Olin College of Engineering

Teacher's Guide for **The Math Behind Our Democracy: Representation**

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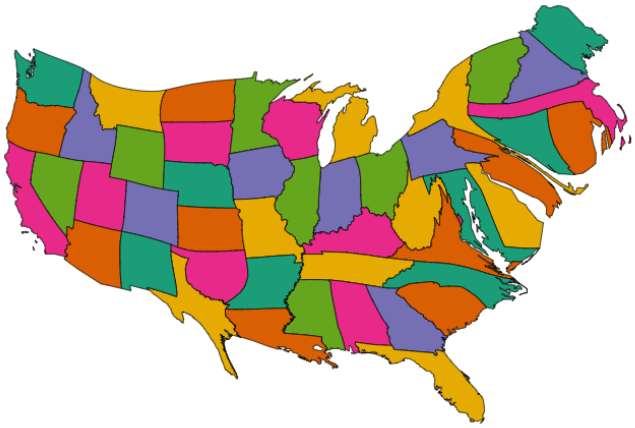
Workshop Description

Who gets a say in democracy? Does a vote in Wyoming count twice as much as a vote in California? Representation in the US is skewed based on where you live and who draws your district boundaries. In this workshop, you will learn about the math behind representation in the Senate, House of Representatives, and the Electoral College. You will see that states with smaller populations have an outsized representation in the Senate and Electoral College. If every state were as big as its vote in the Senate, the US would look like the map on the below on the left. You'll use free online tools to make maps like these, to visualize different aspects of representation in the US - and what that means for democracy.



Workshop Requirements

- Time: **55 minutes or longer**
- Materials: **Access to computers with Google sheets, slides, docs, and ability to download files.**
- Suggested ages: **7th-12th grade**
- Students should know: **how to use Google apps**

Learning Goals

- Understand that very simple math can have great consequences
- See the meaning of numerical data
- Learn how to represent data visually using a cartogram generator
- Gain interest in representation and voting issues

Workshop Notes

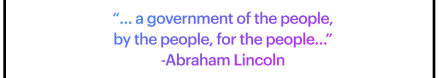
- If the students are studying anything related to government, this is a great workshop to tie in some math and data visualization. It could also be a part of a unit where students are learning to use spreadsheets, as students will make heavy use of a few basic spreadsheet operations.
- It is important for you to have a firm idea of the process so you can help students troubleshoot. Practice following the steps in the assignment sheet a few times. When demoing the process for class, run through at least three examples (you can use the first three parts of the assignment sheet, or think of another example to show), because it helps for the students to see all the steps in order a few times.

Materials

Make a copy of this google slideshow and share it with the class. Students will add screenshots of their cartograms to display their maps.

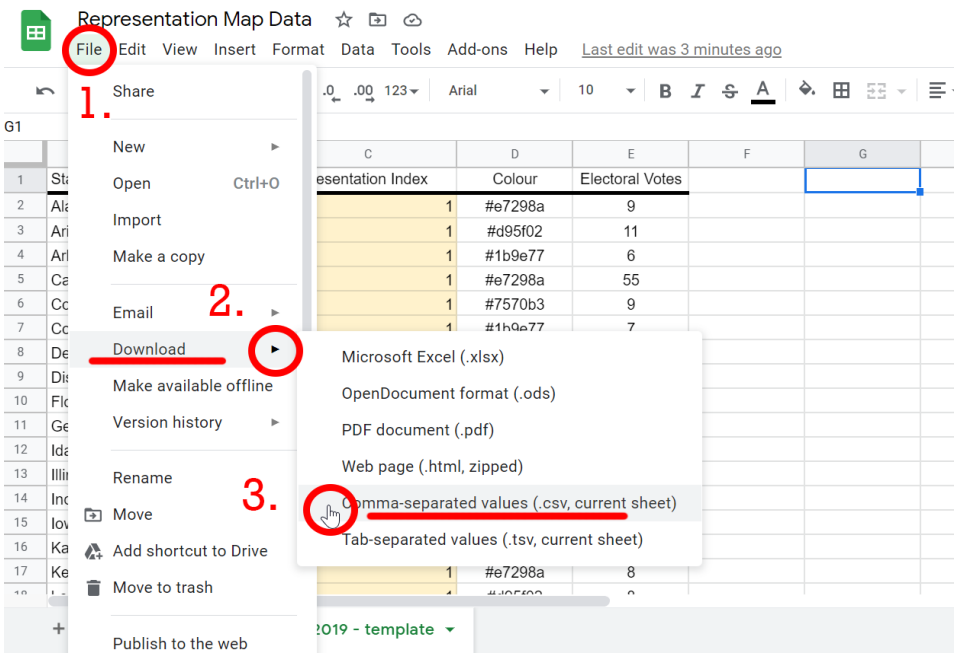
Print out or share this assignment sheet with the class; it explains how to make cartograms, which you should also practice so that you can demo the process during class and then help students as needed.

Presentation Notes

	Welcome slide
	"Abraham Lincoln once said…." Today we'll explore the power of the people in our government.

Direct VS Representative
The Forms of Democracy
• Direct Democracy: the people always vote on policy initiatives directly
  • Ex: every person in your family always votes on what is for dinner
• Representative Democracy: the people vote for representatives who then vote for policy initiatives
  • Ex: your family votes for 1 member that chooses what's for dinner
• America is a Representative Democracy
	The US is a representative democracy, where we elect congresspeople and senators, who then decide on the laws.

Equal VS Proportional **The Kinds of Representation** • Equal Representation: when each state has the same number of representatives • Proportional representation: when the amount of representatives is based on population • The American Government has both. The Senate has equal representation and the House has proportional representation.	The House has proportional representation, with each state getting more or fewer representatives based on their population. The Senate has equal representation, where each state gets 2 senators, no matter its size or population. "Equal representation" is a misnomer, because a person living in California is represented less equally than a person living in Wyoming.
Today we'll use google sheets & cartograms to visualize data on the Senate, House, & Electoral College.	Intro into class activity. More details on Demo Slide.
DEMO	Spend 8-12 minutes walking through the first three examples in the assignment sheet. The students will do this right after, but it helps for them to see all the steps in order a few times: filling in the spreadsheet, downloading it, and uploading it to go-cart.io/cartogram.



Activity Time

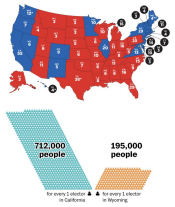
Have them practice with examples 1 and 2 on the assignment sheet. Give them about 5 minutes, but check in with individual students or with a temperature check of the class to see where people are at. (You will give the students more freedom to experiment soon, but having everyone start with the same examples will ensure that everyone is comfortable with the process).

Share the link to the class-wide share-out document, and have them add a screenshot to the slideshow. Encourage students to move ahead in the assignment sheet if they get done early.

The Senate
Equal Representation

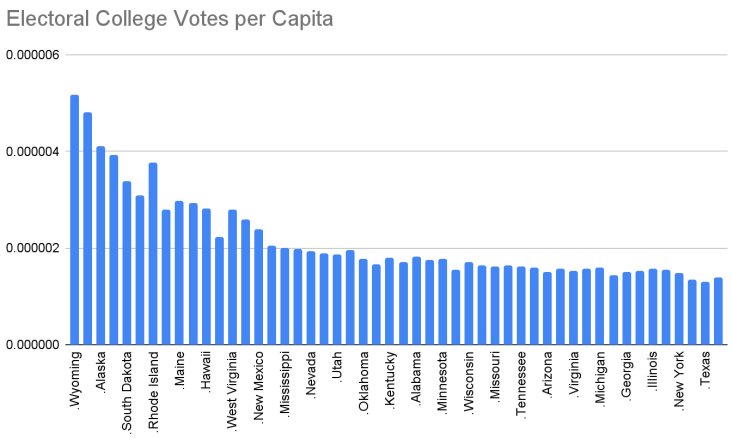
- 2 Senators for each state
- 2 X the 50 states = 100 senators
- The 50 Democrats represent 41,549,808 more people than the 50 republicans.

Once enough people are done with the activity, move on to this slide to talk about the Senate.

The House of Representatives **Proportional Representation** • 435 voting members who each represent a specific district in their state • The Permanent Apportionment Act of 1929 set 435 as the number of representatives • Established the formula for apportionment of those 435 seats after each census. • Due to the fixed number of members and the rule that each state gets at least 1 representative we have to do some fancy math to get to exactly 435 House reps	Intro into the House.
The Electoral College **Representation in the Executive Branch** • How we elect our President and Vice President • 538 electors, one for each House representative, each senator, and 3 for DC • 435 + 100 + 3 = 438 • A hybrid system of representation 	Intro into the Electoral College.
How does this system based on a hybrid form of representation models impact the power of a vote in each state?	This is a guiding question for the next activity.
Activity Time	Now have them work on examples 3 and 4, where they are creating cartograms for the House and Electoral College. You can tell them they already made one for the Senate, when they made the equal-area map in example 1. This part should take 5-6 minutes, and you can help students troubleshoot.
Senators  Population 	When they're done, bring the students back to discuss the maps they just created. Toggle between these two slides, having the students note the differences between the two maps (one scaled by population and the other scaled by the number of Senators). Note the differences between the two, and how the map is distorted from one to the other. Whenever a state shrinks, it means its people have less of a say at the federal level. A state which expands has more voting power for each person living there.

Representatives  Population 	Toggle between these two slides having the students note the differences between the two maps (one scaled by population and the other scaled by the number of representatives) These should be very close to being the same so note the slight changes.
Electors  Population 	Toggle between these two slides having the students note the differences between the two maps (one scaled by population and the other scaled by the number of electors). Note how this is different from the other two maps: it still resembles the population map, but it is much more distorted than the house of representatives map. This is because states with a small population like Wyoming still have at least three electors, whereas they might only have a single representative.
Activity Time	Now have them make cartograms using Electoral College data and compare them to the population based cartogram. Now have them do example 5. They will need to think for a minute about how to create a formula for how many representatives there are for every one million people in a state. Have them take a screenshot of their result and upload it to the class-wide share-out document.
	At the end of class, share your screen and go through the slides in the share-out document. Prompt students to talk about the slide(s) they added and what the meaning of their cartogram is. The first three maps are examples.

Extensions



The same questions can be explored in a more quantitative way through graphing with google sheets. For a graphical extension to the cartogram workshop, print out or copy and share this tutorial and make a copy of this slideshow for students to add screenshots and display their graphs.

Please use these materials and tailor them to your students!

We encourage you to use these materials, editing and modifying them as appropriate for your students! When you use, share, incorporate, or modify these materials, please keep the license notice (from the footer) and credit "Olin College's course on Mathematics/Engineering Outreach for Adolescent Learners." We also humbly request that you email sarah.adams@olin.edu if you use these materials, as we are tracking their impact and how far they travel!