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**Fair & Unfair Die Experiment**  
 **Possible Protocol 1 (PP1): roll once; if get 6 then conclude the dice is not fair; if roll any other number then conclude it is fair. Analyze PP1:**

**if the dice were fair, what is the probability it would be judged to be unfair? Oppositely, if the dice were unfair, what is the probability that it would be judged to be fair?**

-There is a ⅙ chance that the dice would be considered unfair and a ⅚ chance that a dice would be considered fair. This is the case as it is stated that only rolling a 6 would label the dice as unfair whereas the other 5 options would label it fair. There is a higher chance that the dice would be considered fair.

**PP2: roll the dice 20 times. (Each person should have done this beforehand.) Group can specify a decision rule to judge that dice is fair or unfair. Consider the stats question:**

**If fair dice are rolled 20 times, what is the likely number of 6 resulting? How unusual is it, to get 1 more or less than that? How unusual is it, to get 2 more or less? 3? Analyze PP2 including the question: if the dice were fair, what is the chance it could be judged as unfair?**

-If we were to roll the dice 20 times, the number 6 would approximately be rolled 3-4 times. (As the number calculated is 3.33) So based on this, we can come up with the rule as follows: If the number 6 is rolled more than 3 times out of the 20 attempts, it is unfair and if it is rolled less than that, it is fair.

Results of 6:  
Alicia: 4/20

Flamur: 6/20

Marvin: 3/20

Abdullah: 4/20

Binomial Probability formula :

The chances of rolling a 6 exactly five times out of 20 attempts.

P(X=k)=(k over n ​)⋅pk⋅(1−p)^n−k

(20

5) X (1/6)^5 x (5/6)^ 20-5 = 9.3%

The chances of rolling a 6 exactly four times out of 20 attempts.

(20

4) X (1/6)^4 X (5/6)^20-4 = 21.5%

The chances of rolling a 6 exactly two times out of 20 attempts.

(20

2) x (1/6)^2 x (5/6)^20-2 = 22.3%

The chances of rolling a 6 one time out of 20 attempts

(20

1) x (1/6)^1 x (5/6)^20-1 = 2.6%

The results conclude that rolling a 6 once or more than five times has a much lower chance than rolling a 6 two to four times. Which makes sense as the average of rolling a 6 out of 20 times is 3.33.

**PP3: roll 100 times and specify decision rules. Some cases are easy: if every single roll comes to 6 then might quickly conclude. But what about the edge cases? Is it fair to say that every conclusion has some level of confidence attached? Where do you set boundaries for decisions? Analyze PP3. What is the chance that fair dice could be judged to be unfair?**

-When you roll a die 100 times, you typically observe the frequency of each outcome (1 through 6) and then apply decision rules to determine if the die is fair. For a fair die, each face should appear approximately equally often. The edge cases depends on how fucked up the die is, the level of confidence depends on the state of the die. Since we know a die has the probability of 1/6, the probability of getting 6 in 100 rolls is 100\*1/6 so it should be about (17) 6’s that is expected. The dice can undoubtedly be considered unfair if (100) 6s are rolled. We would be able to determine if the dice are fair if they were rolled and the result was closer to the initial probability of 16.7%, which is explained by the law of large numbers.