

**PROBLEM SET 8 – LECTURES 16-18 (CLASSES 19-21)**

**QTM 110, OXFORD COLLEGE OF EMORY UNIVERSITY**

**ZACHARY BINNEY, PHD**

**10 total points**

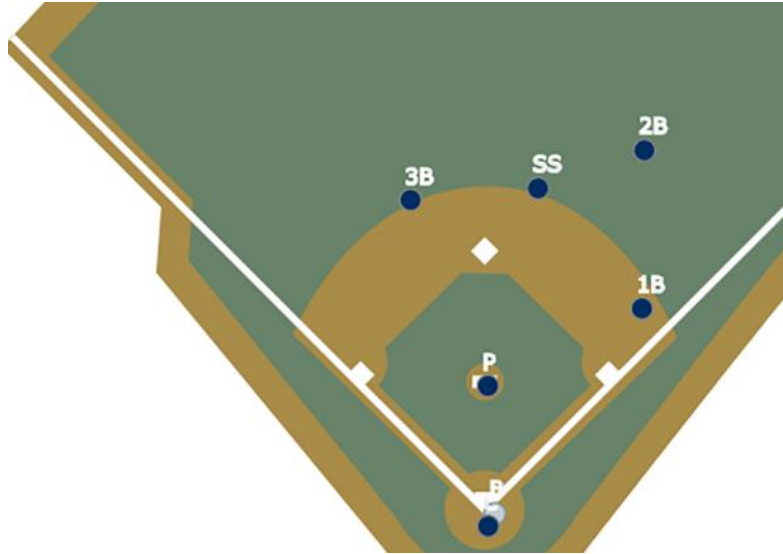
**Part I: Regression to the Mean (2 pts)**

1. In about 1-2 sentences, describe how regression to the mean plagues each of the following analyses.
  - a. In baseball, there is this idea of the “Home Run Derby Curse.” The Home Run Derby is an event, roughly midway through the baseball season, where the best home-run hitters – including some selected because they hit the most homers in the first half of the current season – are invited to...well, hit a bunch of home runs off of easy pitches. The Home Run Derby curse states that players hit home runs at a lower rate after the Derby than before, with the theory being hitting easy pitches at the Derby “messes up their swing” or knocks their timing off. But you have another theory, right? (0.5 pts)  
NOTE: The same problem arises when, early in the season, a player (in any sport!) is “on pace” to break some record – like the number of home runs in a single season – only to slow down as the season drags on and fail to break it. Sometimes commentators will claim, “The pressure got to him!” or “Pitchers get better as the season goes on.”
  - b. In 1933, a statistician named Horace Secrist released an economic analysis. He ranked businesses in various sectors – we’ll just focus on grocery stores – on sales-to-expenses ratios in 1916 and 1922. He found that the best performing grocery stores in 1916 were merely above-average in 1922, and the worst-performing stores from 1916 were merely below-average in 1922.  
Secrist theorized that competition held down the most successful businesses and helped incompetent businesses because every business has to subject itself to the most common practices in its field. But you know better, right? (0.5 pts)

- c. In a 1976 *British Medical Journal* study, scientists studied the effects of bran on “oral-anal transit time” – or how long it takes you to poop out what you eat. The mean time for humans is about 48 hours, but hopefully you’ve noticed by now in your lives that it’s not always consistent (i.e. sometimes you’re constipated, sometimes you have diarrhea).
- The study simply involved feeding bran to a bunch of people. The authors found that those with the fastest “transit times” slowed down to closer to 48 hours after consuming bran. Bran works, right? (0.5 pts)
- d. In the Air Force, a psychologist comes in to tell officers that when training fighter pilots, positive reinforcement (understanding and helping them to do better when they fail) works better than negative reinforcement (screaming at them). The officers laugh. No no, they say, every time a pilot does well and we praise him, he does way worse the next time. Every time he does poorly and we scream at him, he does way better the next time. Clearly negative reinforcement is better, right? (0.5 pts)

**Part II: Prediction and Adaptation (2 pts)**

2. In about 1-2 sentences, describe the behavioral adaptation problem(s) that may arise in each of the below examples.
- a. In baseball, the defense typically arranges its players roughly evenly on the field to be best able to catch a batted ball and get the hitter out. However, in recent years analysts have discovered that some hitters have a strong tendency to hit the ball towards one side of the other. This has led teams to sometimes “employ the shift” against these hitters, where they move all defenders to one side of the field to better defend it, while leaving a large gap on the other side of the field. (1 pt)



- b. In 1969 the U.S., as part of Operation Intercept, disrupted major marijuana shipments, which led to a reduced supply and raised prices. Briefly discuss the responses of 1) suppliers and 2) users in about 1 sentence each. (1 pt)
- c. The educational literature tells us that flipped classrooms and active learning (e.g. using class time to work on problem sets rather than conduct lectures, as we do in this course) and frequent low-stakes assessments (e.g. multiple graded problem sets or quizzes weekly rather than having most of your grade depend on 2-3 exams) help students learn better and result in lower stress.  
But until COVID-19, these techniques were used by only a small percentage of instructors – so all analyses of their effectiveness were done in a context of *mostly*

“traditional” courses. What happens if many instructors at Oxford adopt these strategies at once? (0 pts – for class discussion)

### Part III: Denominators (6 pts)

3. Pretty much every college uses misleading fractions to trick students in their marketing materials – yes, even Oxford. Unfortunately I don't have Oxford's specific data readily handy, so we'll have to use hypothetical data.

The problem often arises in claims about class size, where you might see a claim like "The average class size is 12 students." Let's break that down a little bit. (1.2 pts)

- a. Write a fraction, in words, for the "average class size" at a college that they might report in a brochure. Assume they are simply averaging the size of all their classes. (0.2 pts)

- b. The key thing for you, though, is the average for the classes *you experience* (that is, observe or inspect).

- i. Write down a fraction for the average class size *you experience*. (0.1 pts)

- ii. Modify that formula for the *average* class size that you and *your best friend (or roommate, or person sitting next to you) at Oxford* experience. (0.1 pts)

- iii. Modify that formula for the *average* class size *all students* experience. (0.2 pts)

- c. Now consider a single (fictional) department at Oxford. Let's call it [Agnotology](#). Let's say they have 10 small discussion classes with 6 students each, and 10 larger intro classes with 25 students each.

- i. What is the "average class size" in the Department of Agnotology (that the college might put in a brochure)? (0.1 pts)

ii. What is the average class size students *experience* in the Department of Agnotology (and by extension the average class size, on average, any single student will experience)? It may help to assume no student is enrolled in more than 1 class in the Department of Agnotology; it won't change our conclusions. (0.3 pts)

iii. Explain in terms similar to the bus stop problem why this difference exists. (0.2 pts)

4. Consider this [interview of Donald Trump by Axios in August 2020](#) – watch from 13:00 to 14:00. The two men cross-talk about two different measures you could use for the “death rate” from COVID-19 (0.8 pts):

-Trump:  $\frac{\text{COVID-19 Deaths}}{\text{Cases}}$  (Case-fatality rate)

-Axios:  $\frac{\text{COVID-19 Deaths}}{\text{Population}}$  (COVID-19 Mortality rate)

a. What question is Trump's statistic answering? What story does it tell? Answer in 1-2 sentences. (0.3 pts)

b. What question is Jonathan Swan's (the Axios interviewer's) statistic answering? What story does it tell? Answer in 1-2 sentences. (0.3 pts)

- c. Which one, in your opinion, tells the more relevant/important story for how the U.S. has handled the pandemic? Why? Answer in 1-2 sentences. (0.2 pts)





6. In a story about a [trial of Crestor](#) – a cholesterol-lowering drug called a statin – the *Wall Street Journal* [reported it reduced](#) the “risk of heart-related death, heart attacks, and other serious cardiac problems by 43%” in men over 50 and women over 60. Here is some actual data from the study:
- Control Arm: 251 of 8,901 patients (2.8%) had heart attacks
  - Crestor Arm: 142 of 8,901 patients (that is, 1.6%) had heart attacks (1.3 pts)
- a. What percent of heart attacks in men over 50 and women over 60 does Crestor prevent? NOTE: If you round the numbers that went into this calculation you may get a percent *slightly* off from what you expect; just ignore that difference! (0.2 pts)
- i. What denominator did you use here? (0.2 pts)
  - ii. Is this an absolute or relative measure? (0.1 pts)
- b. If I treat 10,000 people with Crestor, how many heart attacks will I prevent?  
HINT: What would happen if all 10,000 people were treated, versus what would happen if all 10,000 people were untreated?  
NOTE: This is a variant of a measure epidemiologists call the “number needed to treat,” or NNT – a common measure of drug effectiveness. (0.2 pts)
- i. What denominator did you use here? (0.2 pts)
  - ii. Is this an absolute or relative measure? (0.1 pts)
- c. Imagine you are the health minister of a middle-income country trying to decide whether to invest your scarce health dollars in Crestor or other drugs. Which of these questions and answers do you find more relevant? Why? Answer in 1-2 sentences. (0.3 pts)

7. In the *Simpsons* episode "Homer the Vigilante," Homer starts a vigilante posse after his daughter Lisa's saxophone is stolen. At one point Homer goes on the Eye on Springfield show with anchor Kent Brockman, and they have this exchange. (0.5 pts)



**Kent Brockman** : Mr. Simpson, how do you respond to the charges that petty vandalism such as graffiti is down eighty percent, while heavy sack beatings are up a shocking nine hundred percent?

**Homer Simpson** : Aw, you can come up with statistics to prove anything, Kent. Forty percent of all people know that.

**Kent Brockman** : I see. Well, what do you say to the accusation that your group has been causing more crimes than it's been preventing?

**Homer Simpson** : Oh, Kent, I'd be lying if I said my men weren't committing crimes.

**Kent Brockman** : *[pause]* Well, touché.

- a. To Kent's question: has Homer's group been causing more crimes than he's been preventing: yes, no, or not enough information? If you don't have enough information, what more do you need to know? (0.3 pts)

- b. A simple analysis of whether there are numerically more total crimes without than with the vigilante posse misses a pretty important aspect of this question. What is it? (0.2 pts)

NOTE 1: Do not simply repeat your answer to part a). We are assuming we're already making a comparison between the actual numbers of crimes and with and without the posse.

NOTE 2: This question isn't based on anything you learned in this lecture; it's purely a critical thinking question.

8. Identify at least one problem in each of the following cases of misleading visualizations. (0.2 pts each, 1.2 pts total)
- a. This one is a survey rather than a visualization, but you can still identify one (of several) issues relevant to this lecture. So: [Poor Prof. Dahly](#). Why is he upset?

 **Darren Dahly** @statsepi · Mar 1 ...

Good luck to the poor sucker they are eventually going to ask to "analyze" this nonsense.

The time I spend has INCREASED by ...					The time I spend has DECREASED by ...				
+100% or more	+50% to 100%	+20% to 50%	up to 20%	No Change	-20% or more	-20-50%	-50-100%	-100% or more	No Change
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15      10      185      

 **Darren Dahly** @statsepi · Mar 1 ...

shit I hope it's not me.

3      1      78      

b.



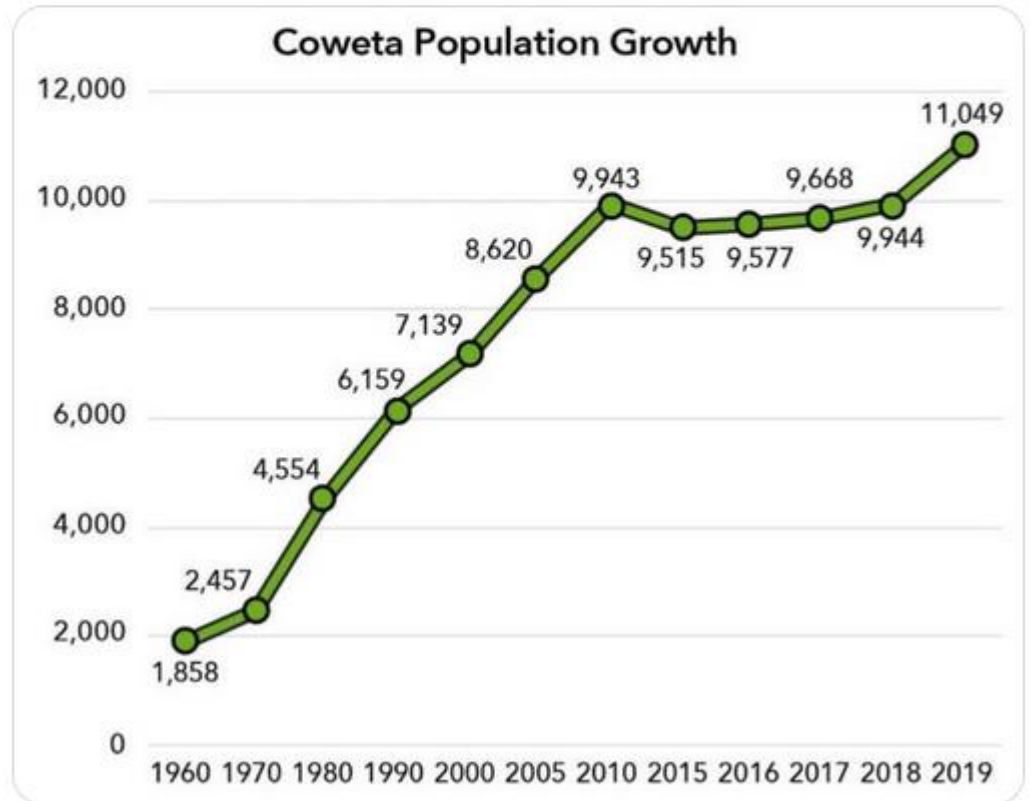
**Sarah Carter** @mathequalslove · Jan 12



Filing this graph away that I ran across on social media today to explore with my statistics students later in the year. This is the population of the town I teach in.



#mtbos #iteachmath #statschat #statchat



13

15

207



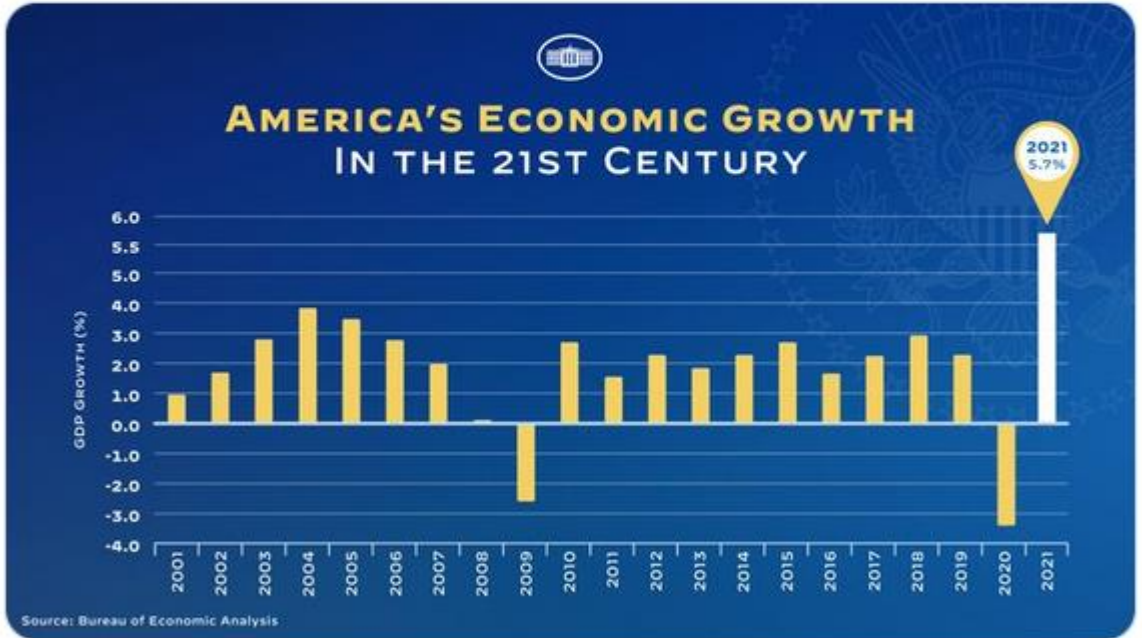
c.



**The White House** ✓  
@WhiteHouse



We just learned that President Biden's first year in office was the strongest year for economic growth since 1984.



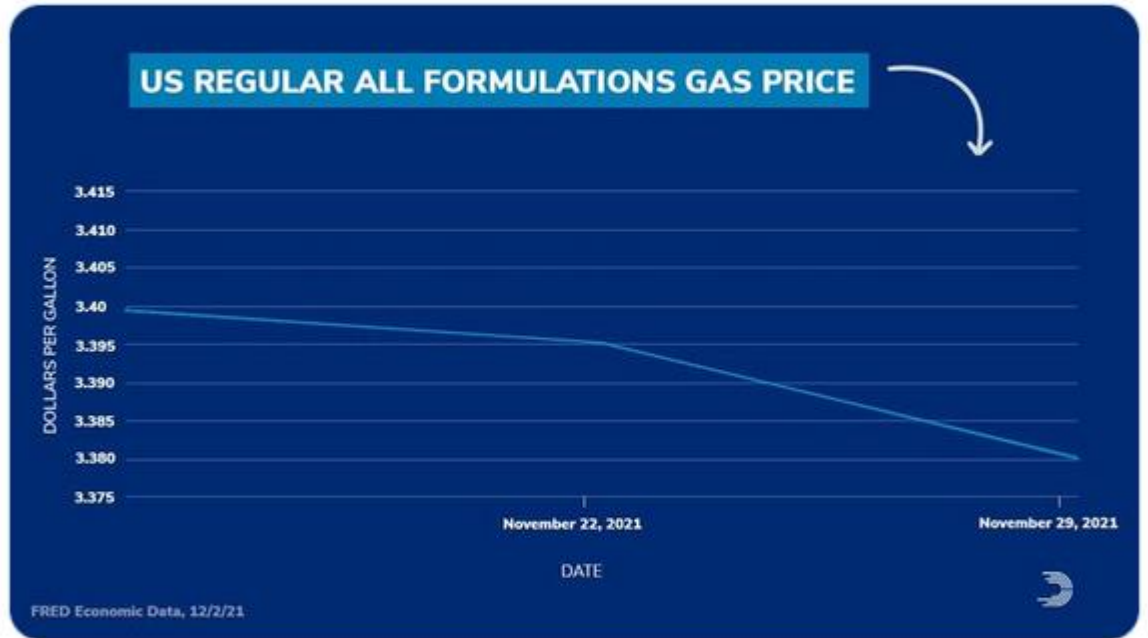
9:35 AM · Jan 27, 2022 · The White House

**5,628** Retweets   **2,653** Quote Tweets   **20.2K** Likes

d. Look the Republicans do *plenty* of this, too, I just happened to come across these recently.



Thanks, [@JoeBiden](#).



2:46 PM · Dec 2, 2021 · Twitter for iPhone

1,494 Retweets 9,052 Quote Tweets 5,130 Likes

- e. I'd agree never to eat pancakes again if I could remove all charts like this from the world.  
HINT: What are pie charts useful for, generally, and is this data appropriate to show that way?

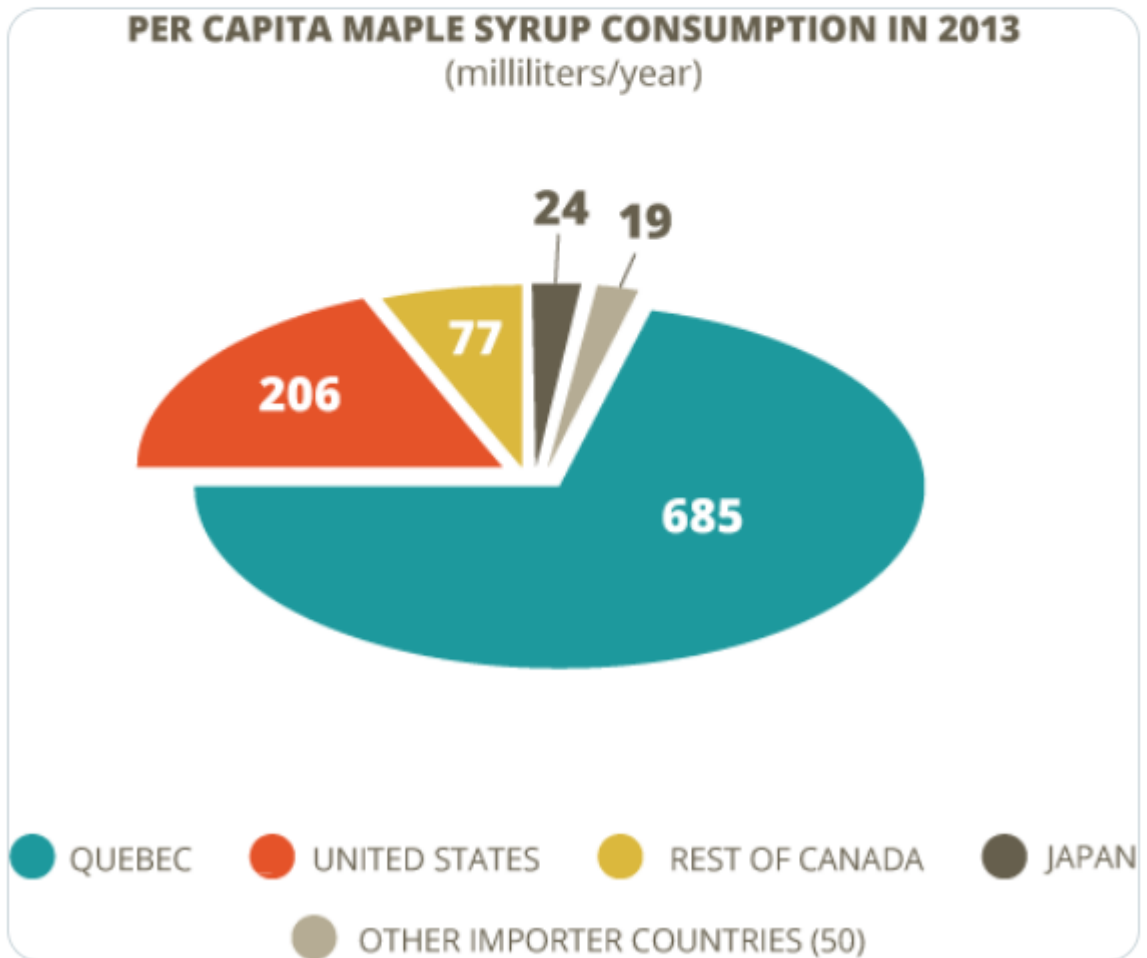


**Alex Mazur, washer-dryer combo renter**  
@mazuretsky



FPAQ, the maple syrup cartel, used to have this chart, brilliant in its horribleness, on their website. In two languages.

[web.archive.org/web/2015072603...](http://web.archive.org/web/2015072603...)





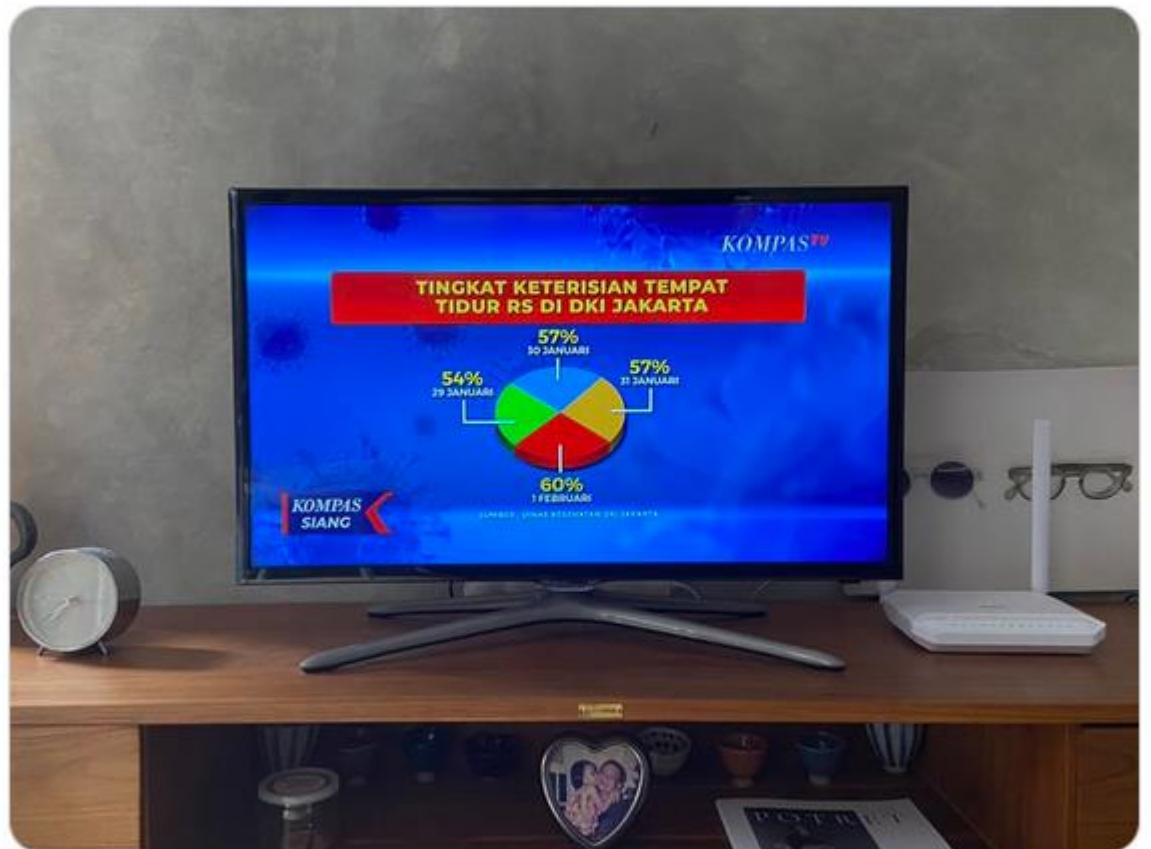
- f. While we're on the subject of pie charts, have a look at this depiction of longitudinal polling data from Indonesia.



**Belle**  
@annabellewenas



Pie chart to show single category historical data 🤔



7:47 PM · Feb 4, 2022 · Twitter for iPhone

2,947 Retweets 3,325 Quote Tweets 10.8K Likes