



# Centers of triangles

from the Esri GeoInquiries™ collection for Mathematics

Target audience – Geometry learners

Time required – 15 minutes

**Activity** Find the circumcenter of a triangle, which is the point where the perpendicular bisectors of the sides of a triangle intersect and it is equidistant to each vertex.

**Math Standards** **CCSS: MATH.HSG-C.A.3.** Construct the inscribed and circumscribed circles of a triangle.  
**CCSS: MATH.CONTENT.HSG.CO.D.12.** Make formal geometric constructions with a variety of tools and methods.  
**CCSS: MATH.CONTENT.HSG.CO.C.10.** Prove theorems about triangles.

**Learning Outcomes**

- Students will find the circumcenter of a triangle.
- Students will construct a perpendicular bisector of a line segment.

Map URL: <http://esriurl.com/mathGeoInquiry14>



## Engage

### How can geometry be used to solve real-world problems?

- Click the URL above to launch the map.
- Click Bookmark and then select Overview.
- An event planner is looking to book a venue for a large music festival that is equidistant from Atlanta, Georgia; Nashville, Tennessee; and Asheville, North Carolina.
- ? How could geometry help her find an appropriate location for her event? *[Answers will vary.]*



## Explore

### Where do you think a good location for the festival might be and why?

- To the left of the map, click Details and then the Show Contents Of Map button.
- Select the Cities layer check box to turn on the layer.
- View these three cities on the map and focus on the space between them.
- ? What shape is created by the lines joining these three cities? *[Triangle]*
- Turn on the Lines layer.
- Note the triangle created by connecting adjacent cities with a line segment.
- Estimate where the music festival should be held. *[Have students point to the location on the map, and remind them that a point that is the same distance from each city might be a good solution.]*



## Explain

### How do you find a point equidistant from the vertices of a triangle?

- Read aloud, “Find the midpoint of each line connecting two cities by either averaging the latitudes and longitudes of the cities at each endpoint and plotting that latitude and longitude, or measure the length of each side, dividing this distance by two, and measure the distance from one endpoint along the line.”
- Turn on the layer, Midpoints.
- Turn on the layer, Perpendicular Bisectors.
- Read aloud, “A perpendicular bisector is a line that goes through the midpoint and is perpendicular to the line segment between the two cities. All the points on this line are the same distance from each city.”
- Turn on the layer, Circumcenter.
- Read aloud, “The circumcenter of the triangle is located along Black Ankle Creek, Athens, Tennessee.”
- Turn on the layer, Circle.
- Read aloud, “A circle has a center at the circumcenter and a radius equal to the distance to any of the three cities. This circle contains all the vertices of the triangle and is circumscribed about the triangle.”

## Elaborate

### What other geometric constructions could be used to solve real-world problems?

- ? Will a triangle's circumcenter always lie inside the triangle? [*Circumcenter is inside acute triangles, on the leg of a right triangle, and outside an obtuse triangle.*]
- ? Are there other centers of triangles, and what is special or unique about each? [*Centroids are where the medians of triangles intersect; orthocenters are where altitudes of triangles intersect; and incenters are where angle bisectors of triangles intersect. Incenters are equidistant from the sides of a triangle and create a circle inscribed in a triangle.*]

## Evaluate

### Is the mathematical solution always the best solution to a real-world problem?

- ? What else should the event planner consider when selecting the location of her event – is there a better place than Athens, Tennessee, for her to hold her music festival? [*Drive times from each city, road infrastructure, bigger cities might have more people attend, local lodging, food availability, and so on.*]

### USE THE MEASUREMENT TOOL

- Click Measure, select the Distance button, and from the drop-down list, choose a unit of measurement.
- On the map, click once to start the measurement, click again to change direction, and double-click to stop measuring.
- Hint: Position the area of interest on the map so that it is not obscured by the Measure window.

### ADD MAP NOTES

- Click Add and from the drop-down list, choose Add Map Note.
- Type a name, select a template from the drop-down list, and click Create.
- In the Add Features pane, choose a symbol and click in the map to place it.
- In the pop-up window, add your desired information.

## Next Steps

**DID YOU KNOW?** ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

**THEN TRY THIS...**

- Using a free ArcGIS Online organizational account, have students modify the map used in this activity and save it to their account, sharing it with classmates.
- Have students select the Analysis button, Use Proximity button, and Create Buffers button or Create Drive Time Areas button to further modify this map.

## TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Holt Geometry by Holt, Rinehart & Winston — Chapter 5*
- *Geometry by Houghton Mifflin — Chapter 10*
- *Geometry by Moise & Downs — Chapter 15*