Rates of population change

from the Esri GeoInquiries™ collection for Mathematics

MATH

Target audience – Algebra learners **Time required – 15 minutes**

Activity	Investigate rates of population growth and decline with US Census data.
Math Standards	**CCSS: MATH.CONTENT.HSF.LE.A.1**. Distinguish between situations that can be modeled with linear functions and with exponential functions. **CCSS: MATH.CONTENT.HSF.IF.B.4**. For a function that models a relationship between two quantities, interpret key features of graphs & tables in terms of the quantities, & sketch graphs showing key features given a verbal description of the relationship.
Learning Outcomes	• Students will investigate rates of population growth and decline. • Students will compare linear and exponential growth rates.

Map URL: http://esriurl.com/mathGeoInquiry5

Engage

How much has your state's population changed since 2000?

→ Click the URL above to launch the map.
? How much has your state's population changed since 2000? *[Answers will vary by state.]*
? Which states have grown (or declined) the most? Is there a regional pattern? *[Answers will vary.]*
? How could we use algebra to explore these changes? *[Use functions to find growth rates.]*

Explore

How does your state's growth compare to the rest of the country?

→ Click your home state.
? What was your state's average annual population growth rate from 2000 to 2010? *[Answer will vary by state.]*
? How does this growth rate compare to nearby states? To the rest of country? *[Answers will vary by state.]*
– The U.S. grew by about 0.93% per year.

Explain

How can we describe the growth rate mathematically?

– To see data on population change, click on a state. Once the pop-up window appears, hover over a bar in the graph for more information on that state's growth from 2000-2010, 2010-2016, and 2016-2021.
? What is the formula for calculating average annual growth? [$Y_t = Y_0(1+r)^t$ where t = original value x $(1 + \text{rate})^{\text{time interval}}$]
? How is this formula different from simply dividing the total growth over time and dividing by the number of years involved? *[This formula accounts for growth that happens each year.]*

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Elaborate

How can we estimate our future population?

– When you click a state, the pop-up window that appears offers projections into the near future.
? Is your state expected to grow quickly soon, compared with the recent past?
? Using the formula for exponential growth, what would your expected population be in 2050?
? What would the population be if there was a growth rate 1 percent higher (or lower) than what is projected for your state?

Evaluate

How well do you understand growth rates?

? What will your state population be if there is 3% annual growth for 5 years, and then 1% growth for the next 5 years? *[Answers will vary by state.]*
? What will your state population be if there is 1% annual growth for 5 years, followed by 3% growth for the next 5 years? *[Answers will vary by state.]*
? Which would lead to a higher population at the end of the 10-year period, or would they be the same? *[Results will be the same, by the commutative property:*
– Example scenario 1, assuming 100 at the start: $100 \times (1.03)^5 \times (1.01)^5$
– Example scenario 2, assuming 100 at the start: $100 \times (1.01)^5 \times (1.03)^5$]

IDENTIFY A MAP FEATURE

- Click a feature on the map, and a pop-up window will open with information.
- Links and images in the pop-up are often clickable.
- An arrow icon in the upper right of the window indicates that multiple features have been selected.
- Click the button to scroll through the features.

TURN A MAP LAYER ON AND OFF

- Make sure that the Details pane is selected, and click Show Contents Of Map.
- To show individual map layers, select the check boxes next to the layer names.
- Hint: If a map layer name is light gray, zoom in or out on the map until the layer name is black. The layer can now be turned on.

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...

• Explore global population in the Welcome to the Anthropocene story map at http://esriurl.com/Geo41804.
• Discover population growth in urban areas around the world in The Age of Megacities story map at http://esriurl.com/Geo41805.

TEXT REFERENCES

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

- *Algebra 2 by Ron Larson — Chapter 7*
- *Algebra 2 by Holt Rinehart — Chapter 6*
- *Algebra 2 by McGraw-Hill Education — Chapter 9*

Version Q1 2018. Send feedback: http://esriurl.com/GeoInquiryFeedback

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