

Midterm (75 minutes)

No calculators allowed. Just set up your answers, for example, $P = 49/52$. BE SURE TO EXPLAIN YOUR REASONING. If you want extra time, you can buy time at a price of 1 point a minute; for example, if your test is handed in 10 minutes after the scheduled finish time, 10 points will be subtracted from the test score.

1. A month before the 2020 U.S. Presidential election, Jimmy Failla, the host of Fox Across America, wrote, *Democratic presidential nominee Joe Biden looks to be ahead in most polls but you'd never know it from driving through the Midwest and counting the campaign signs on people's houses. No, by that metric, President Trump is on pace to win in a lawn-slide. Ahem....*

I can report with full confidence that a recent family road trip took us through the battleground states of Ohio, Pennsylvania, and Michigan and in all three states the "Biden-Harris" signs were running a distant third behind "Trump-Pence" and "Sweet Corn For Sale."

I was so taken by the phenomenon that I've been discussing it non-stop with our nation's truck drivers on my radio show, "Fox Across America," to make sure I wasn't hallucinating from all the sugar I ingested at road-side pie stands.

With less than 30 days until the election, the general consensus from callers to my radio show is that Trump signs outnumber Biden signs by about 25 to 1 in all 50 states.

Give two distinct explanations for why this sign poll turned out to be so wrong.

2. The writer Arthur Koestler once argued that the law of large numbers is wrong because it requires a coin flips in a series to be related—a preponderance of heads must be balanced by a preponderance of tails at some point in order for the law of large numbers to be true—yet coin flips are, in fact, independent, which makes the law of large numbers false. Explain why you either agree or disagree with Koestler's argument.
3. Napoleon Hill's *Think and Grow Rich*, originally published in 1937, sold more than 100 million copies and is the twelfth best-selling book of all time, behind *The Da Vinci Code* and ahead of *Harry Potter and the Half Blood Prince*. *Think and Grow Rich* is actually based on Hill's previous book, *The Law of Success*, written in 1925, which reported the results of Hill's interviews with 45 millionaires in order to identify the characteristics this group shared in common. As a statistician, what problems do you see with this study?

4. Israel has a very high COVID-19 vaccination rate yet, on August 15, 2021, 58% of the Israelis hospitalized for COVID-19 were fully vaccinated—suggesting that vaccinations are ineffective or even harmful. Why is this 58% number misleading from a purely statistical standpoint? That is, the same *statistical* criticism could be made about a similar statement for any vaccination and any disease. What statistical technique would you use to solve this problem?

5. It has been estimated that as many as 50% of the people infected with COVID-19 are asymptomatic and do not know that they have been infected. If the data on the number of deaths and the number of people who test positive are accurate, but the number of asymptomatic infections is higher than previously estimated, which of the following would be higher, lower, or the same as previously estimated?

- The percentage of the population that has been infected
- The percentage of the population that has died from the disease
- The percentage of the people who were infected that died.
- The percentage of the people who tested positive that died.

6. Actuarial exams are considered the most difficult of all professional exams:

Actuaries are compensated very well. And just like any other well-paid profession, it takes a lot of work to get there. But unlike doctors or lawyers, actuaries need to, in order to become fully credentialed, pass a series of difficult tests called Actuarial Exams. These are very hard. Very very hard.

People who fail an exam can retake it, and it has been estimated that only 20% of the people who take an actuarial test pass on the first attempt. To become an actuary in the U.S. or Canada, you need to pass 7 or 10 exams depending on the subfield. Using these statistics, Cory estimated that his chances of passing 7 actuarial tests on the first try is only $0.2^7 = 0.0000128 = 1/78,125$. What is wrong with this calculation?

7. A study of the hot hands phenomenon included pairs of basketball free throws shot by two players, A and B. Player A took 338 pairs of free throws. When he made the first shot, he made the second shot 88.1% of the time; when he missed the first shot, he made the second shot 90.6% of the time. Player B was also more likely to make the second shot after missing the first shot: 61.2% versus 59.3%. Yet, when the data were combined, the players made 81.1% of their second shots after making the first shot and only 72.9% of the second shots after missing the first shot!

- How would you explain this reversal?
- Which player do you think took more shots?

8. You are playing a card game in which you are dealt 4 cards from a standard 52-card deck in which every card is different.
 - a. How many possibilities are there for the hand you will be dealt?

 - b. If you play 4 games, what is the probability that you will be dealt the same hand at least once?

9. Suppose that 20% of the people who are given breathalyzer tests for intoxication are legally intoxicated and 80% are not, and that the test gives a positive reading 85% of the time when a person is intoxicated and gives a negative reading 80% of the time when a person is not intoxicated. If the test comes back positive, what is the probability that the person who was tested is, in fact, not intoxicated?

10. What is visually misleading about this figure comparing the prediction errors for five models using either a lag of 1 month (red bars) or lags of both 1 and 2 months (green bars) to make the predictions? You do not need to know what is being predicted or what “lags” are in order to answer this question.

