CS 491 and 591, Special Topics in Computer Science
Professor: Leah Buechley
https://handandmachine.org/classes/computational_fabrication