CS24420 Scientific Python --- Semester 2 --- Practical Worksheet 4

Probability Distributions and Confidence Intervals

The tasks this week are about probability distributions and calculating confidence intervals.

1. Write a Python program to calculate the confidence interval of a sample

a) Generate a population of 10,000 random numbers from a normal distribution with a mean of 0 and a standard deviation of 1, and calculate the population mean
*[Hint: for `stats.norm.rvs`, **`loc`** is the mean and **`scale`** is the standard deviation]*

b) Sample 100 individuals randomly from the population and calculate the sample mean and standard deviation

c) Calculate an estimate of the standard error of the mean by dividing the sample standard deviation by the square root of the sample size

d) Calculate the confidence interval for a confidence level of 95%
[Hint: `stats.t.interval`]

e) Test whether the population mean is captured by the confidence interval

f) Repeat steps **b** to **e**, 100 times, counting the number of times that the interval captures the population mean. How does your result relate to the confidence level you asked for?

2. Write a Python program to simulate throwing some six-sided dice and calculate the odds of getting different numbers of sixes

a) Write a function that simulates throwing 6 six-sided dice and returns the **number of sixes** thrown.
[Hint: you could generate 6 random integers from 1 to 6 using `random.randint` and count how many equal 6; or you could use `stats.randint.rvs` to generate an array of 6 at a time; or some other method]

b) Estimate the chances of rolling **3 or more sixes** by using your function to "throw" the six dice 1,000 times and counting how many times the result is 3 or more. Express your result as a percentage, and also as a probability value (range 0-1)

c) Using the appropriate `stats.binom` function, calculate directly what the probability *should* be, under ideal conditions. Howe does this compare to your experimental result?
[Hint1: With a coin, the success probability was 0.5, but to roll a 6 on a six-sided die the success probability would be...?]
*[Hint2: (probability of **3 or more** sixes) must logically be 1 - (probability of **2 or fewer** sixes), which you **do** know how to calculate...]*

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