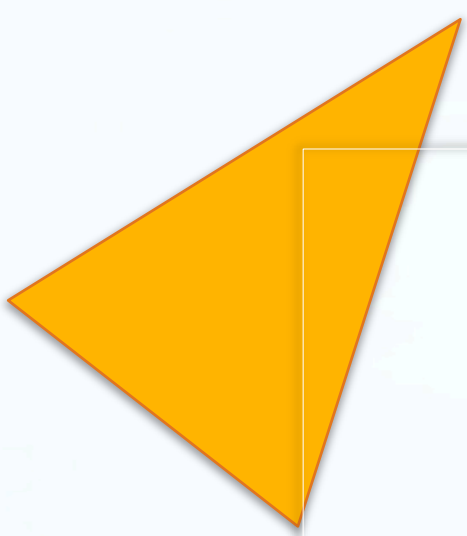
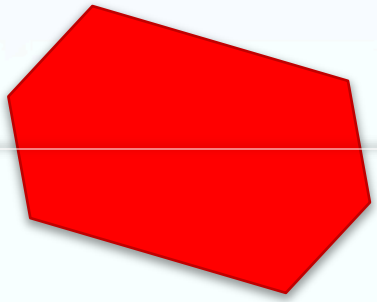
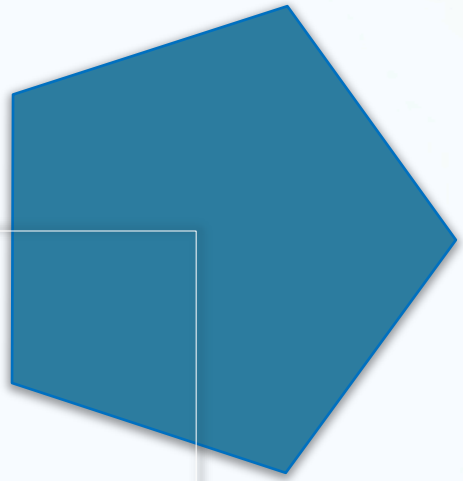
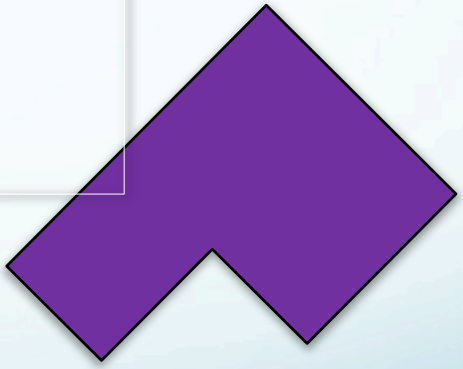




CSC 240 Computer Graphics
Video 3: Polygons

Nick Howe
Smith College

Portions based on slides & content courtesy Sara Mathieson

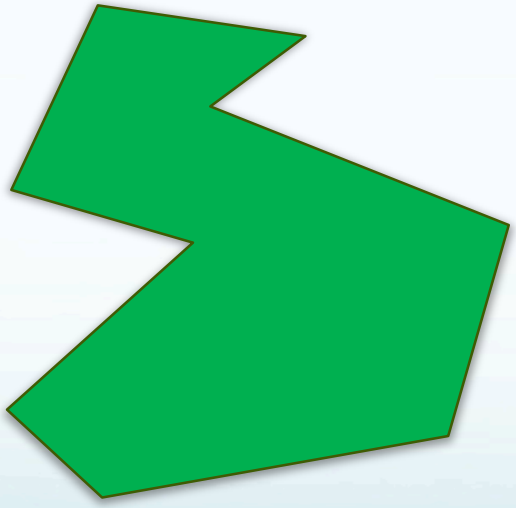




Polygon Definition

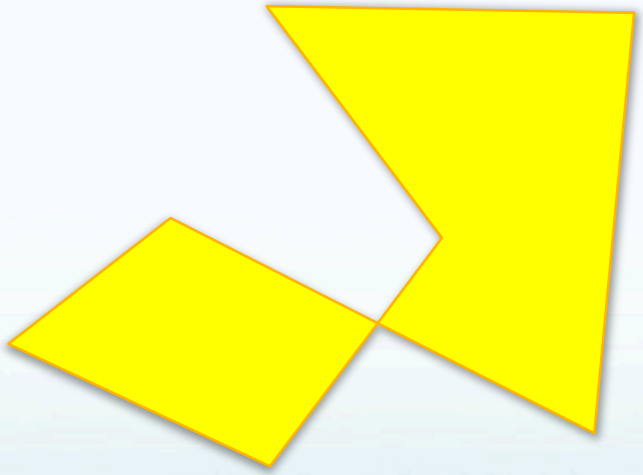
A chain of line segments that forms a closed loop

Simple Polygon



- No self-intersections
- No overlapping points

Complex Polygon

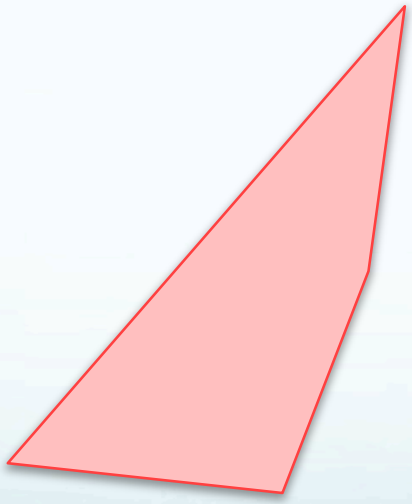


- Self-intersections
- And/or overlapping points

Polygon Definition

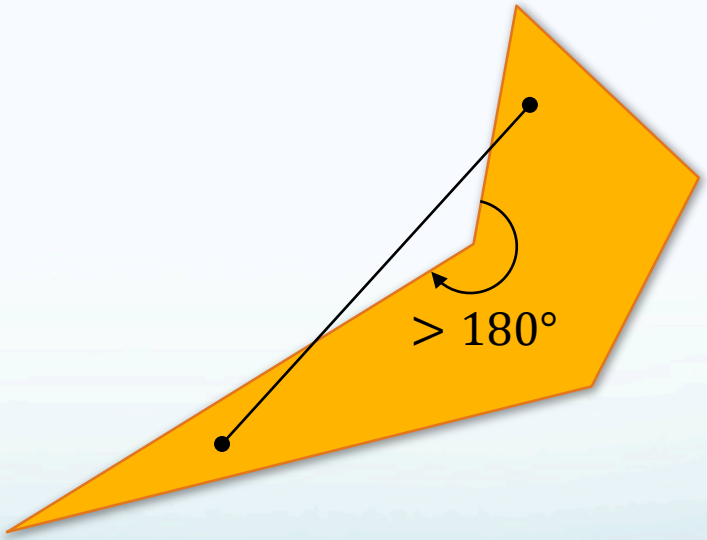
A chain of line segments that forms a closed loop

Convex Polygon



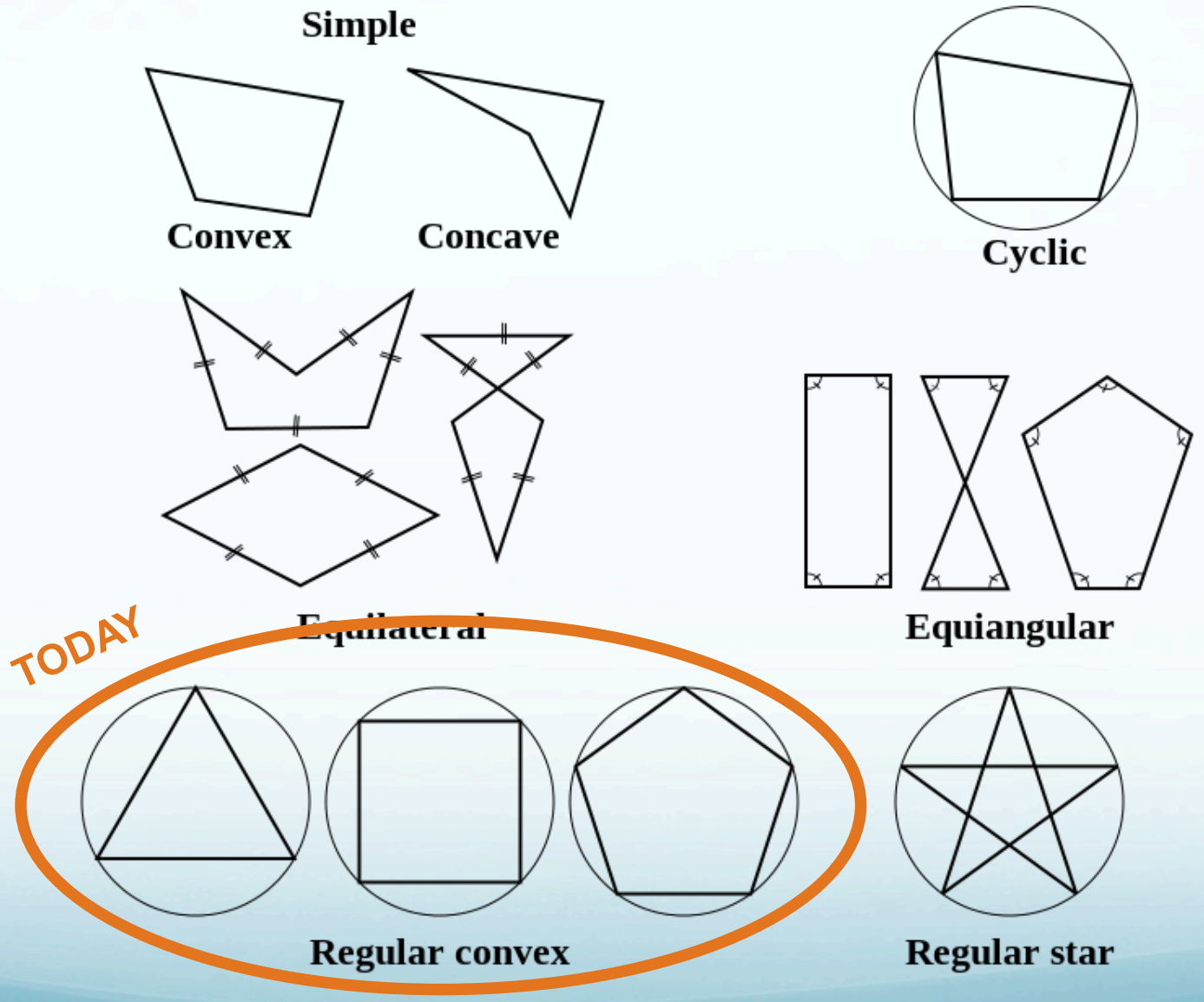
- All internal angles less than $180°$
- Line segments beginning and ending inside remain inside everywhere

Concave Polygon



- At least one internal angle greater than $180°$
- Exists a line segments beginning and ending inside that passes outside the shape

More polygons

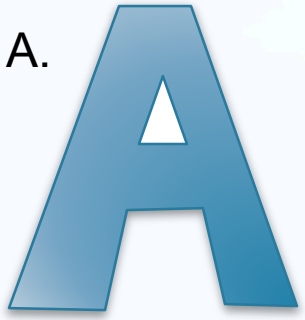


"Polygon types" by Salix alba, Wikipedia

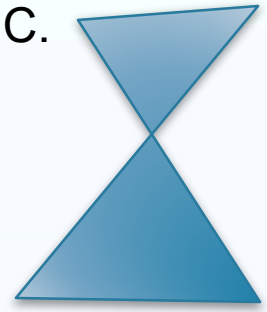
Questions

PAUSE NOW & ANSWER

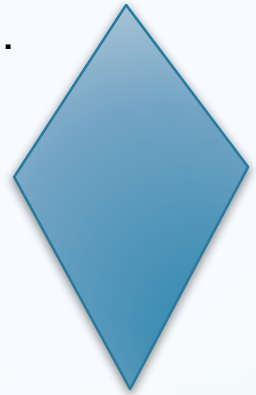
Consider the shapes shown here.

A. 

B. 

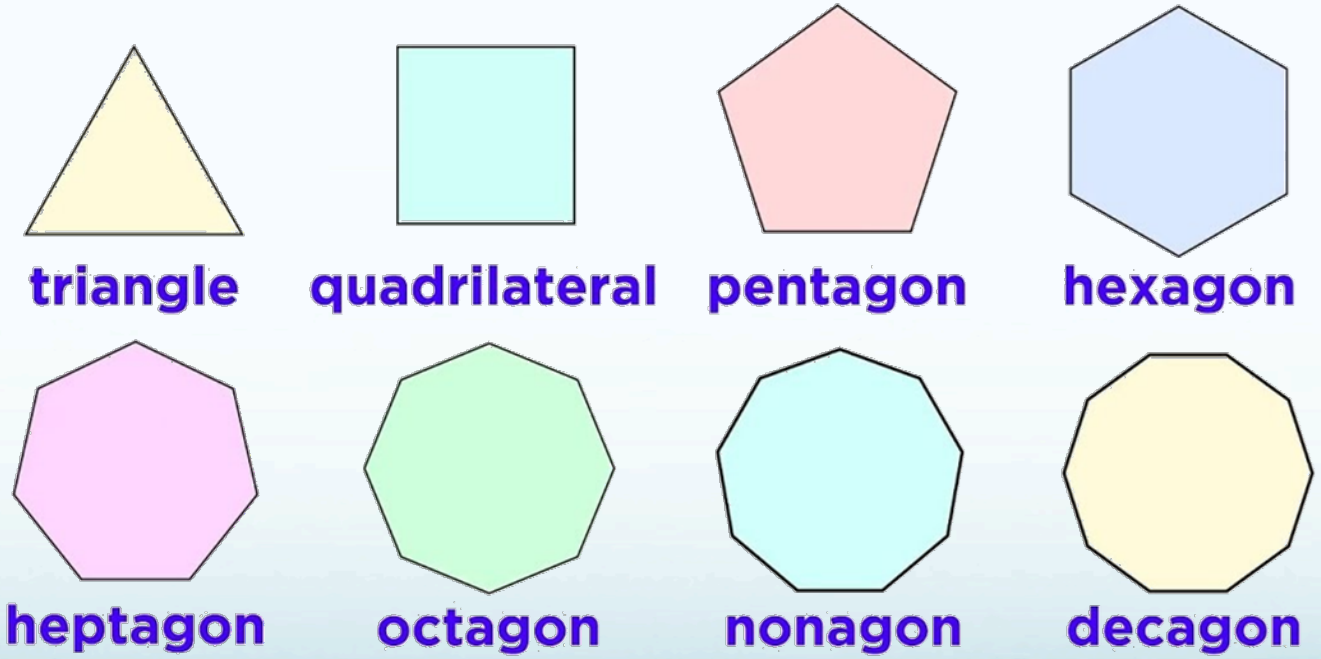
C. 

D. 

E. 

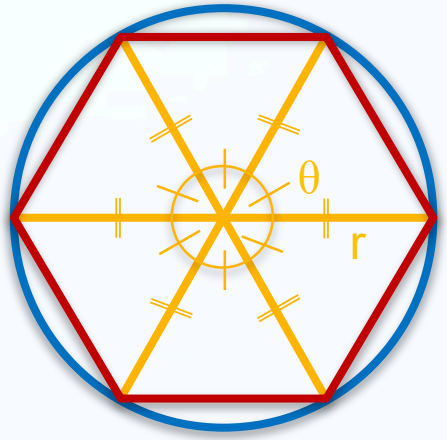
1. Which are polygons? *B, C, D, E*
2. Which are complex polygons? *C*
3. Which are concave polygons? *C,D*

Regular Polygon Algorithm



Observations

- Regular polygon fits within a circle
  - ➔All vertices same distance from center
  - ➔All pizza slices the same



- Let's use this to help us draw polygons.
  - ➔For a polygon with ***n*** sides, what is θ…

    In degrees?

    360/n

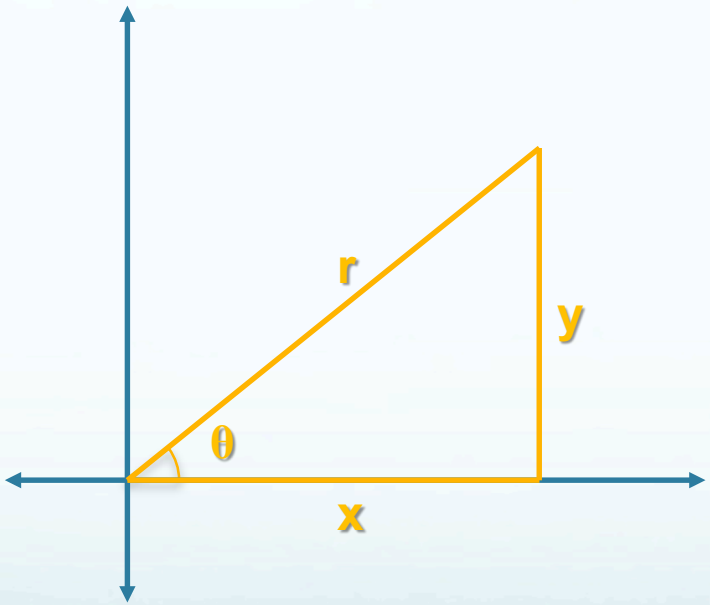
    In radians?

    $2\pi/n$

Recall that a full circle is 360 degrees, or 2π radians.

Trigonometry Review

- What is the relationship between r, θ, x, and y?



$$\sin\theta = \frac{y}{r}$$

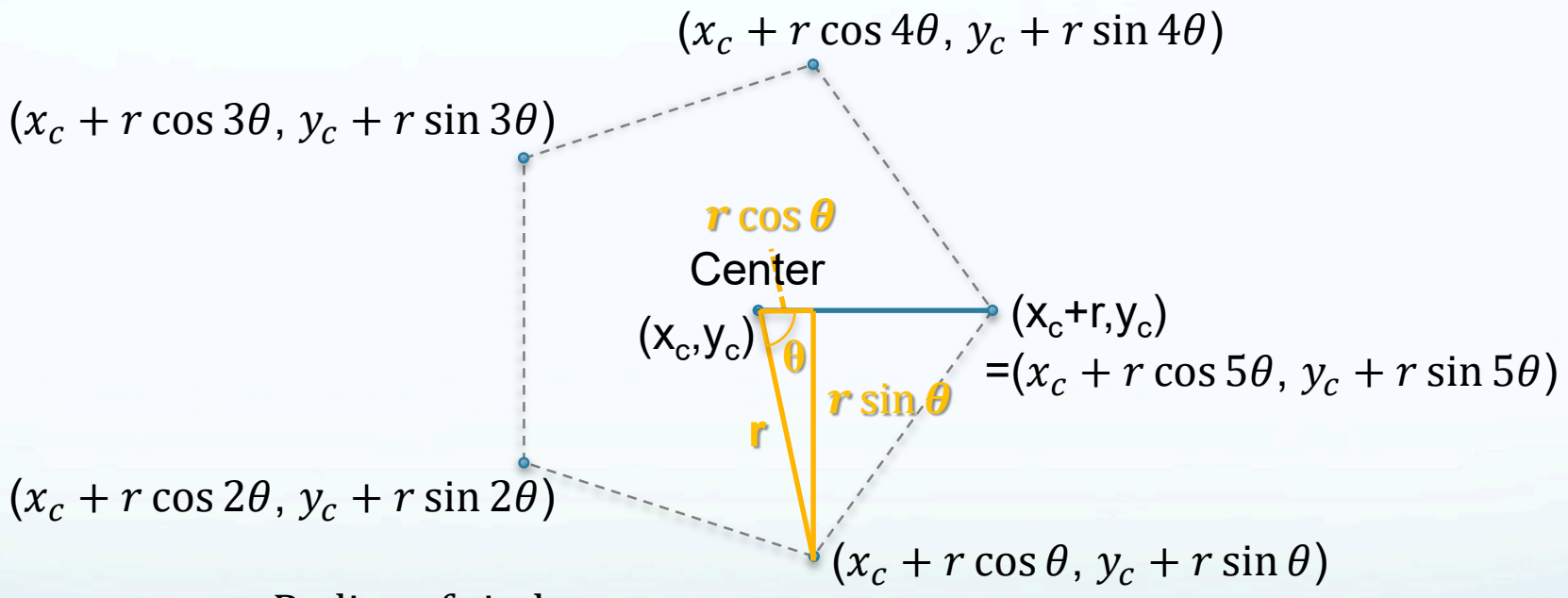
$$\cos\theta = \frac{x}{r}$$

$$\tan\theta = \frac{y}{x}$$

$y = r \sin\theta$

$x = r \cos\theta$

Points of a Pentagon



Radius of circle: r

Number of sides: n = 5

Wedge angle:

$$\theta = \frac{2\pi}{n}$$

JavaScript Math

- **Math.round(2.8)** // returns 3
- **Math.floor(2.8)** // returns 2
- **Math.min(70,50)** // returns 50
- **Math.max(70,50)** // returns 70
- **Math.random()** // returns a number between 0 and 1
- **Math.sin(x)**, **Math.cos(x)**, **Math.tan(x)**
- **Math.pow(4,2)** // 4^2, returns 16
- **Math.sqrt(16)** // returns 4

Polygons in 2D Graphics

```
graphics.beginPath();         // prepare for stroke sequence
graphics.moveTo(10,10);   // change position (pen up)
graphics.lineTo(10,20);      // change position (pen down)
graphics.lineTo(30,20);      // change position (pen down)
graphics.closePath();        // return to start
graphics.stroke();           // actually draw shape
graphics.fill ();            // fill interior (assuming simple closed shape)
```

We're no longer relying on our own line-drawing implementation here. These methods are already built into the graphics object.

Regular Polygon Pseudocode

Define a function… (What will the arguments be?)

- Compute the wedge angle θ
- Move to first vertex
- Loop through all adjacent vertices and add sides
- Finish the stroke to draw the shape

```
graphics.strokeStyle = "black";
graphics.fillStyle = "blue";
```

Questions

PAUSE NOW & ANSWER

1. A particular polygon has a central wedge angle of 36 degrees. How many sides does it have?

   10 sides

2. What is $\frac{2\pi}{5}$ radians in degrees?

   72 degrees

3. Our formula for the position of the kth vertex of a regular polygon is $(x_c + r\cos k\theta, y_c + r\sin k\theta)$. How would you modify the formula to rotate the polygon by angle α?

   Add it to the sin and cos arguments: $(x_c + r\cos(k\theta + \alpha), y_c + r\sin(k\theta + \alpha))$

Review

After this video, you should know how to:

- Define simple, complex, convex, and concave polygons
- Compute the center “pizza slice” angle of an n-sided regular polygon
- Compute the coordinates of a vertex given the center point and angle
- Draw a sequence of lines in Javascript
- Write a function to draw a regular polygon

Music: https://www.bensound.com