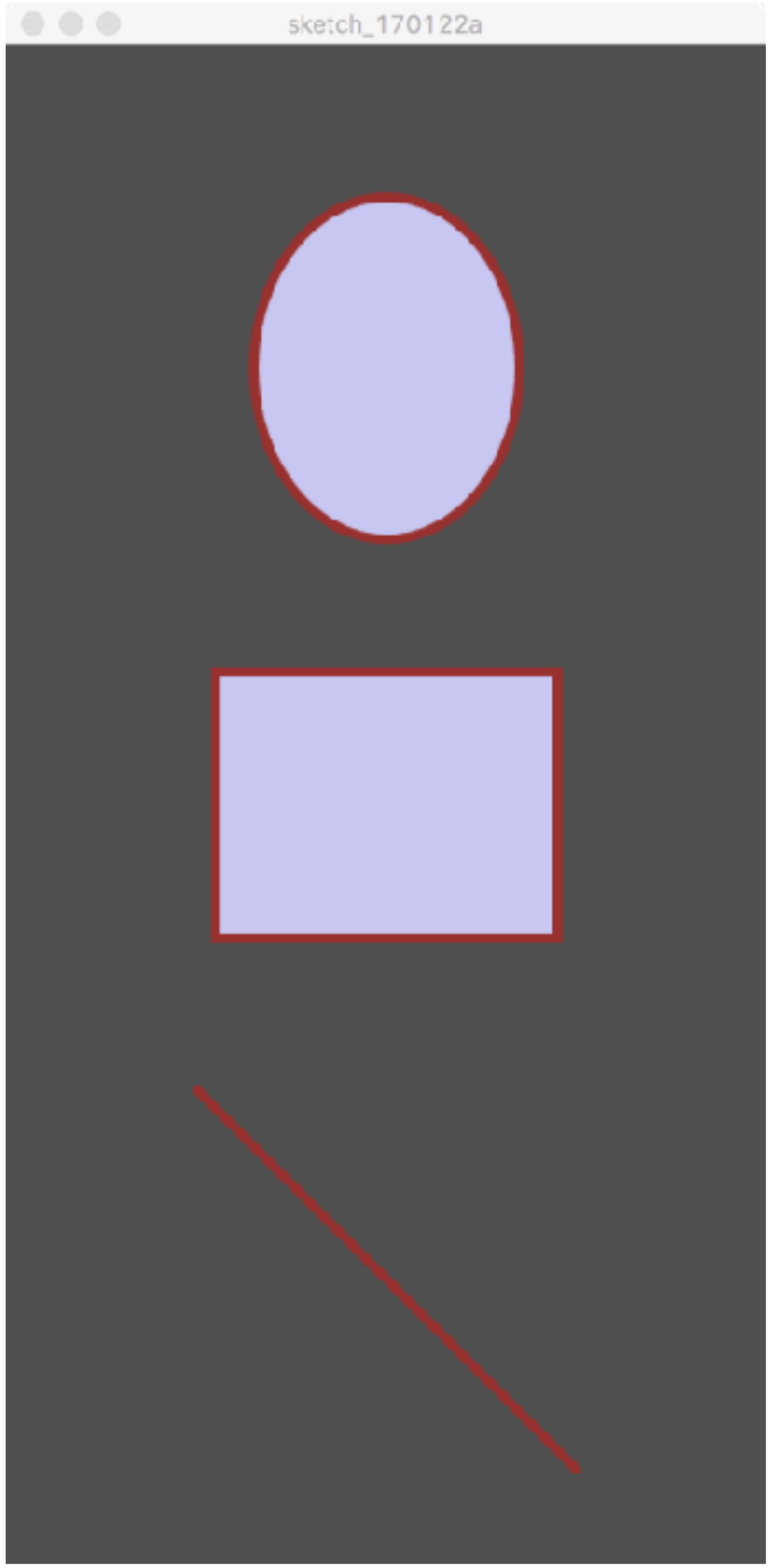
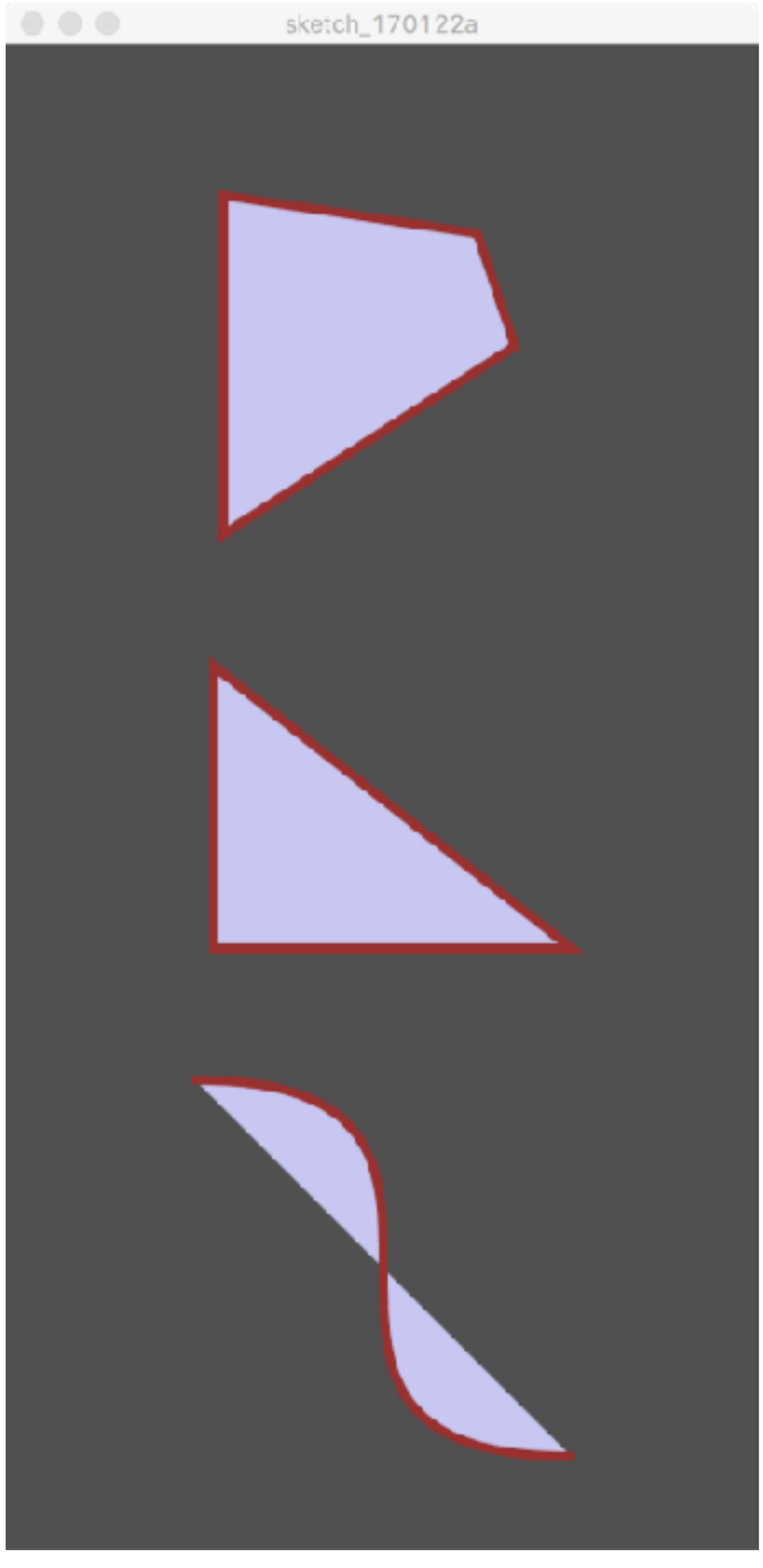
Module 04

Advanced Shapes

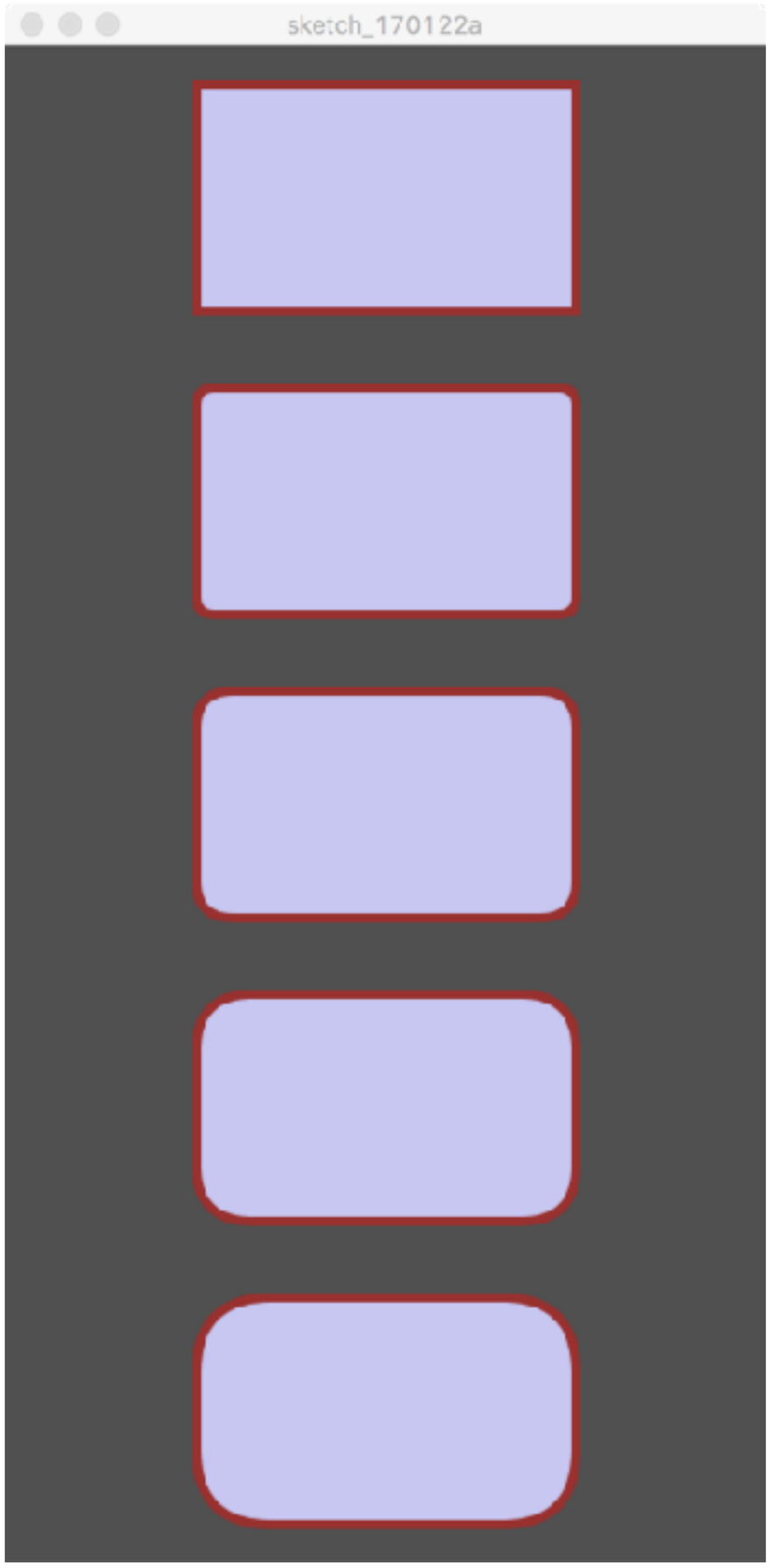
```
void setup()
{
  size( 400, 800 );
  background( 80 );
  rectMode( CENTER );

  fill( 200, 200, 240 );
  stroke( 150, 50, 50 );
  strokeWeight( 5 );

  ellipse( 200, 170, 140, 180 );
  rect( 200, 400, 180, 140 );
  line( 100, 550, 300, 750 );
}
```



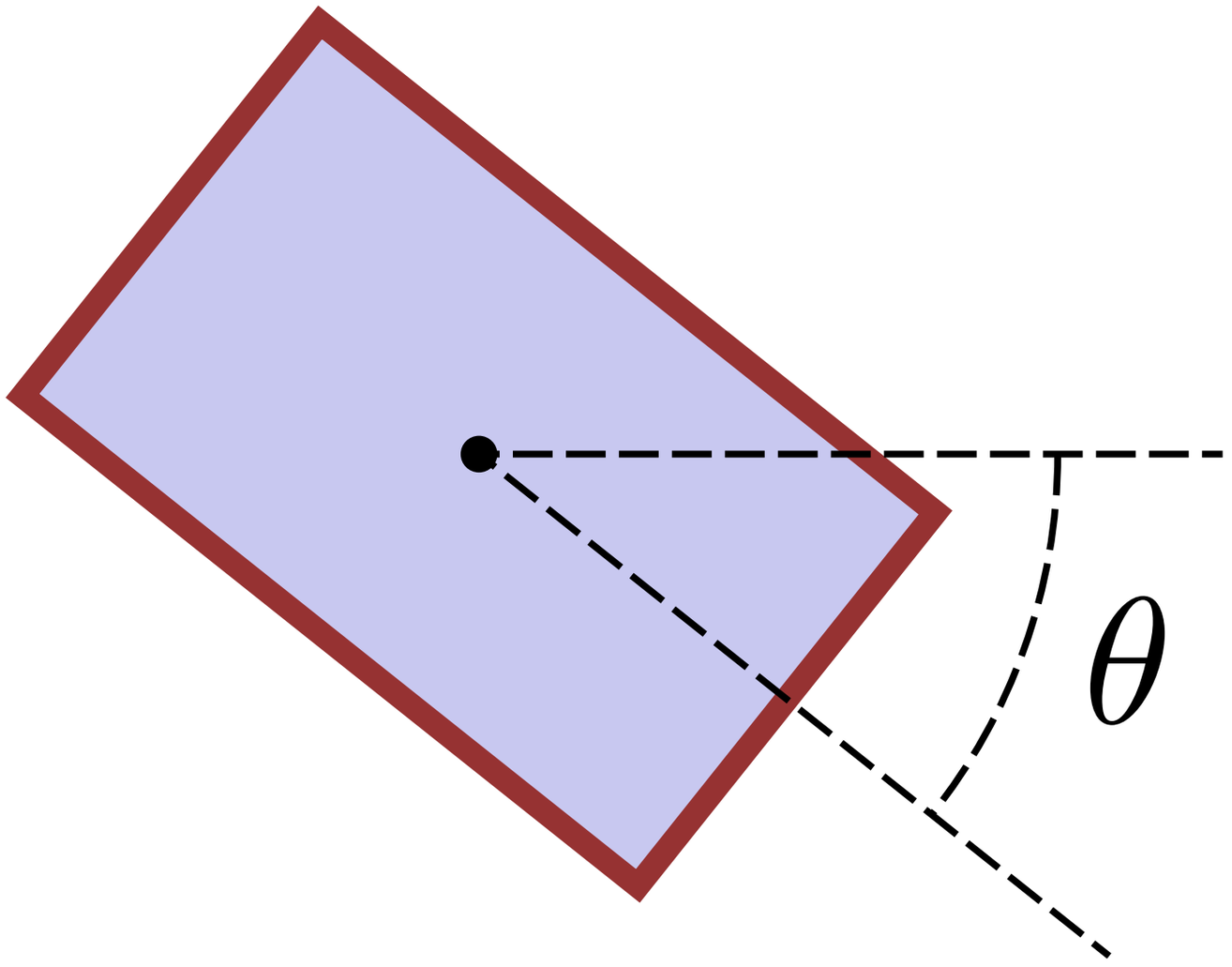
```
void setup()
{
  size( 400, 800 );
  background( 80 );
  rectMode( CENTER );

  fill( 200, 200, 240 );
  stroke( 150, 50, 50 );
  strokeWeight( 5 );

  quad( 115, 80, 115, 260,
    270, 160, 250, 100 );
  triangle( 110, 330, 110, 480,
    300, 480 );
  bezier( 100, 550, 300, 550,
    100, 750, 300, 750 );
}
```

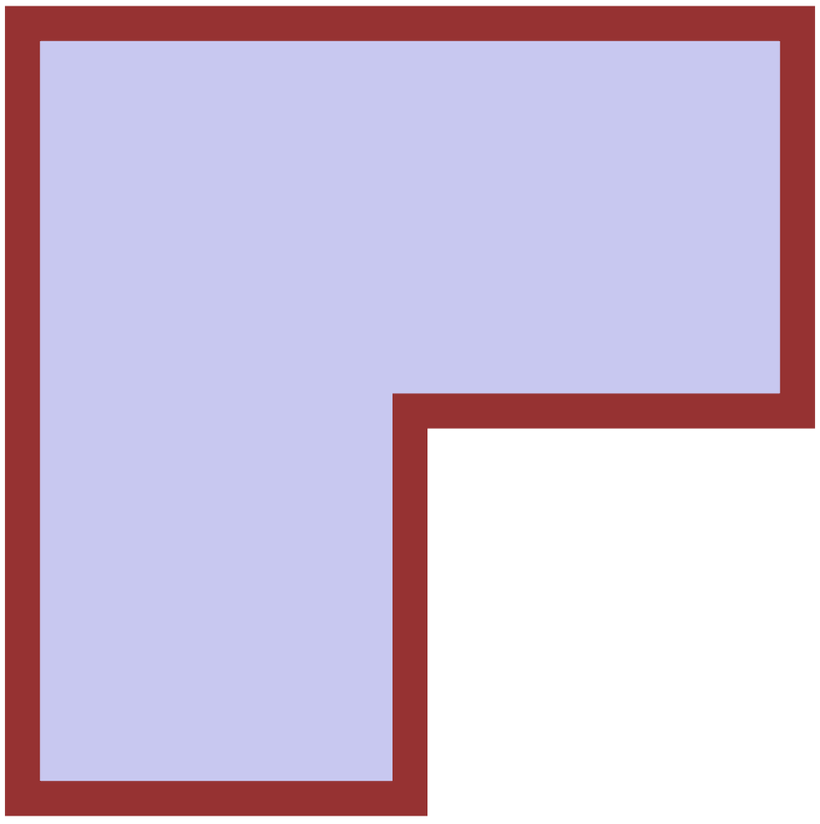


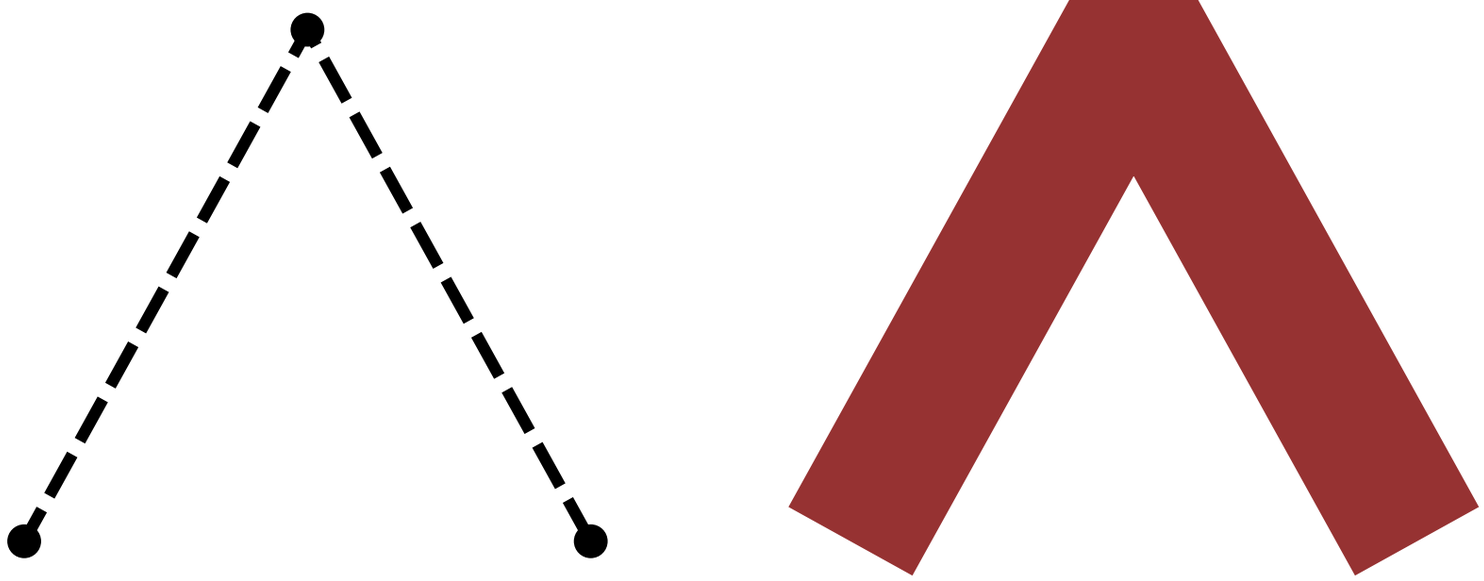
```
void setup()
{
  size( 400, 800 );
  background( 80 );

  fill( 200, 200, 240 );
  stroke( 150, 50, 50 );
  strokeWeight( 5 );

  for( int idx = 0; idx < 5; ++idx ) {
    rect( 100, idx * 160 + 20,
        200, 120, idx * 10 );
  }
}
```

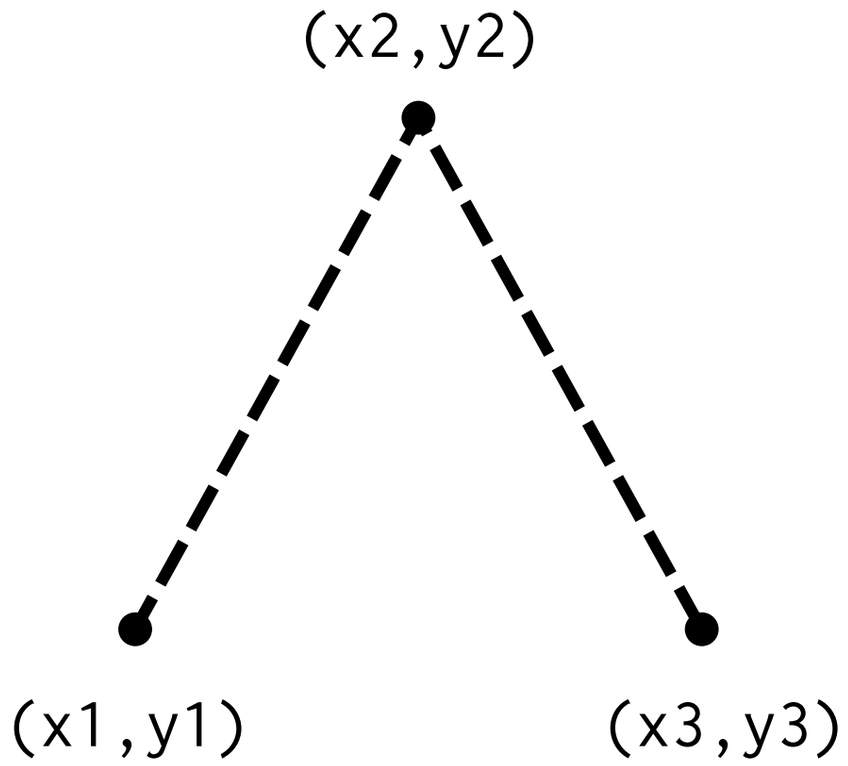


Limitations

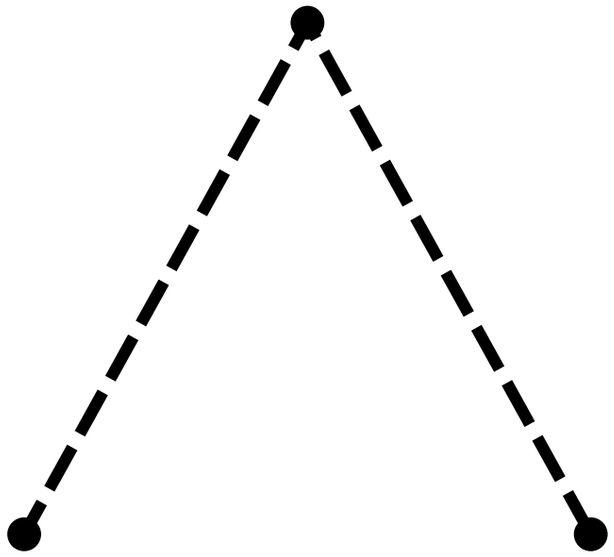




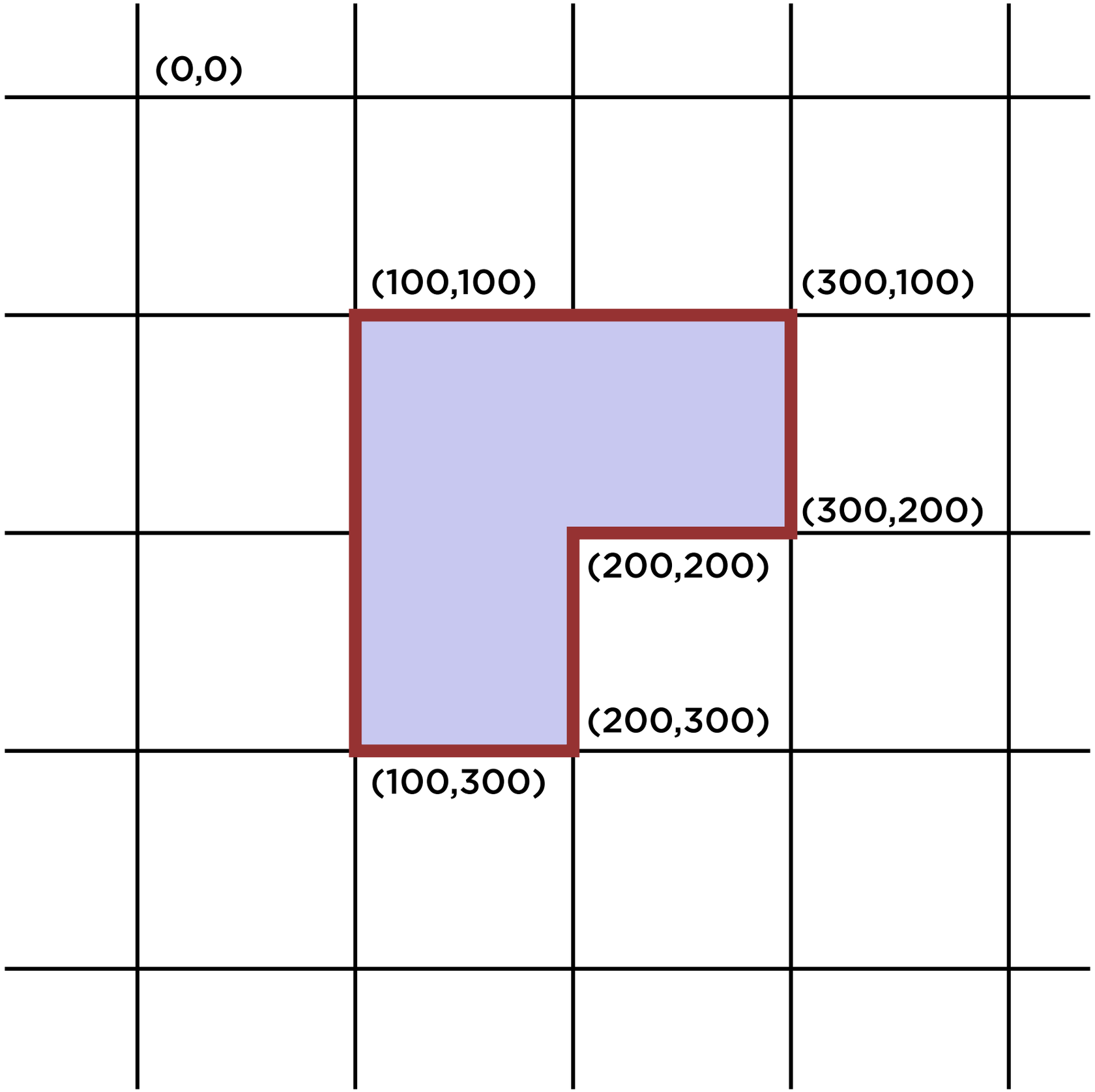




```
line( x1, y1, x2, y2 );
line( x2, y2, x3, y3 );
```



`strokeCap( SQUARE )` `strokeCap( PROJECT )` `strokeCap( ROUND )`

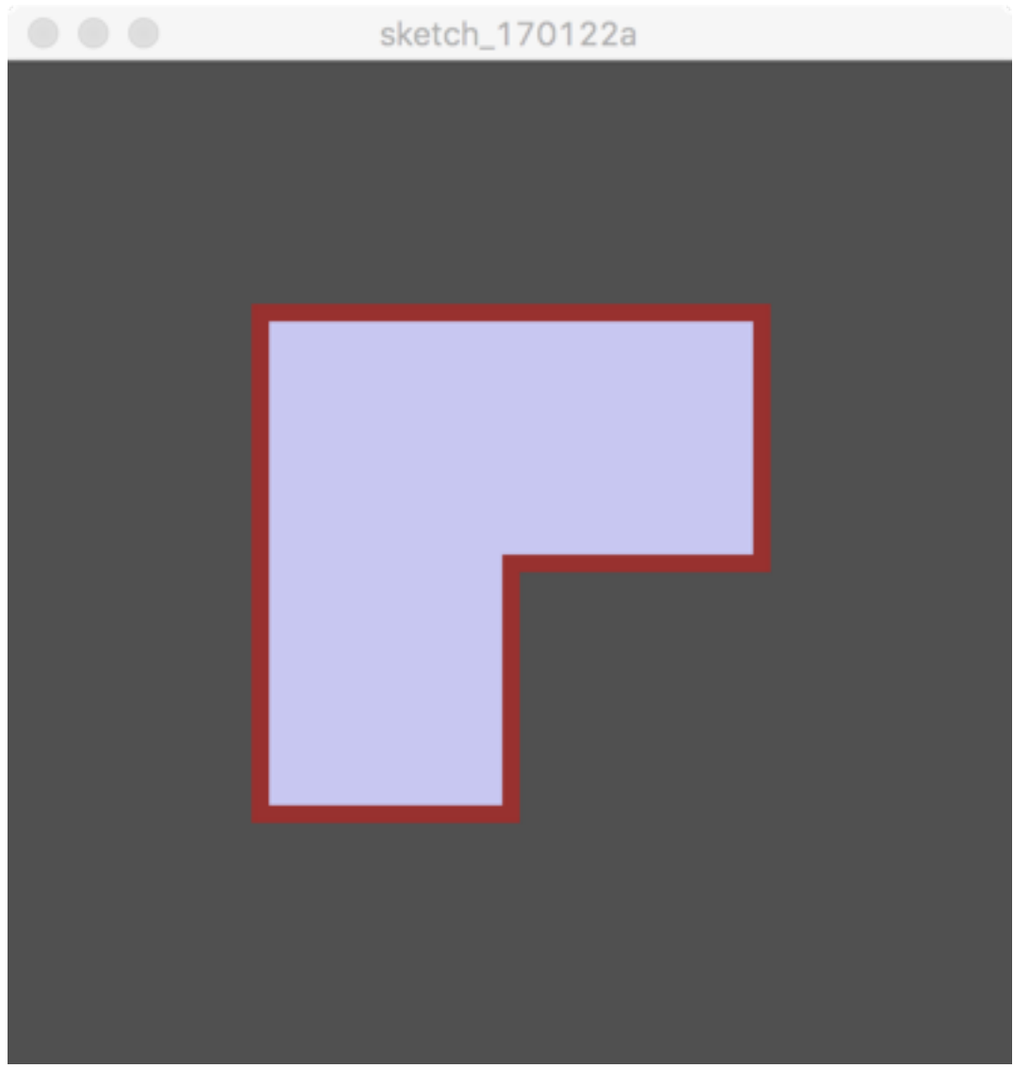

(0,0)
(100,100)
(300,100)
(300,200)
(200,200)
(200,300)
(100,300)

`beginShape()` **“I will now draw a shape.”**

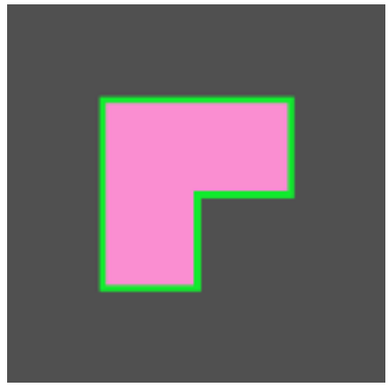
`vertex()` **“Here’s one corner of that shape I’m drawing.”**

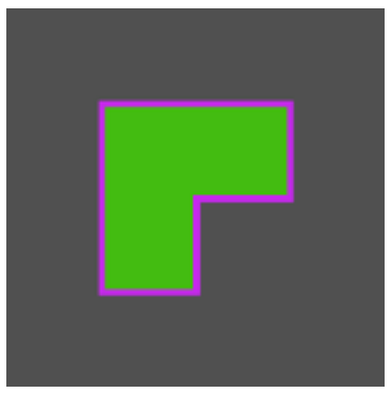
`endShape()` **“Now I am finished drawing my shape.”**

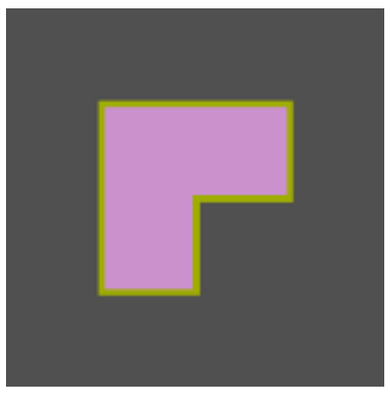
```
beginShape();
  vertex( 100, 100 );
  vertex( 100, 300 );
  vertex( 200, 300 );
  vertex( 200, 200 );
  vertex( 300, 200 );
  vertex( 300, 100 );
endShape( CLOSE );
```

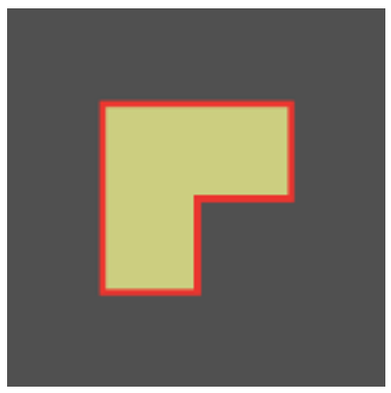


```
for ( int idx = 0; idx < 8; ++idx ) {
  fill( random(255), random(255), random(255) );
  stroke( random(255), random(255), random(255) );
  background( 80 );

  beginShape();
    vertex( 100, 100 );
    vertex( 100, 300 );
    vertex( 200, 300 );
    vertex( 200, 200 );
    vertex( 300, 200 );
    vertex( 300, 100 );
  endShape( CLOSE );

  save( "output-" + idx + ".png" );
}
```





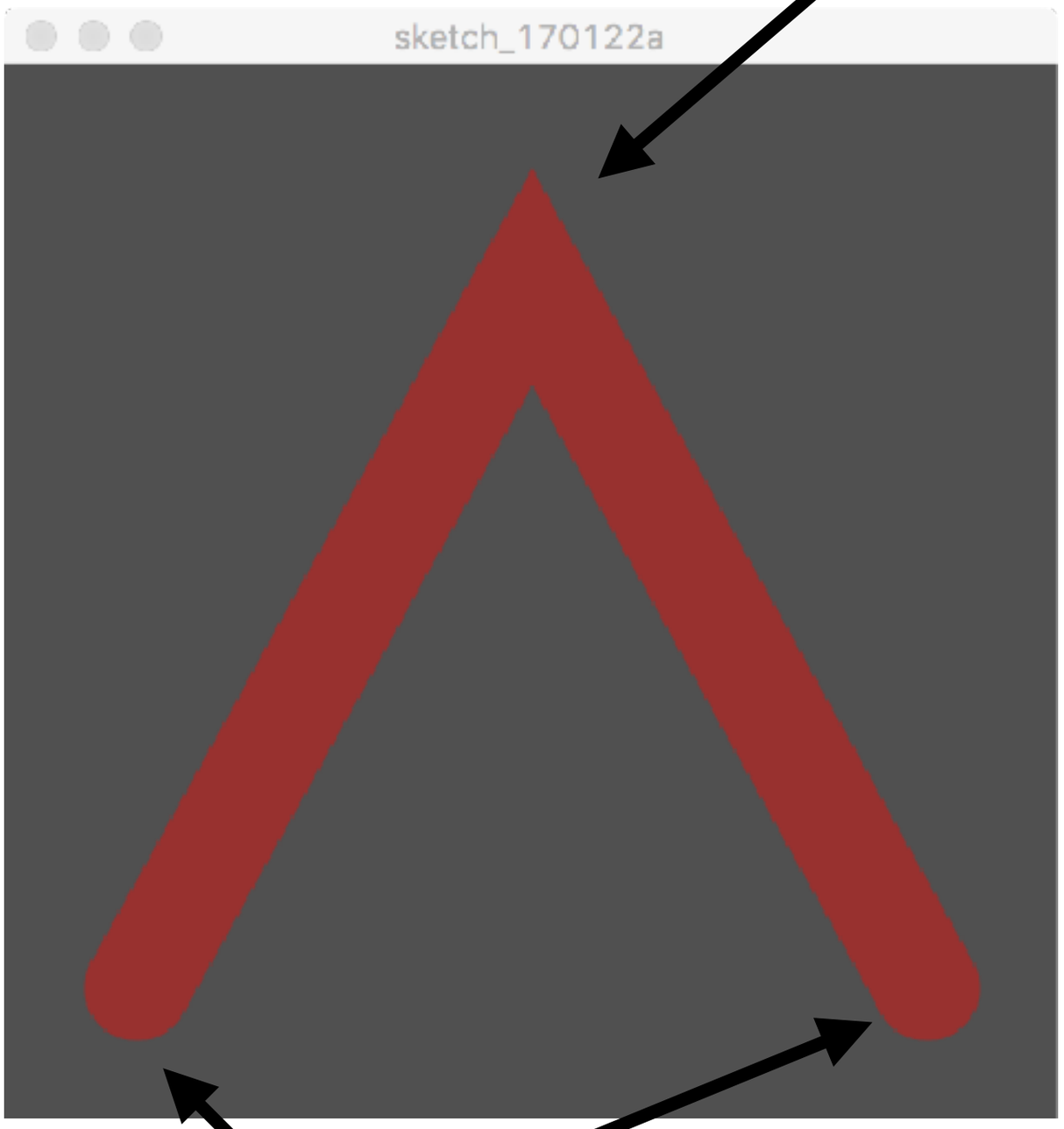




```
float[] coords = {
  100, 100,  100, 300,  200, 300,
  200, 200,  300, 200,  300, 100
};

beginShape();
  for ( int idx = 0; idx < coords.length; idx += 2 ) {
    vertex( coords[idx], coords[idx+1] );
  }
endShape( CLOSE );
```

```
beginShape();
  vertex( 50, 350 );
  vertex( 200, 80 );
  vertex( 350, 350 );
endShape();
```

strokeJoin()

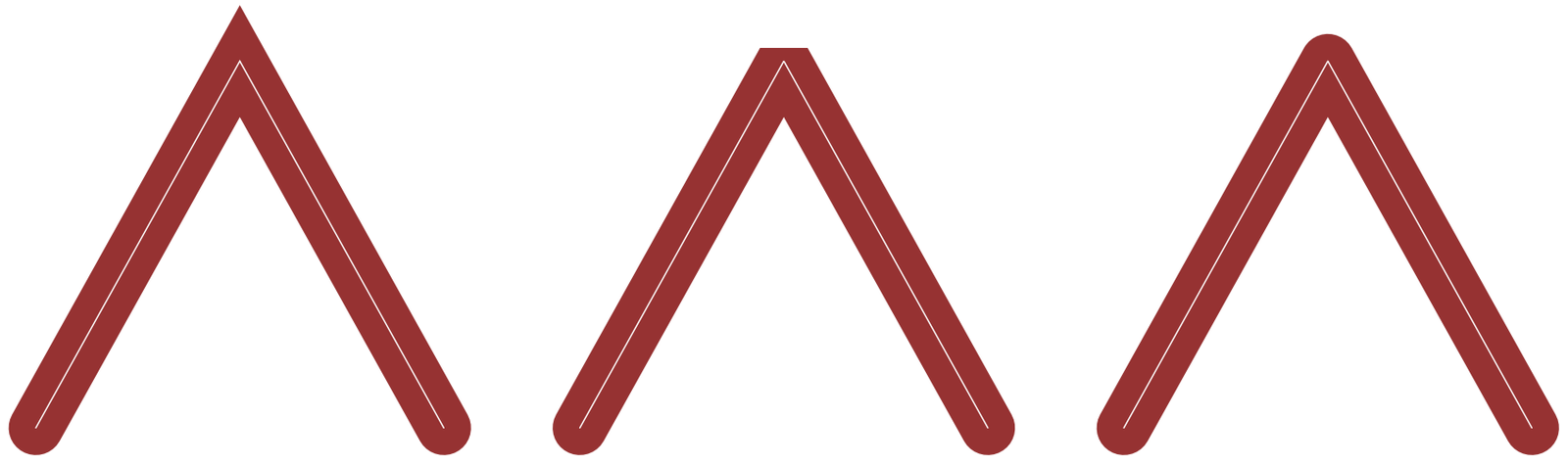


strokeCap()

strokeCap(SQUARE)

strokeCap(PROJECT)

strokeCap(ROUND)

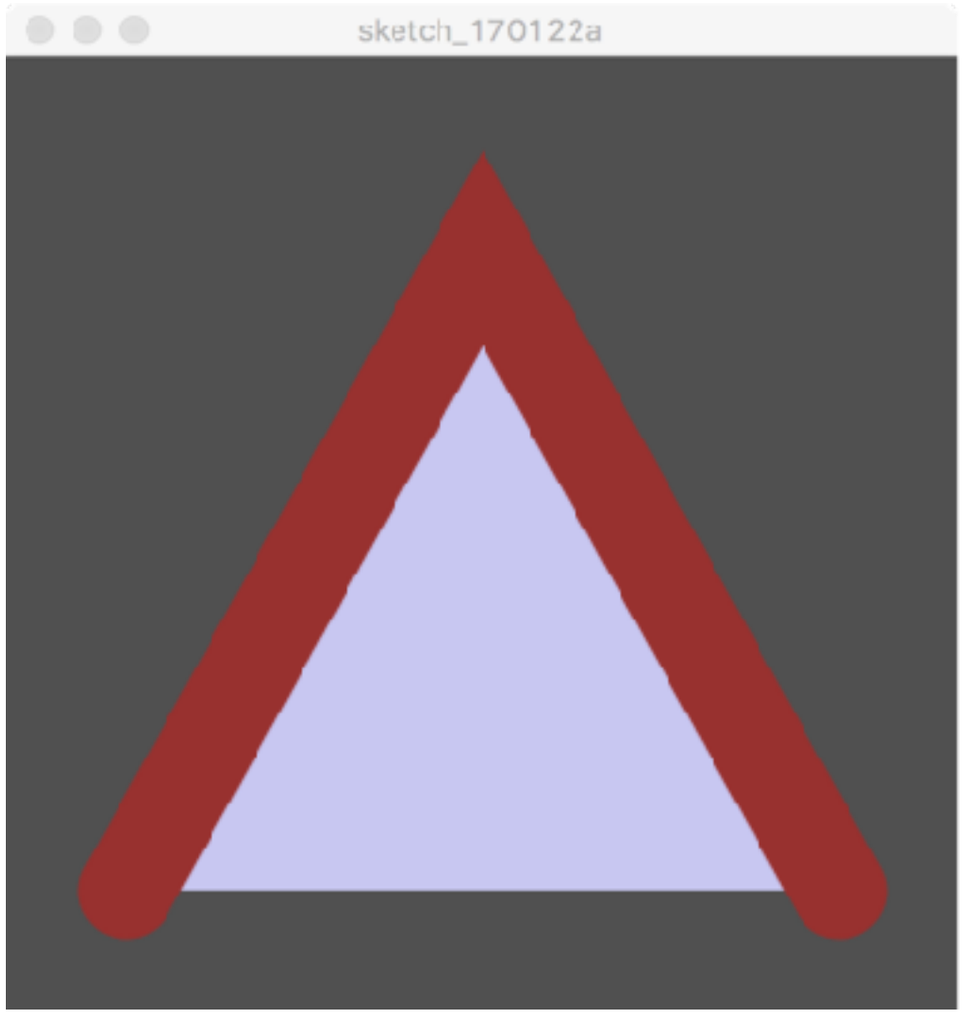


strokeJoin(MITER)

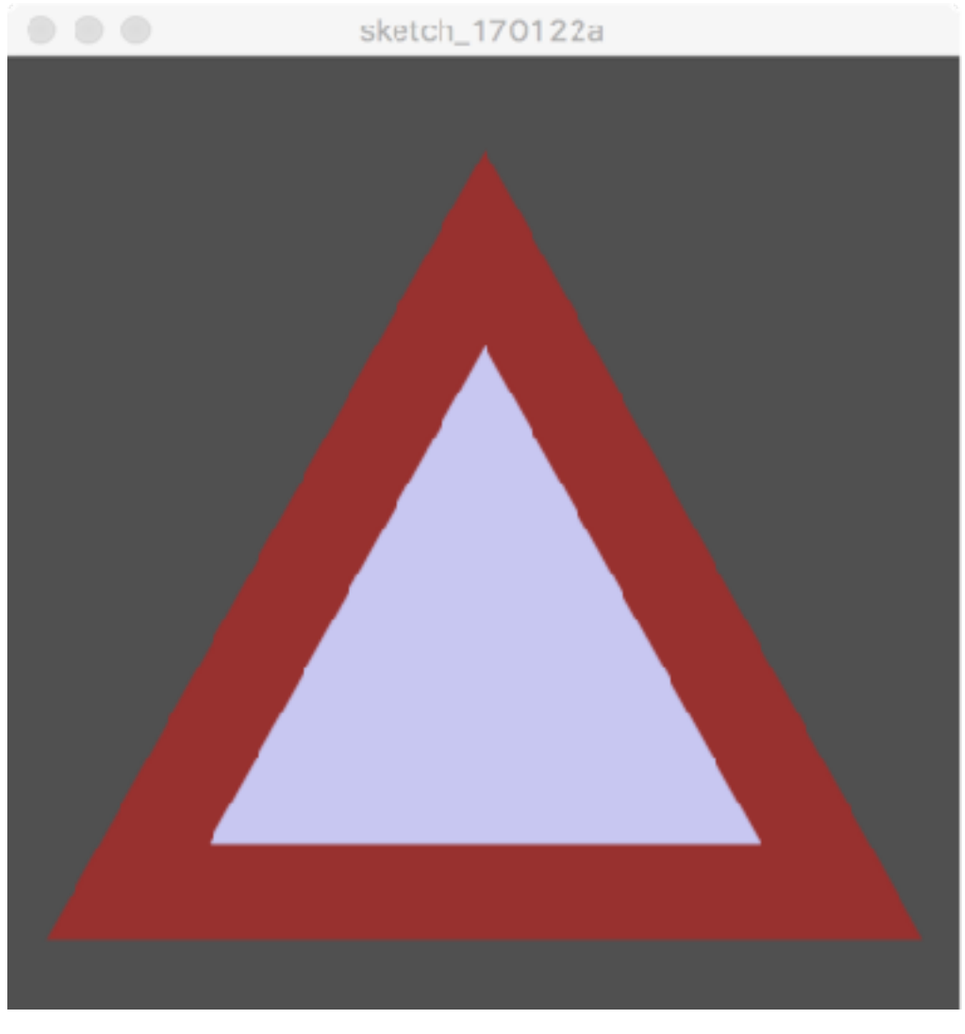
strokeJoin(ROUND)

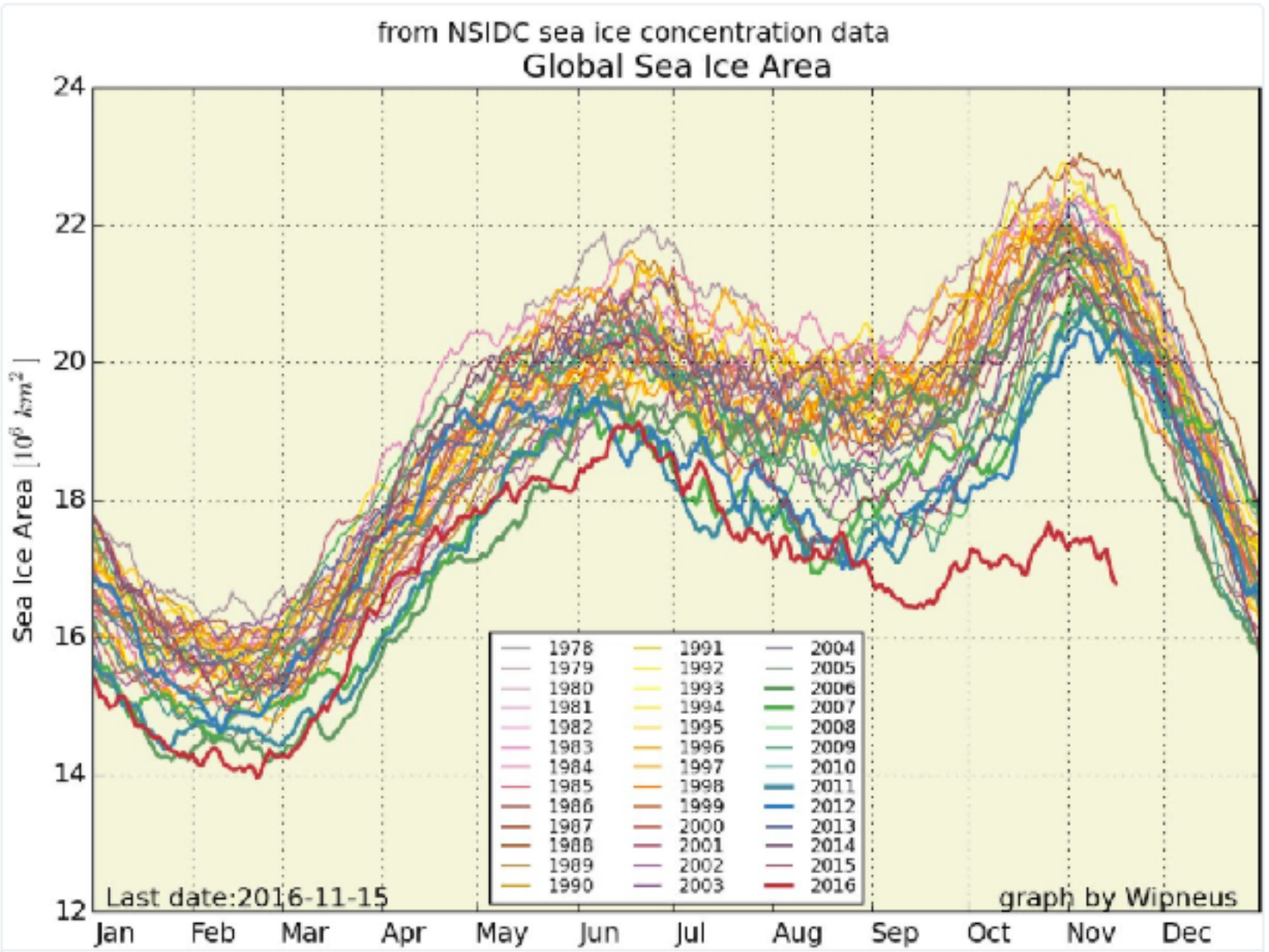
strokeJoin(BEVEL)

```
fill( 200, 200, 240 );
stroke( 150, 50, 50 );
strokeWeight( 40 );

beginShape();
vertex( 50, 350 );
vertex( 200, 80 );
vertex( 350, 350 );
endShape();
```




```
fill( 200, 200, 240 );
stroke( 150, 50, 50 );
strokeWeight( 40 );

beginShape();
vertex( 50, 350 );
vertex( 200, 80 );
vertex( 350, 350 );
endShape( CLOSE );
```





Zack Labe
@ZLabe

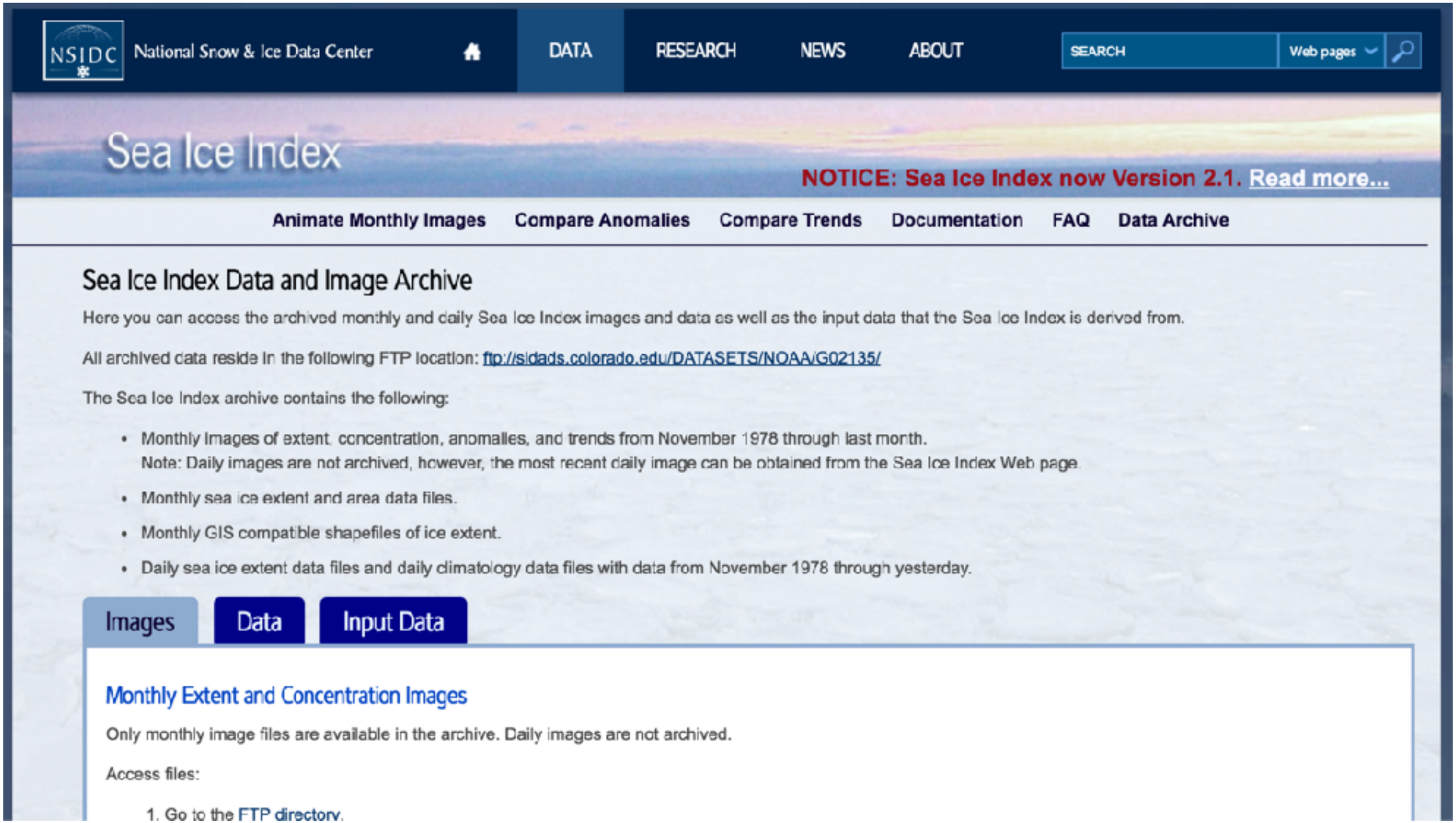
Follow

This is not normal. Global #seaice area...

(via sites.google.com/site/arctische…)

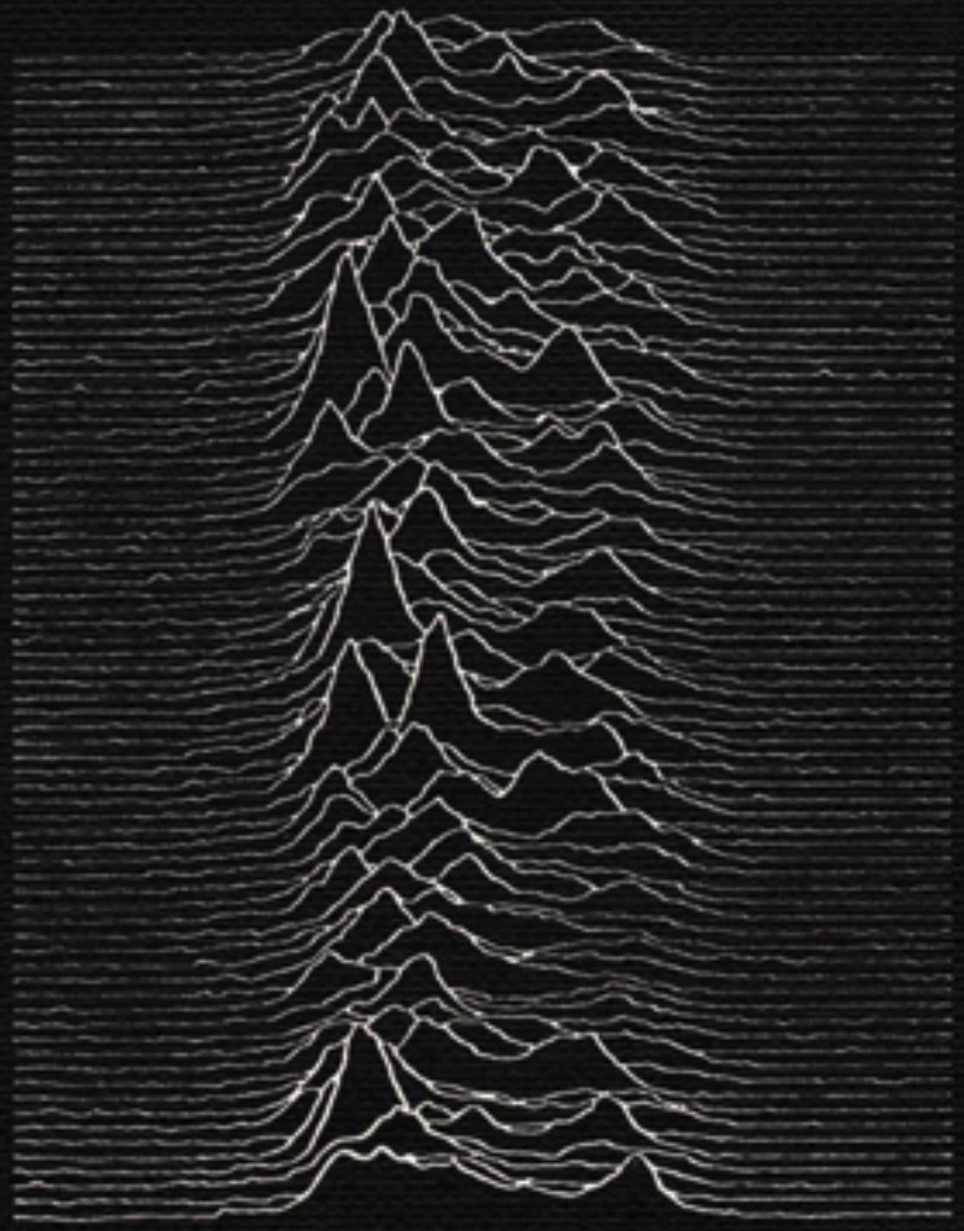
10:38 AM - 16 Nov 2016 · Irvine, CA

904 438

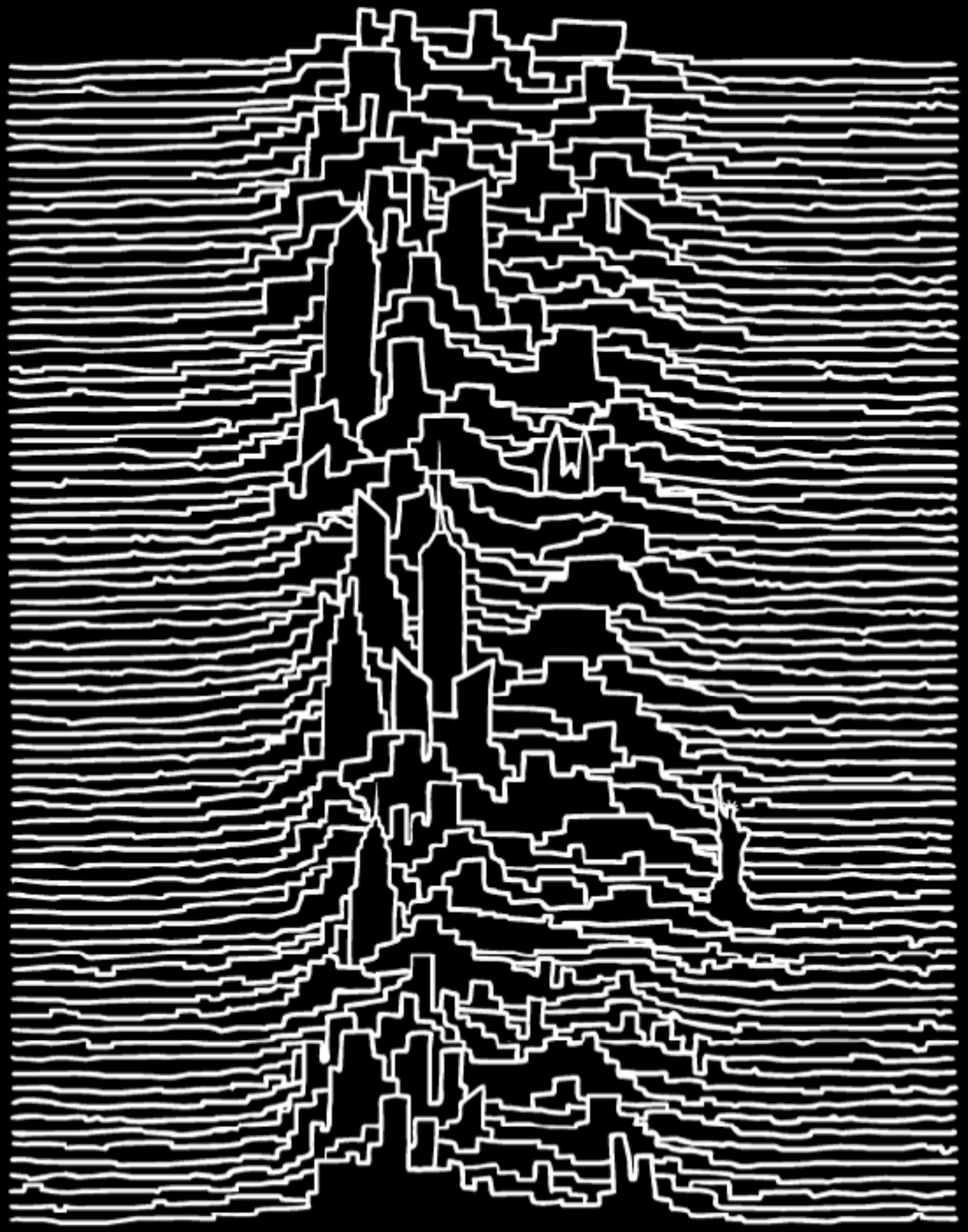


https://nsidc.org/data/seaice_index/archives.html

1979 15.6 16.38 16.52 15.56 14.09 12.65 10.52 8.18 7.22 9.43 11.19 13.58
1980 15.05 16.07 16.21 15.55 14.08 12.37 10.43 8.08 7.86 9.49 11.72 13.75
1981 15.11 15.75 15.7 15.19 13.92 12.62 10.67 7.89 7.25 9.21 11.21 13.78
1982 15.34 16.14 16.23 15.62 14.18 12.75 10.81 8.3 7.45 10.02 11.96 13.87
1983 15.16 16.1 16.19 15.36 13.57 12.39 10.95 8.39 7.54 9.69 11.68 13.49
1984 14.69 15.42 15.72 15.23 13.7 12.25 10.22 7.94 7.11 8.87 11.32 13.21
1985 14.96 15.77 16.14 15.41 14.26 12.45 10.16 7.5 6.94 8.92 11.42 13.25
1986 15.12 15.99 16.16 15.23 13.55 12.14 10.5 8.04 7.55 9.92 11.81 13.46
1987 15.28 16.21 16.02 15.38 13.85 12.61 10.81 7.72 7.51 9.33 11.59 13.6
1988 15.25 15.73 16.23 15.32 13.75 12.11 10.12 7.99 7.53 9.51 11.73 13.87
1989 15.23 15.67 15.62 14.53 13.05 12.37 10.47 8.0 7.08 9.55 11.57 13.57
1990 15.07 15.69 15.99 14.79 13.36 11.77 9.68 6.87 6.27 9.4 11.37 13.36
1991 14.58 15.37 15.6 15.03 13.58 12.29 9.76 7.46 6.59 9.2 11.16 13.21
1992 14.86 15.62 15.62 14.8 13.31 12.2 10.7 7.96 7.59 9.64 11.91 13.53
1993 15.2 15.85 15.98 15.3 13.6 12.07 9.74 7.39 6.54 9.25 11.78 13.58
1994 14.94 15.72 15.71 15.07 13.82 12.16 10.3 7.7 7.24 9.53 11.35 13.61
1995 14.74 15.37 15.44 14.71 13.22 11.66 9.23 6.75 6.18 8.98 11.05 13.09
1996 14.35 15.32 15.25 14.35 13.14 12.17 10.46 8.29 7.91 9.43 10.61 13.21
1997 14.62 15.63 15.69 14.69 13.39 11.99 9.66 7.35 6.78 8.8 10.94 13.35
1998 14.94 15.9 15.78 14.99 13.86 11.95 9.67 7.56 6.62 8.89 10.79 13.34
1999 14.57 15.48 15.52 15.24 13.92 12.19 9.65 7.44 6.29 9.14 11.03 12.95
2000 14.54 15.3 15.38 14.75 13.26 11.8 9.81 7.27 6.36 8.95 10.58 12.89
2001 14.42 15.42 15.72 14.97 13.78 11.75 9.28 7.53 6.78 8.6 10.94 12.92
2002 14.57 15.47 15.54 14.46 13.18 11.77 9.58 6.57 5.98 8.83 10.8 12.89
2003 14.59 15.35 15.61 14.68 13.09 11.85 9.53 6.93 6.18 8.67 10.32 12.89




WHAT IS THIS?
I'VE SEEN IT ON TUMBLR



Representing points

It's easy to pass a point to a function: just pass *x* and *y* separately.

```
vertex( 37, 192 );
```

Can we write a function that *returns* a point?

```
[redacted] makeAPoint() { ... }
```

```
[illegible] sampleUnitSquare()
{
   float x = random( 1 );
   float y = random( 1 );

   return [illegible] [illegible] x [illegible] y [illegible];
}
```

```
float[] sampleUnitSquare()
{
  float x = random( 1 );
  float y = random( 1 );
  float[] result = { x, y };
  return result;
}
```

```
class Point
{
  float x;
  float y;

  Point( float xIn, float yIn )
  {
    x = xIn;
    y = yIn;
  }
}
```

```
class Point
{
  float x;
  float y;

  Point( float xIn, float yIn )
  {
    x = xIn;
    y = yIn;
  }
}

Point sampleUnitSquare()
{
  float x = random( 1 );
  float y = random( 1 );

  return new Point( x, y );
}
```

```
void setup()
{
  for( int idx = 0; idx < 100; ++idx ) {
    Point pt = sampleUnitSquare();
    ellipse( pt.x * 100, pt.y * 100, 10, 10 );
  }
}
```

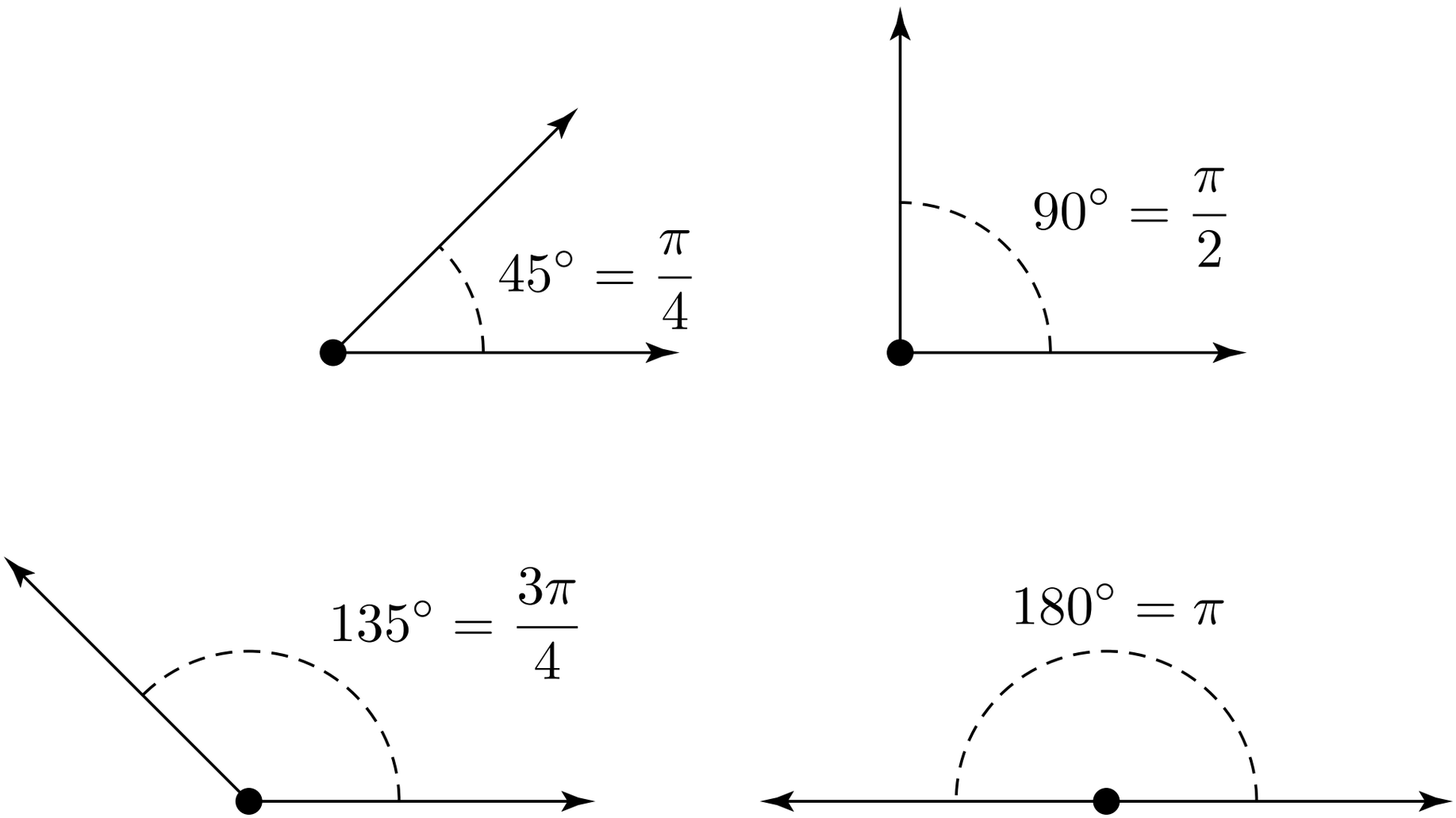
Processing offers a built-in class `PVector` for representing points in 2D (and 3D!).

```
PVector sampleUnitSquare()
{
  float x = random( 1 );
  float y = random( 1 );

  return new PVector( x, y );
}

void setup()
{
  for( int idx = 0; idx < 100; ++idx ) {
    PVector pt = sampleUnitSquare();
    ellipse( pt.x * 100, pt.y * 100, 10, 10 );
  }
}
```

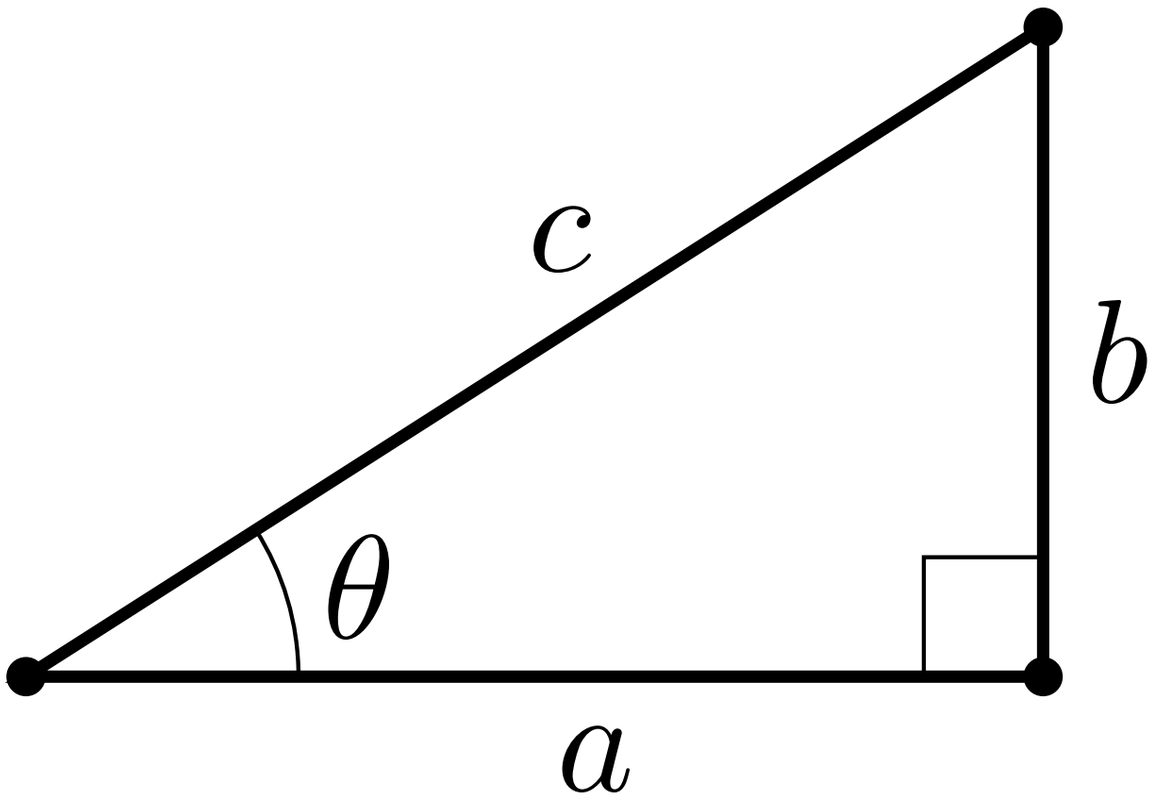
```
PVector[] pts = {
  new PVector( 100, 100 ),
  new PVector( 100, 300 ),
  new PVector( 200, 300 ),
  new PVector( 200, 200 ),
  new PVector( 300, 200 ),
  new PVector( 300, 100 )
};

beginShape();
for ( int idx = 0; idx < pts.length; ++idx ) {
  vertex( pts[idx].x, pts[idx].y );
}
endShape( CLOSE );
```

Angles

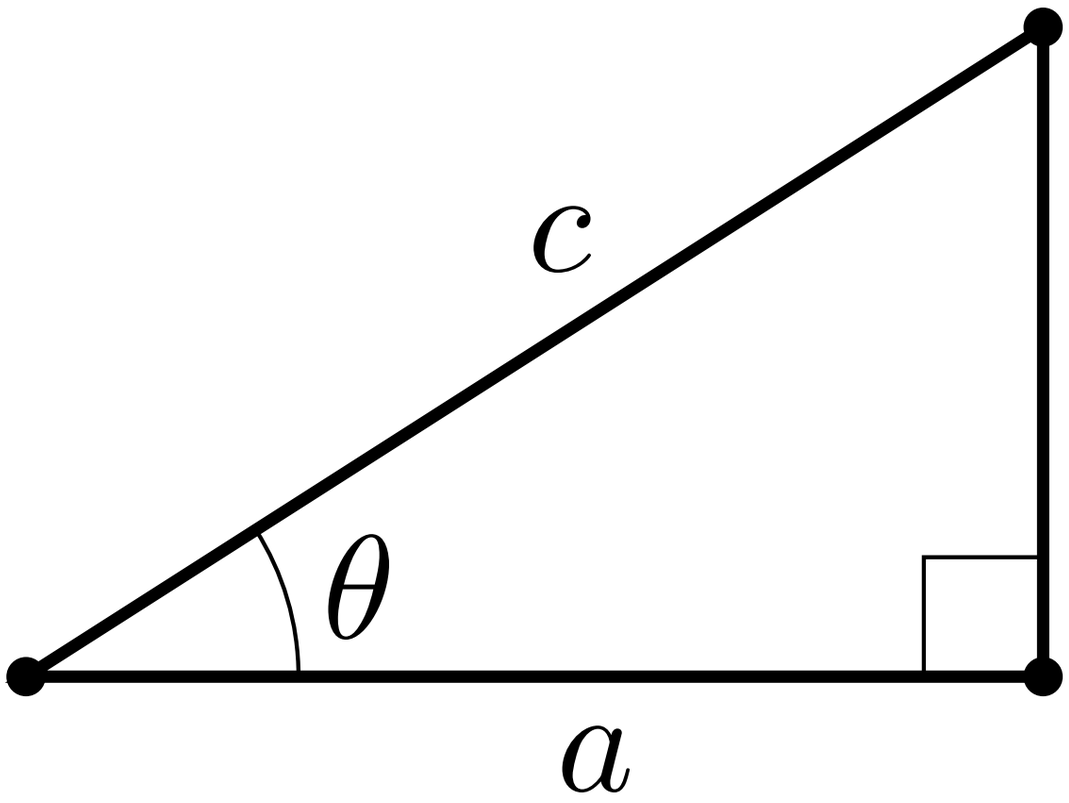
An *angle* is the measurement of the opening between two lines. We learn to measure angles in degrees, but programming languages usually expect them in *radians*.



Trigonometry



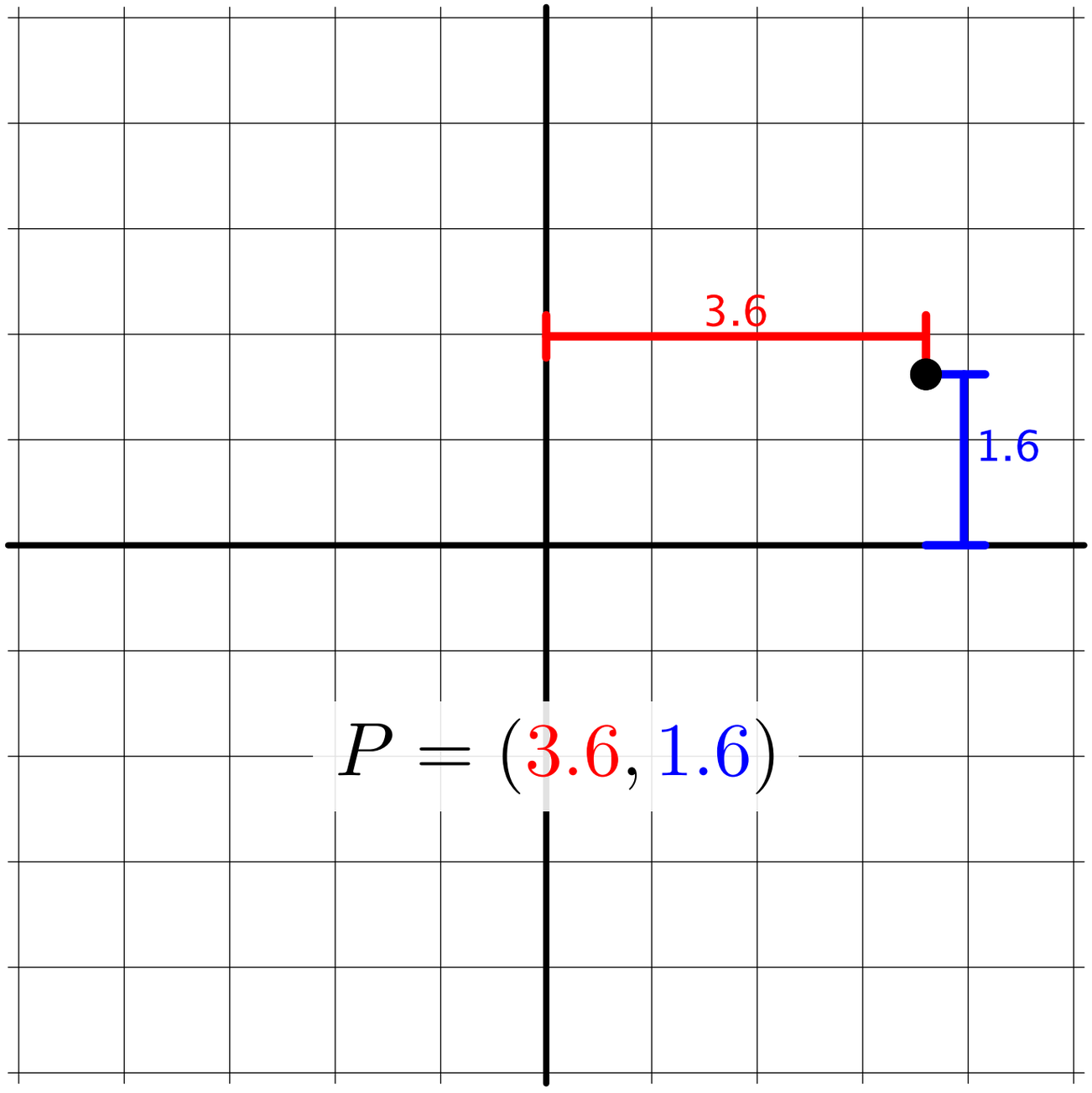
Trigonometry



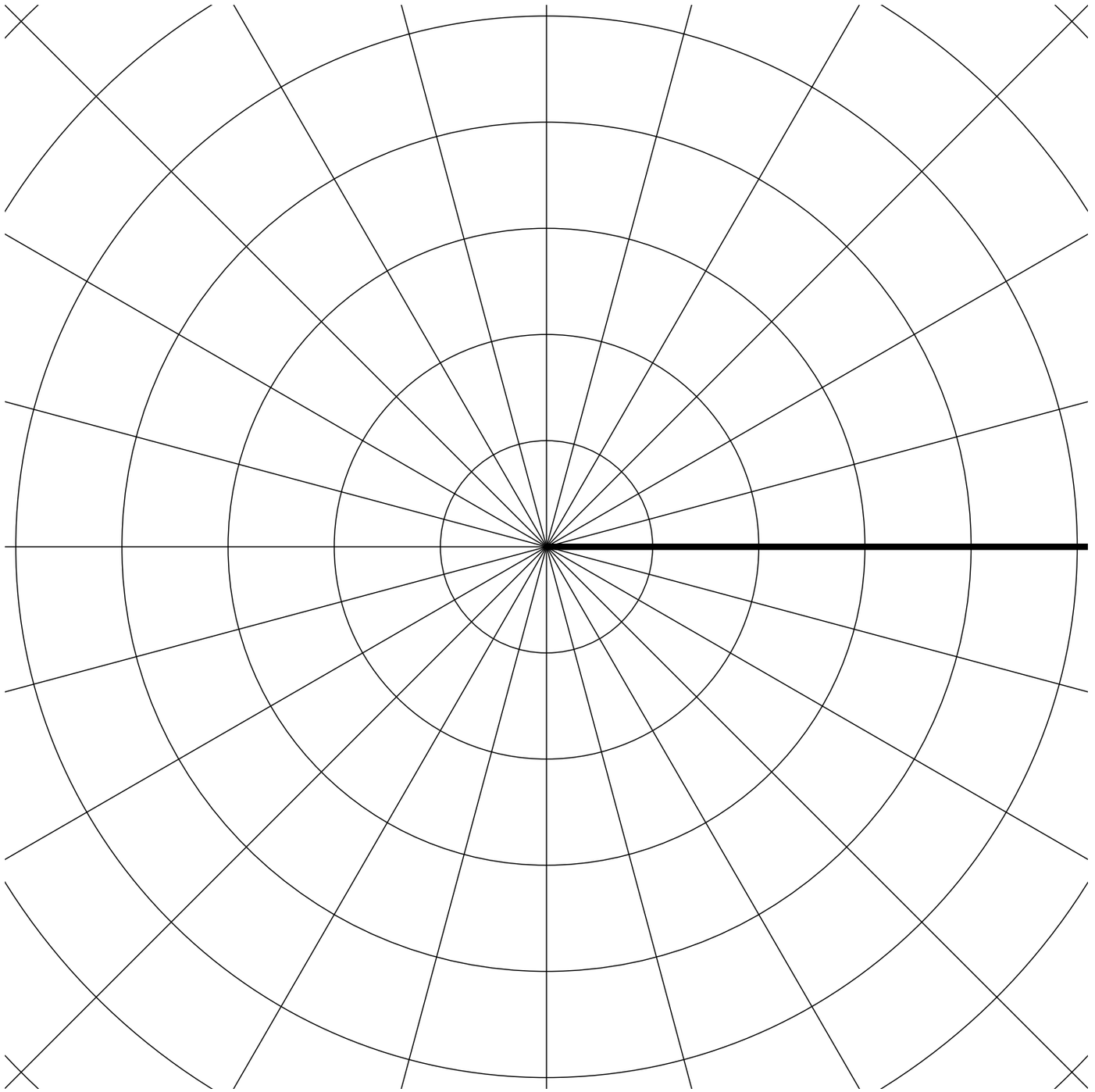
$$\sin\theta = \frac{b}{c}$$

$$\cos\theta = \frac{a}{c}$$

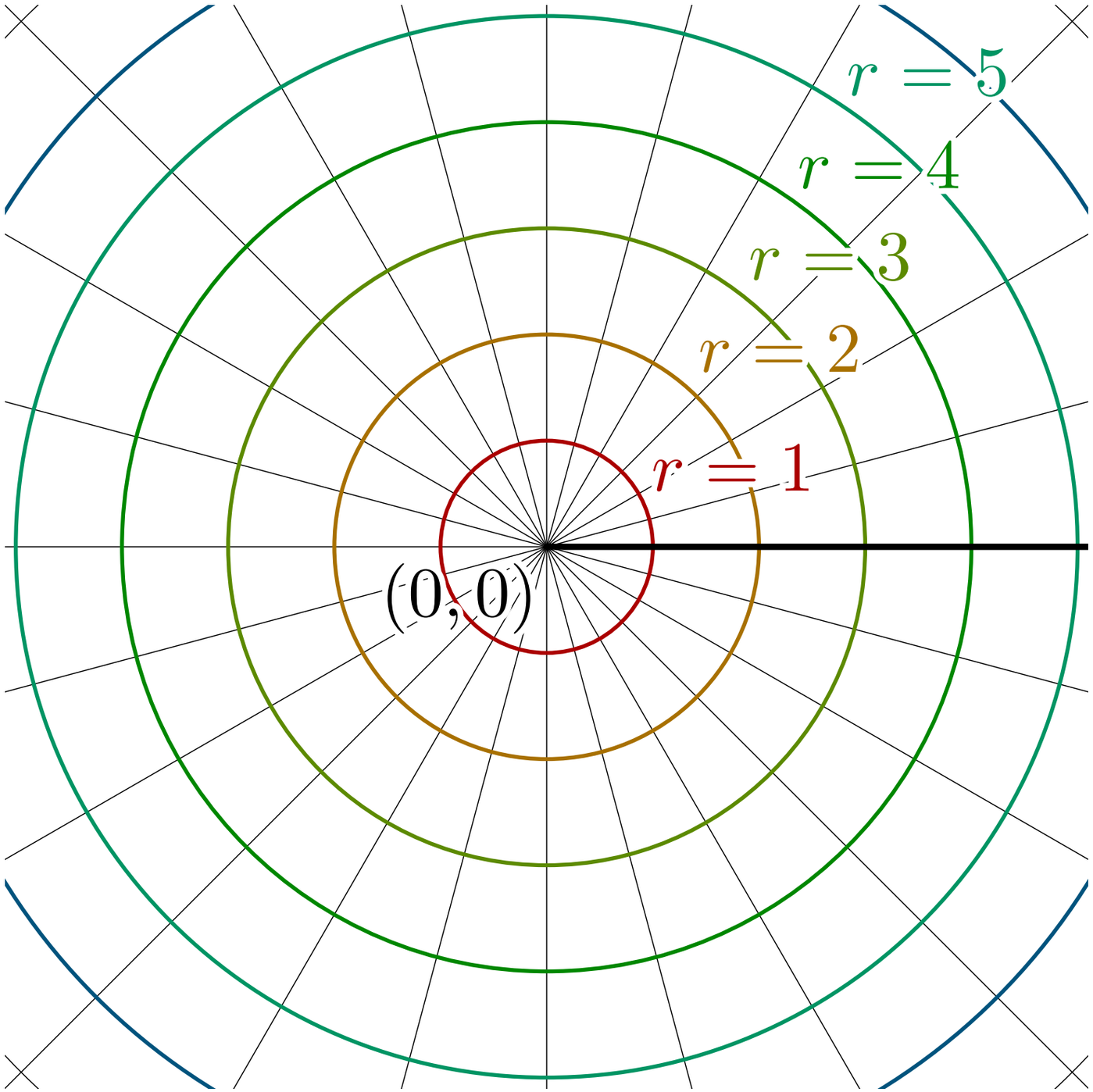
Cartesian (i.e., regular) coordinates



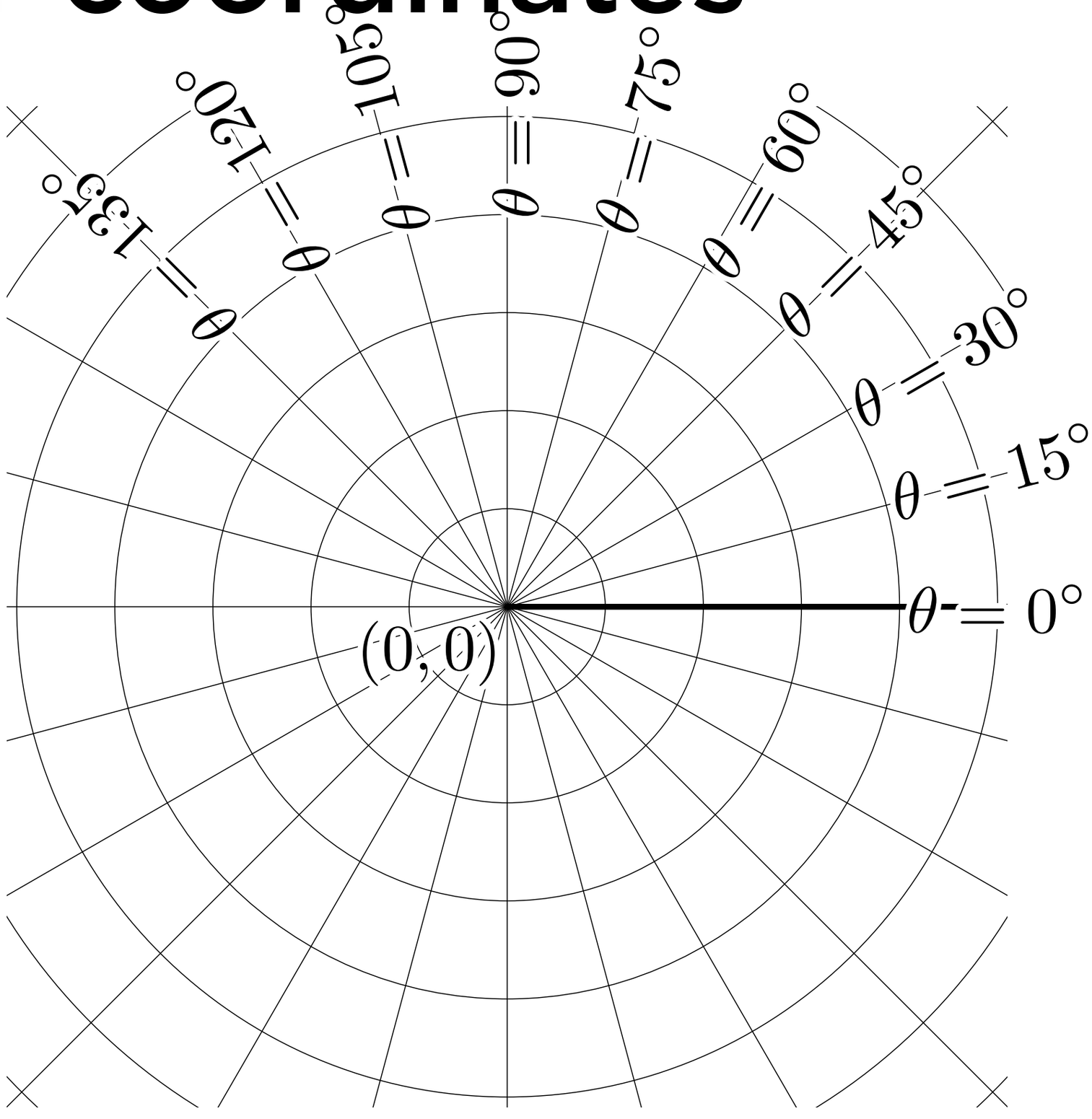
Polar coordinates



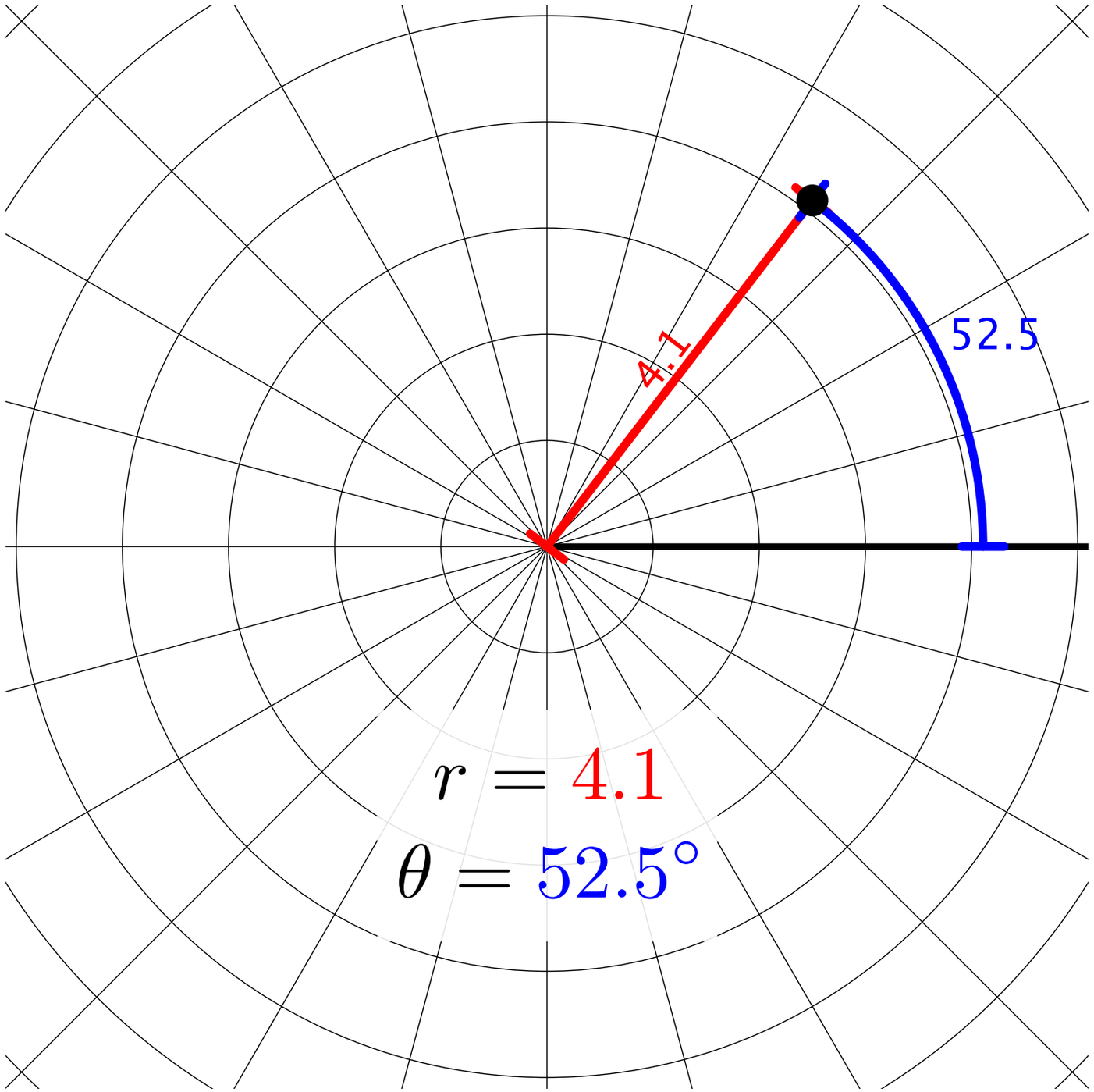
Polar coordinates

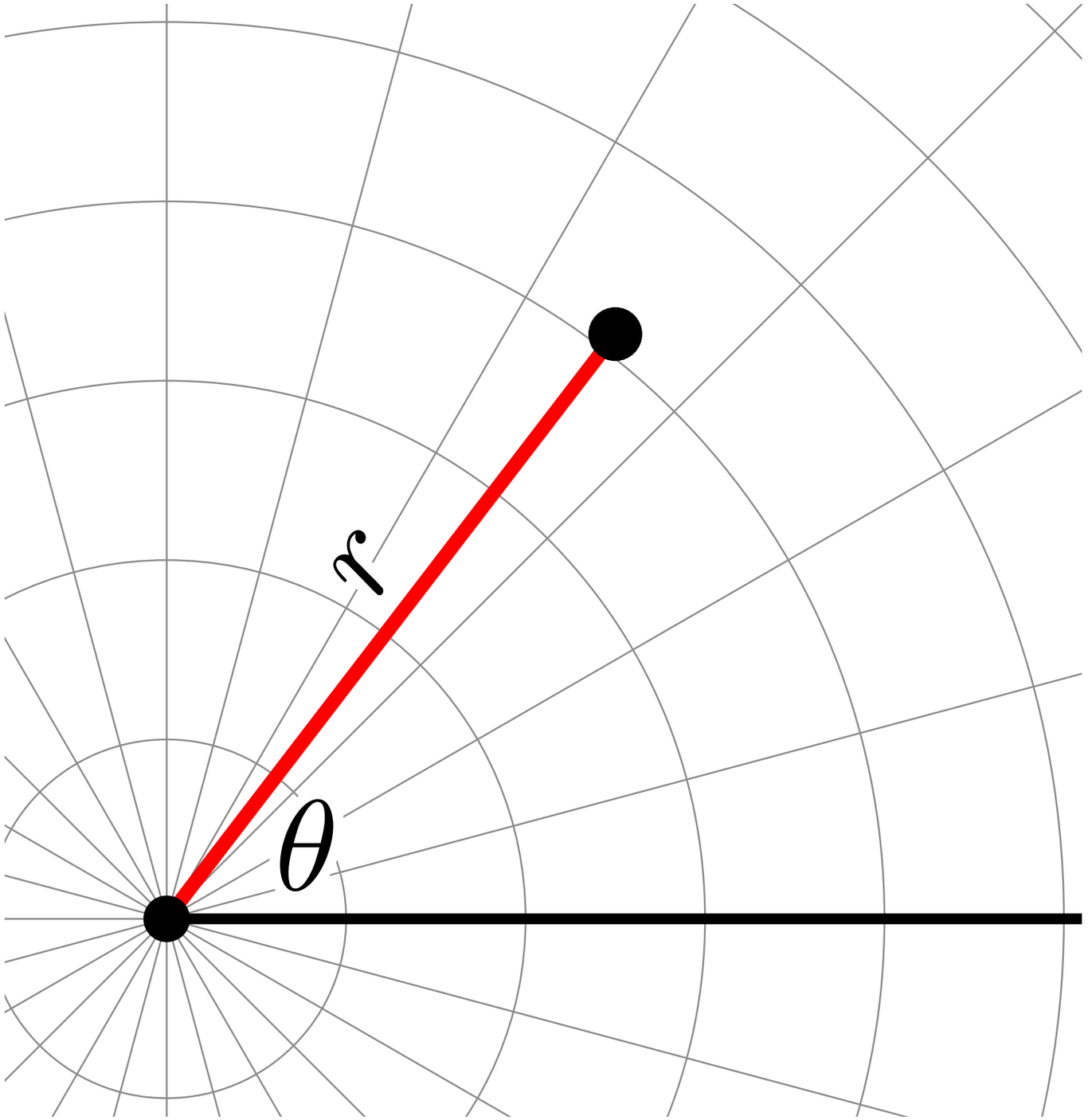


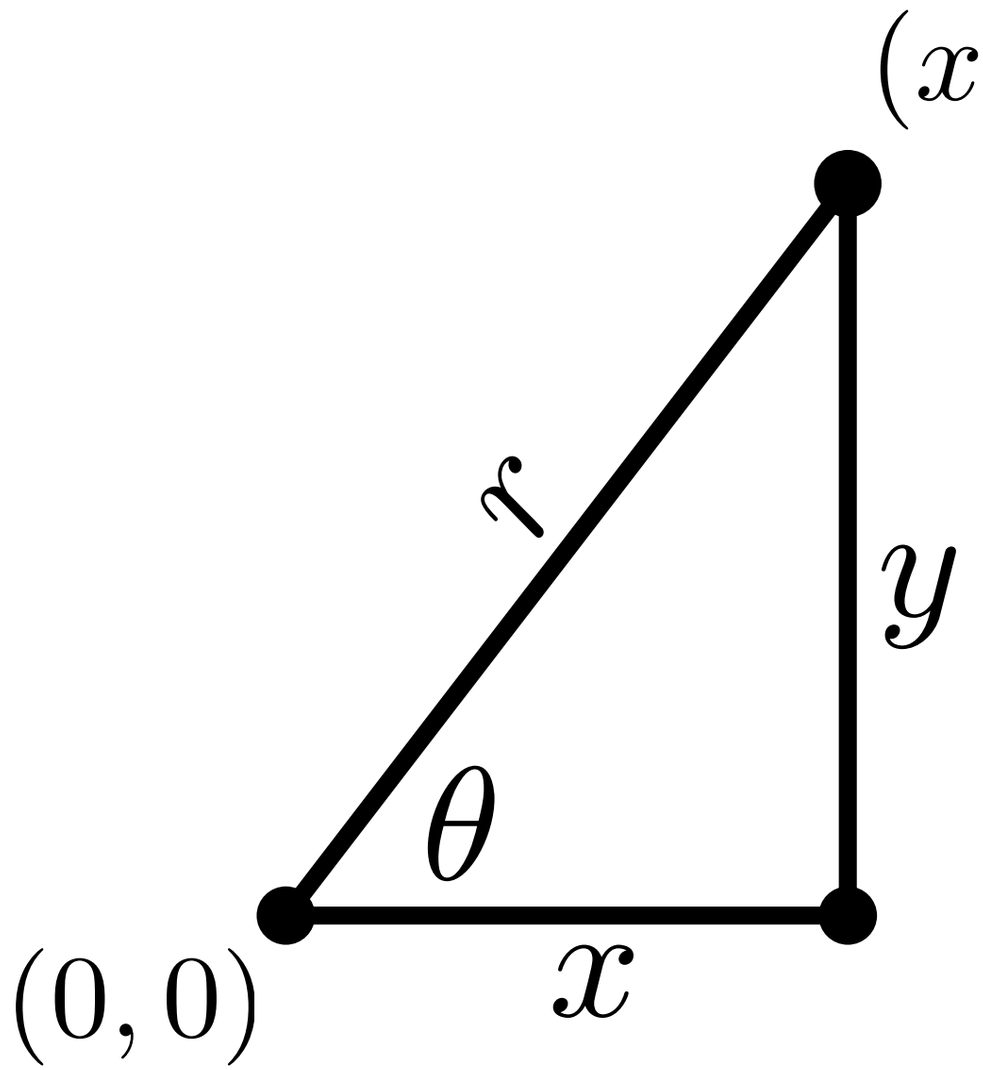
Polar coordinates



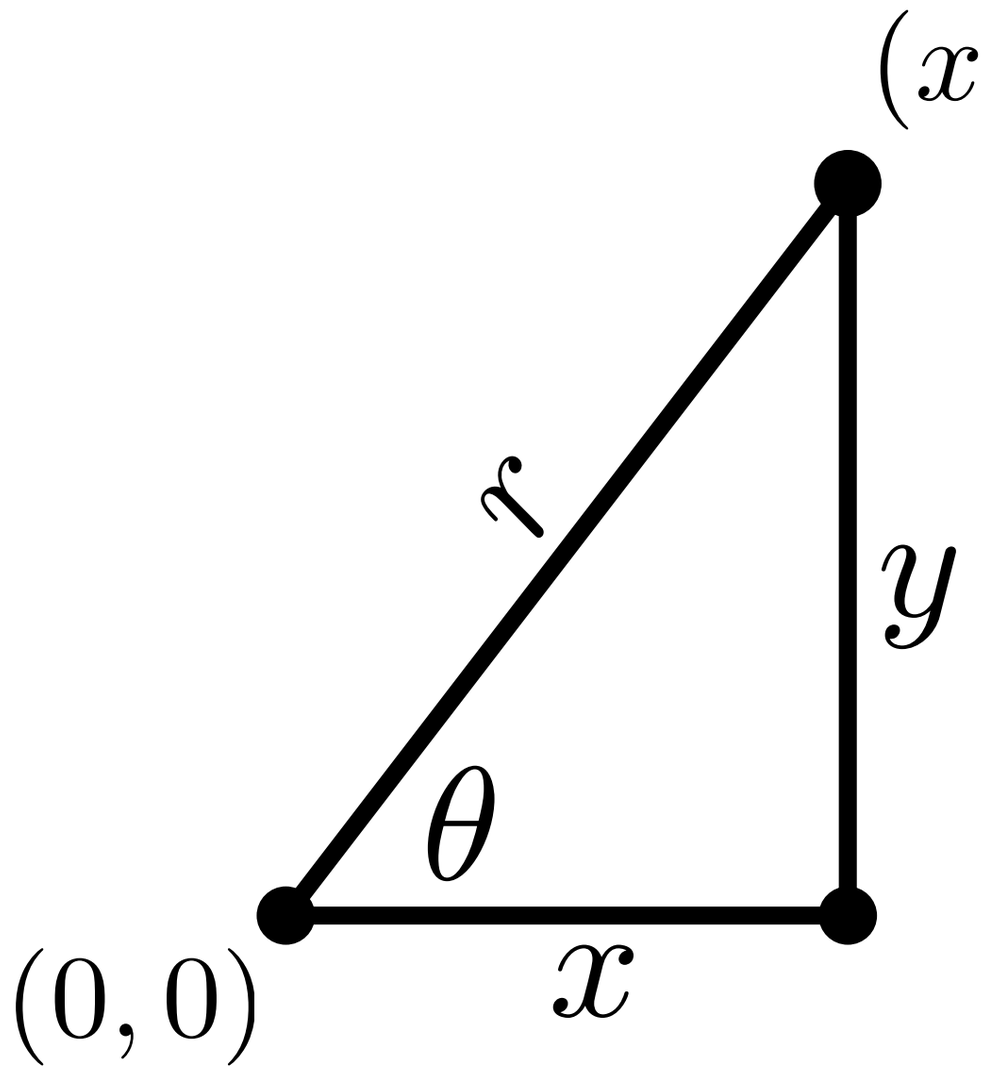
Polar coordinates



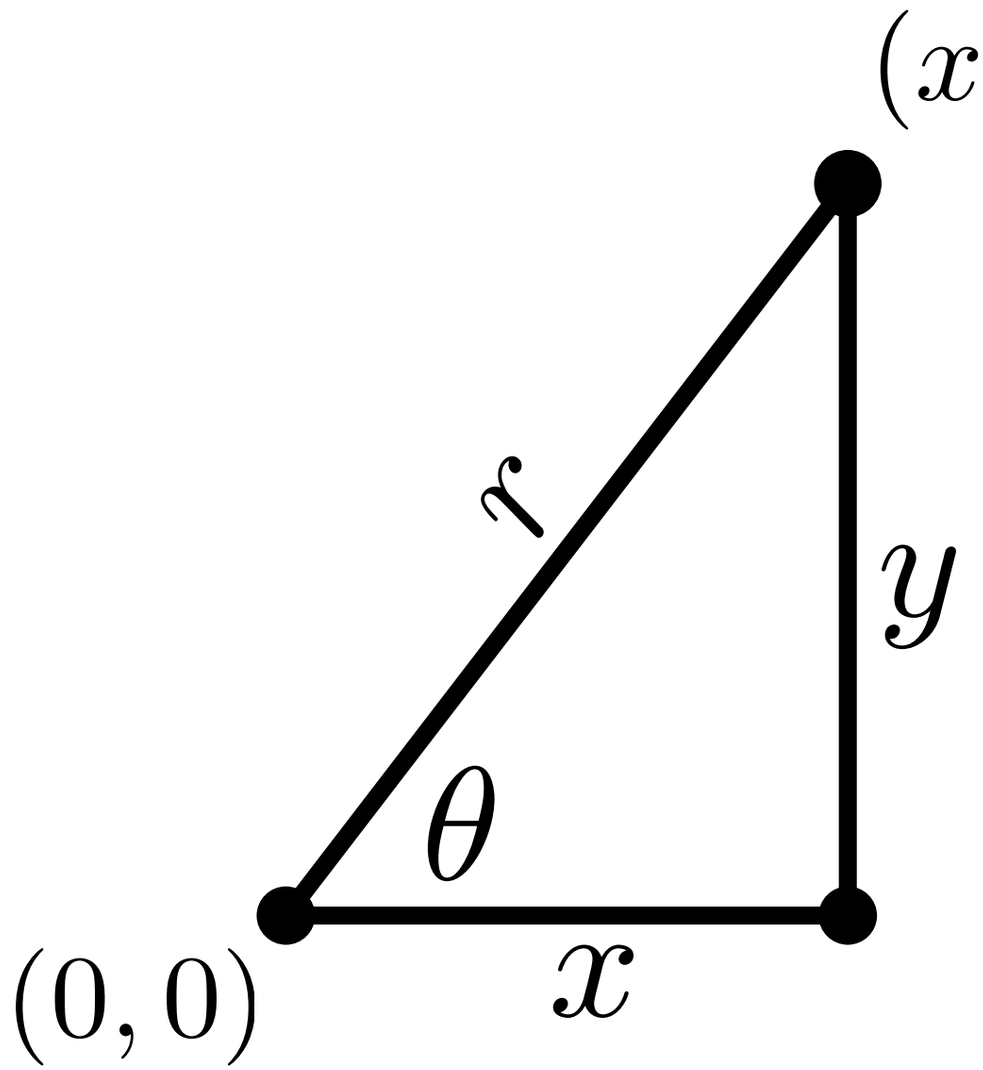

r
θ



$$\cos\theta = \frac{x}{r}$$



$$x = r\cos\theta$$



$$x = r\cos\theta$$
$$y = r\sin\theta$$

Polar to Cartesian

```
PVector polar( float r, float theta )
{
  float x = r * cos( theta );
  float y = r * sin( theta );

  return new PVector( x, y );
}
```

Polar to Cartesian

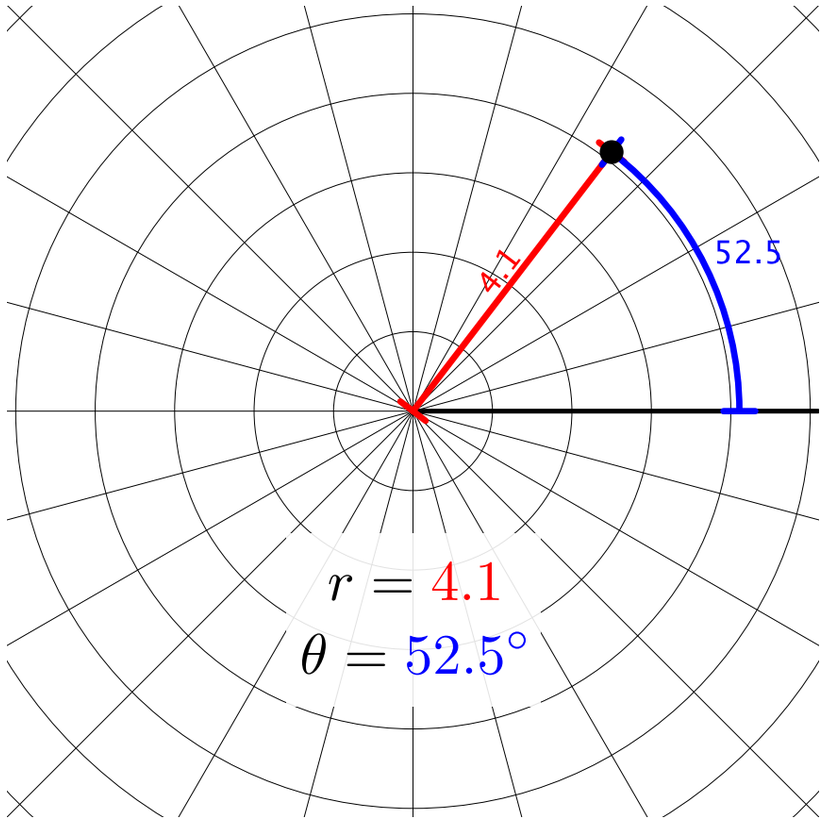
```
PVector polar( float r, float theta )
{
  float x = r * cos( radians( theta ) );
  float y = r * sin( radians( theta ) );

  return new PVector( x, y );
}
```

Let’s specify angles in degrees to avoid headaches.

Polar to Cartesian

This is the part you need to know:

```
PVector polar( float r, float theta ) {…}
```



Regular polygons