

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 your test score.

1. In 2005, Granite Construction applied for a permit to build a quarry near Temecula, California. Rocks would be dislodged from a mountain by daily blasts of 10,000 pounds of explosives and then crushed into gravel and sand that are used for concrete, asphalt, and other construction materials. Mining and processing would go on 20 hours a day, 6 days a week, with 1,600 trucks entering and leaving the site daily.

The proposed quarry was in a mountain gap where ocean breezes carry cool air to the Temecula Valley. Residents were alarmed about the effect of this quarry on the city's economy and property values. However, an economist hired by Granite to prepare an economic analysis argued that in the city of Corona, which is 40 miles away and had mines for many years, there had been a "direct positive correlation" between annual mine production and property values over the past twenty years. Temecula residents evidently should be celebrating that their city was chosen for this quarry—which would have a positive effect on property values.

Provide a clear, persuasive refutation of this statistical argument.

2. Professor Smith wrote a random number program to select 20 of the 21 students for ten 2-person teams; the student who is not selected does not have to do the assignment. If you are one of the students, say, Mary McBeth, what is the probability that you will not be selected?
3. If Cory has a 0.5 probability of picking a stock that will do better than the average stock ("beat the market") and each outcome is independent, what is the probability that, out of 10 picks, at least 8 will beat the market?
4. Cameron is taking a class where the final grade is an equal average of the homework and test scores
$$G = 0.5H + 0.5T$$
where H and T are both graded on a scale of 0 to 100. Near the end of the semester, Cameron's G was 92. Then Cameron got a 90 on a test and the teacher raised Cameron's G to 93.5. Is this possible or did his teacher make a mistake? Explain your reasoning.

5. The Powerball lottery has two drums, one with 69 white balls (numbered 1 through 69) and one with 26 red balls (numbered 1 to 26). A player pays \$2 for a ticket and picks 5 white numbers and 1 red number. The player wins the jackpot if the 5 white numbers match the 5 numbers drawn from the white-ball drum (not necessarily in order) and, in addition, the player's red number matches the 1 number drawn from the red-ball drum.

In the August 23, 2017, Powerball drawing, the stated jackpot was \$700 million, with the winner having the choice of taking: (a) an immediate prize of \$443 million; or (b) 30 annual payments, starting at \$10,536 immediately and increasing by 5% each year. With either option, there is a 25% federal tax on the payout.

- a. What is the probability of winning the jackpot?
- b. What is the expected value of buying a ticket, assuming there is, at most, one winner, and that the player chooses the \$443 million prize. (Just set up the equation and ignore the additional smaller prizes.)
6. You are on a jury and, after hearing all the testimony, you believe that there is 60% chance the accused person is guilty. In the jury room, you listen to the arguments of another jury member who is so impressive that you believe that there is a 90% probability that this juror will reach the correct conclusion. If the defendant really is guilty, there is 90% probability this juror will conclude the defendant is guilty, and if the defendant is innocent, there is 90% probability this juror will conclude the defendant is innocent. What is your revised probability that the defendant is guilty if this juror concludes that the defendant is guilty?
7. Yahtzee is a game played with five 6-sided dice. In each turn, the player rolls the five dice and can choose to set aside some of the dice and roll the remaining dice. After the second roll, the player can choose to set aside more dice and roll the remaining dice a final time. Dice that have been set aside cannot be rolled again. At the end of a recent game, Smith needed to roll five numbers that were the same in order to score a 50-point Yahtzee (for example, five 6s.). On his first roll, he got 6, 6, 6, 3, 2. He kept the three 6s and rolled the other two dice. If they are both 6s, he stops; if one is a 6, he keeps it and rolls the last die; if neither is a 6, he rolls both dice one more time. What is the probability that he will get his five 6s, for a 50-point Yahtzee?

8. Suppose that Stock A's return over the next 12 months is normally distributed with a mean of 10 and a standard deviation of 10, while Stock B's return is normally distributed with a mean 20 and a standard deviation of 20. Which stock has a higher probability of having a negative return?

9. In 2014, President Obama said,

Folks can make a lot more potentially with skilled manufacturing or the trades than they might with an art history degree. . . . Now, nothing wrong with an art history degree—I love art history. So I don't want to get a bunch of emails from everybody. I'm just saying, you can make a really good living and have a great career without getting a four-year college education as long as you get the skills and training that you need.

An incensed columnist replied,

What he should have apologized for, however, was not his glibness but his wrongness. Based on data from his own administration, a college education is a much better way to prosperity than on-the-job training.

To show this, the columnist pointed out that the unemployment rate is 13.9% for high school dropouts, 9.1% for high school graduates with no college degree, and 3.9% for those with a four-year college degree.

As a statistician, how would you respond to this evidence?

10. In March 2015, a professor of Psychology and Music reported that musicians in traditional musical genres (like blues, jazz, country) live much longer than do musicians in relatively new genres (like metal, rap, hip hop). The professor concluded that performing new genres was more dangerous than going to war: “People who go into rap music or hip hop or punk, they’re in a much more occupational hazard profession compared to war. We don’t lose half our army in a battle.” Suggest a statistical explanation for why these data are misleading.

