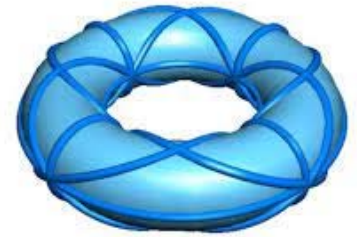**Chapel Hill Math Circle**
Session 3 – October 21, 2023: Polygons and Diagonals
Beginners' Group (grades 1-3), 10:30-11:30a
Mr. Barman – dilip@trianglemathinstitute.com
Supplies needed: rulers, spaghetti, paper, colored pencils, optional rope

Welcome to Chapel Hill Math Circle! We're glad that you are here to have some fun! If you were here last time, we talked about shapes. Let's review a bit.

We discussed **closed shapes** where something could be contained. **Polygons** are closed shapes with straight lines. A **simple shape** has no crossing lines. **Regular polygons** have all the lines the same and all of the angles in between the lines the same.

Let's focus on simple polygons today and discuss convex and concave polygons, diagonals, and maybe triangles today. Ready to have fun?

Convex and Concave Polygons

Can you draw some simple polygons where if you travel in a straight line from one part of the polygon to another you always stay inside of the shape? These are called **convex**. Now make some simple polygons where a straight line leaves the polygon. These are called **concave**.

Concave	Convex

I like to remember this by thinking of a concave shape as having a "cave". You can also think about this as taking a straight march; do I have to show my passport to enter another country and then re-enter my country? If so then my country's shape is concave.

Here are examples I made of concave and convex shapes. No matter where I draw a line in a convex shape, I always stay inside the shape. That's not true for a concave shape! Make a few more examples of concave and convex shapes below.
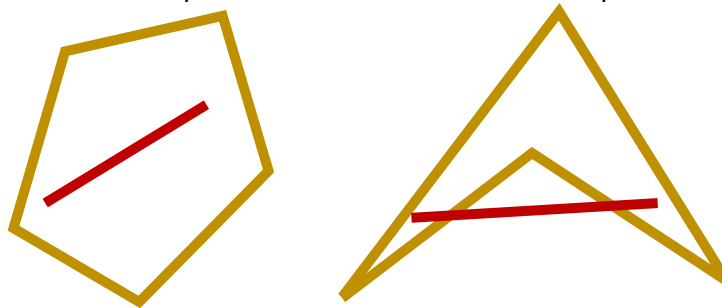

Let's get up and move around - can you work with a partner to make a shape with rope that is convex? Concave? How about with your body? Can you move a piece of paper or index card to prove that a shape is convex or concave?

Concave	Convex

Diagonals

What do you think a diagonal is? Can you use different colors to draw all the diagonals in these polygons? Do all triangles have the same number of diagonals? All 4-sided polygons? All 5-sided ones? All any-sided ones?
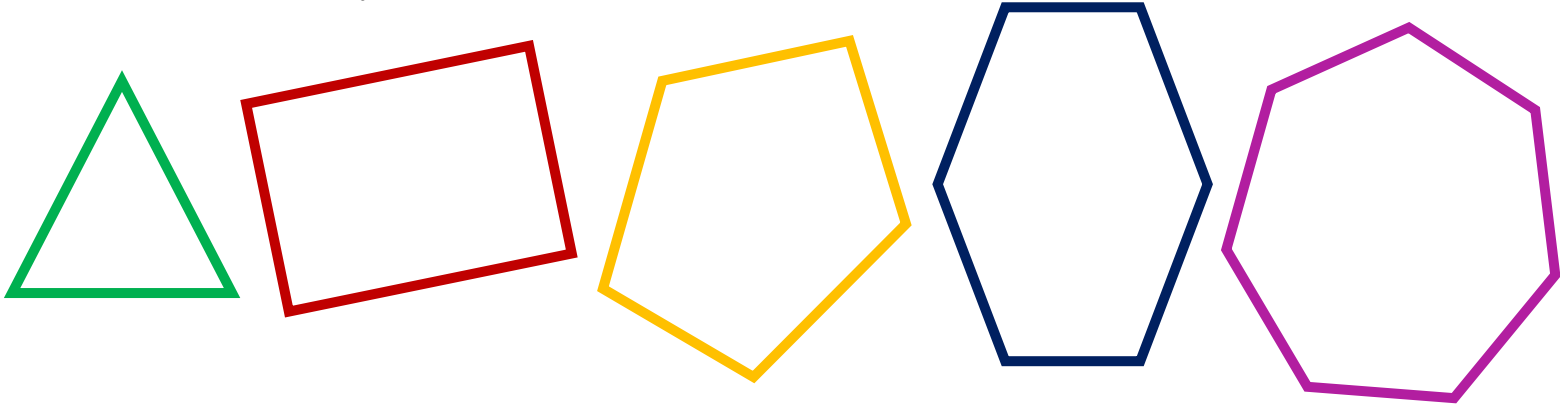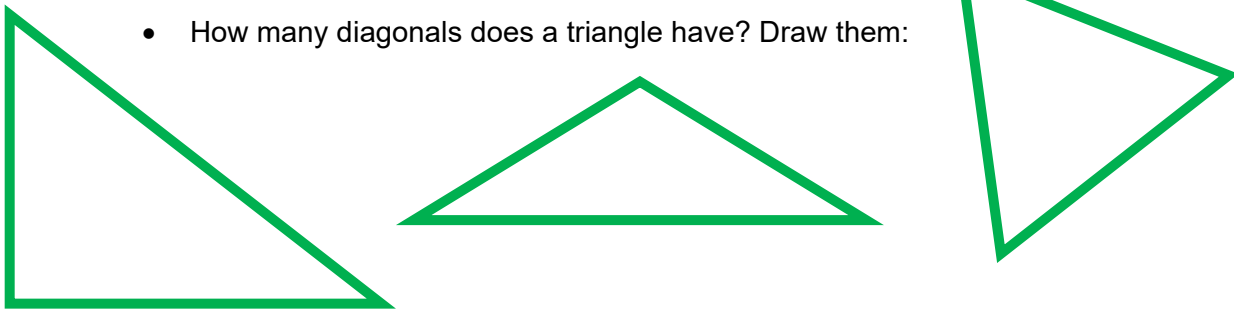
(Don't peek till I tell you: A diagonal is defined as a line segment between two "vertices" of a polygon that aren't directly connected.)
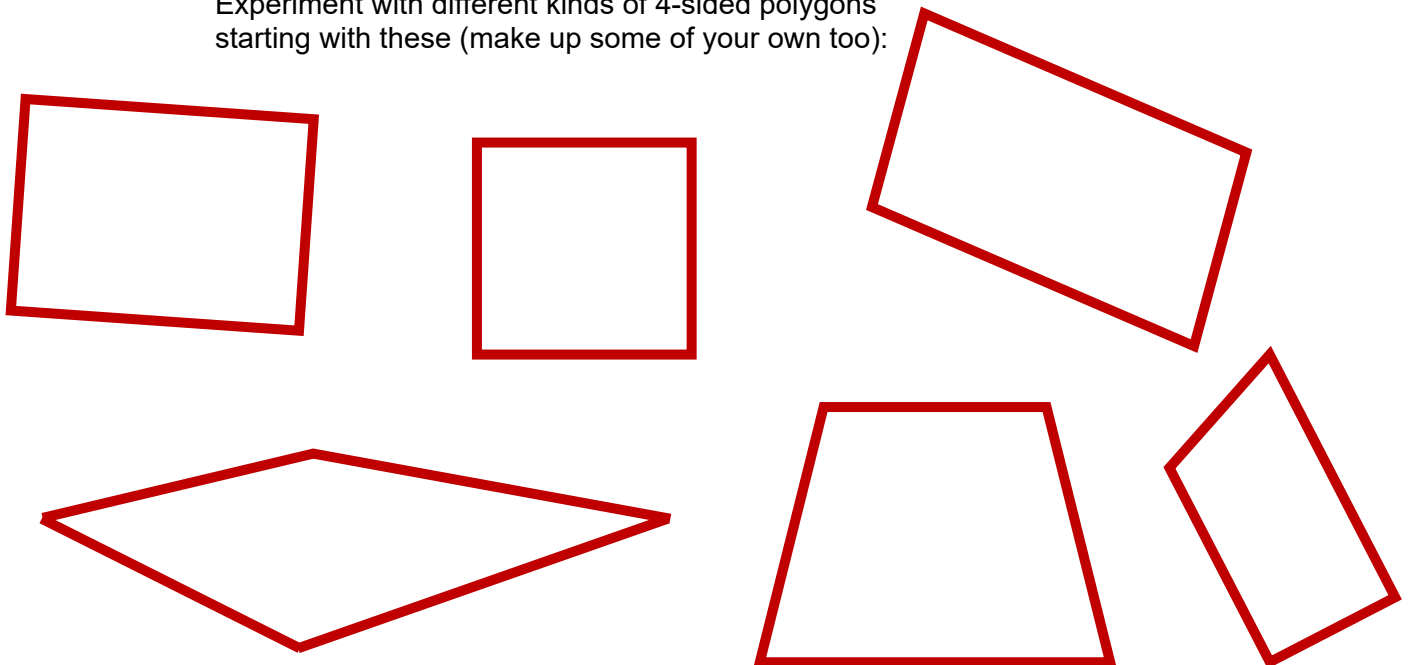
How many diagonals?

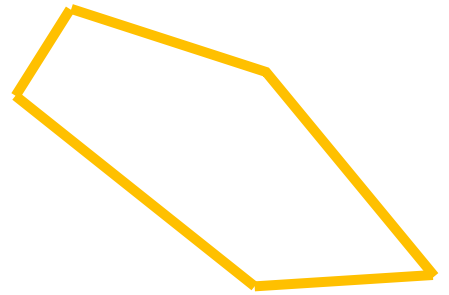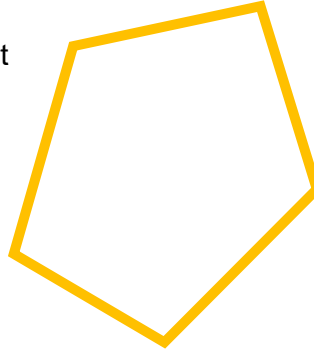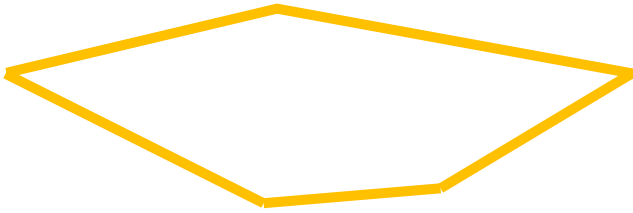Once we agree what a diagonal is, let's count diagonals.

- How many diagonals does a triangle have? Draw them:

- How many diagonals do 4-sided polygons have? Experiment with different kinds of 4-sided polygons starting with these (make up some of your own too):

- How many diagonals do 5-sided polygons have? Experiment; start with these:

Make a table of what you have found so far. Do all polygons of the same number of sides have the same number of diagonals? If not then list all the possibilities.

Do you have a prediction of how many diagonals a 6-sided polygon would have? How about 7-sided polygons?

Number of sides	Number of diagonals
3	
4	
5	
6	
7	

**So how do we count diagonals?**
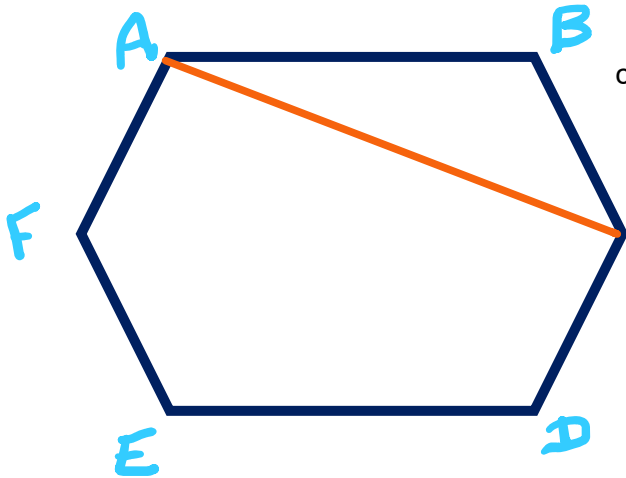
Let's describe a diagonal as a line segment connecting a vertex to another vertex of the shape that isn't a neighboring vertex. Here is a picture describing one diagonal in a hexagon (6-sided polygon). I have labeled the vertices (plural of vertex) with letters.

How many diagonals start at A? I drew one and will call it AC.

How many diagonals start at A?
List all of them starting with AC.

Do you agree that a triangle has no diagonals? And that a 4-sided polygon has 2?
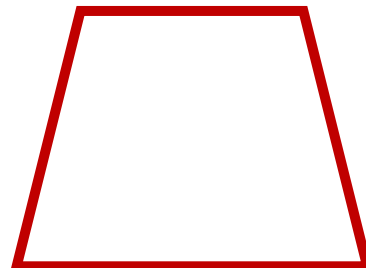
Play with 5-sided, 6-sided, and maybe even more-sided polygons

How many diagonals do you find? Can you name them? What patterns can you find? Can you guess and confirm the number of diagonals for polygons with more sides?

My notes on counting diagonals

Did you find any patterns or ways to predict the number of diagonals for any number of sides? Oh how about color - do colors for you go with certain shapes, letters or numbers?

Patterns and ways to predict diagonals

Do colors go with certain shapes for you?

My notes on making triangles

(if we have time) Spaghetti and Triangles!

Use pieces of spaghetti or even cut out lengths of paper to create triangles. Can you make any kind of a triangle? Can any three lengths make a triangle? We will probably pick up with this next time!

Keep on playing at home!

At home keep playing with your spaghetti pieces and see if you can figure out what kinds of pieces can make triangles and other shapes. Can you think of interesting ways to describe shapes like 3-, 4-, and 5- sided figures? Keep your eyes open – where do you see polygons?

I hope you had fun! See you next time!

P.S. For your parents: you may enjoy looking over the website splashlearn.com/math-vocabulary/geometry/polygon about polygons.

Have Fun!

Mr. Barman