MATH 1000 IN-CLASS ACTIVITY 8

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Name:

These discussion topics were inspired by Chapter 7 of *How Not to Be Wrong* by Jordan Ellenberg, titled "Dead Fish Don't Read Minds".

Suppose there is a rumor that, due to the fact that the molded designs on the two sides of a US quarter are different, a quarter is actually more likely to land heads than tails when flipped. This may seem silly to you, but imagine that this is an idea that makes sense to people and has gained some traction in the popular culture, despite not yet being scientifically investigated.

(1) If you flip a perfectly fair coin 5 times, what is the probability that you get 5 heads? What is the probability that you get at least 4 heads? How does this relate to significance testing if a researcher flips 5 coins to try to confirm this rumor?

(2) Suppose that a researcher, in an effort to address the rumor, flips a quarter 5 times, and gets 3 heads. Then he tries it again, and gets 1 head. Then he repeats the process again and again, until finally, on his 47th sequence of 5 flips, he gets 5 heads. He then reports his results, but ONLY for that final sequence of 5 flips, in an effort to declare a statistically significant result that U.S. quarters are unfair and skew toward landing heads.

Do you think this researcher's methodology is sound? If not, do you think he is being intentionally deceptive, or is it reasonable that he could be unaware of the problems?

(3) Consider the following alternative scenario. In addition to the previously discussed rumor, there is a more detailed hypothesis that the unfair effect is only present in quarters minted during certain years, while it is absent in quarters made other years. To test this hypothesis, a researcher performs five coin flips apiece with a quarter minted each year between 1960 and 2017. She finds that the five flips of the 1973 quarter were all heads, and reports a statistically significant result indicating that 1973 quarters are unfair and skew toward heads. She makes no mention in her findings of the fact that she tested other years as well.

Assuming all the coins were actually fair, what was the probability that at least one of the years would result in five heads? How would you compare the methodology issues in this reporting of results with the previous example?

(4) Finally, consider the following scenario. Because the rumor about unfair quarters has gained some steam, 100 separate researchers, completely unaware of each other, decide to flip five quarters to test the hypothesis. Of the 100 researchers, 4 of them get five heads, and report their statistically significant results that indicate U.S. quarters are unfair and skew toward heads. The other 96 get insignificant results, and, as is the M.O. of scientific research, report nothing. Newspapers and websites around the globe soon report that not one, but FOUR SEPARATE studies indicate that U.S. quarters are unfair.

Assuming all the coins were actually fair, what was the probability that at least one of the 100 researchers would get five heads? Were there any flaws with the methodologies of the INDIVIDUAL researchers? If not, does that mean we should accept the findings as meaningful?

(5) Which of these three scenarios is the most like the dead salmon and the photographs? Which of these three scenarios is the most difficult to see through as an outsider?