Assessed Worksheet 3

Your Name Here

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# Assessed Worksheet 3

## Element 010-3

## Maths for Biosciences MOD005667

### The Problem: Manufacturing Biased Coins

You work for a company that manufacturers biased coins to sell to as novelty gifts. The coins are weighted to favour either heads or tails when flipped. Your task is to determine how many coin flips it takes to reliably determine if a coin is fair or biased. You want to create coins with 50%, 55%, 60%, and 65% chance of getting heads. Note, the 50% coin is a fair coin.

#### Part 1: Building the coin flip simulator (10 marks)

Begin by writing an R function that simulates coin flips. The function should take as input the number of coin flips you want to simulate, and the probability of getting heads. It should return a 2 X 2 matrix containing the number of heads and the number of tails recorded. You can use chatGPT to help you write your function.

#### Part 2: Experimental design (30 marks)

Design a series of experiments using your function that will allow you to determine the relationship between number of coin flips, and whether you can detect if each of your coins are biased. Each individual experiment will consist of a single call to the coin flip simulator you wrote in Part 1 combined with your statistical evaluation of the results of that simulation. The appropriate statistical test to determine if a series of coin flips are fair is the Chi-Squared test.

Think about what you will need to vary in each case to determine this relationship. Also, think about how many times you will need to repeat an experiment to understand how consistent the results are when you repeat the same experiment multiple times. I suggest you begin by experimenting with your coin flip simulator to get a feel for how it behaves while you design your series of experiments.

**Describe your experimental approach as clearly and succinctly as possible (no more than 100 words).** You will be marked on the clarity of your explanation.

#### Part 3: Data collection (25 marks)

Perform the experiments you have described in part 2 using R. Your R code should perform your experiments and store the results in a data frame. For each experiment you should store in your data frame the experimental parameters (number of flips, probability of heads), and the results of the Chi-squared for the simulation (Chi-squared statistic, p value). Note that if you have written your coin flip simulator correctly, the output of the simulator will be in the correct matrix form to feed directly into the chisq.test() function in R.

**Print your data frame to your final document. If your data frame contains more than 50 rows, print the first 50 rows.**

#### Part 4: Results (25 marks)

Display the results of your experiments from Part 3. Are your data best displayed as a table, or a graph, or both? Decide how you want to display your results and produce your display using R. There are many possible ways to display your data. A high marking results display will favour clarity and simplicity.

#### **Part 5: Discussion (10 marks)**

What is the relationship between the amount of bias in the coin, and the number of flips required to detect that the coin is biased? Why do you think this might be? **Give your answer in 50 words or less.**