Assignment I.

problems for probability concepts

due: October 16, 2019

code in Python, Matlab, Mathematica, or C/C++

problem 1 PHYS 139/239

You have three coins and you toss all three. When all three landed you count the number of heads and tails.

The first coin is biased with 40 percent probability of heads.
The second coin is biased with 70 percent probability of heads.
The third coin is biased with 65 percent probability of tails.

(a) a.1 What is the probability that all three landed on heads?
a.2 What is the probability that all three landed on tails?
a.3 What is the probability that two are heads and one is tail?
a.4 What is the probability that two are tails and one is head?

(b) Write code for computer simulation which demonstrates the the correctness of your answers

(c) How are the counts deviate less and less from the theoretical expectations as you increase the number of simulated events? Show that you can reach 0.1 percent accuracy in your answers.

(d) Try to give a formula for the estimated deviations.

problem 2 PHYS 139/239

You are an oracle and when asked yes or no questions you do not know the true answer but with probability P = 1/4 you say "Yes" and with probability 1-P = 3/4 you say "No".

Give your theoretically sound procedure for the following problems:

(a)How do you come up with the answer if you only have a fair, two-sided coin which you can toss several times before you give the answer?

(b)Same problem with P = 1/3.

(c)Same problem with P = $1/\pi$ PHYS 239 only

(d)Write computer code for the oracle so that she can replace the coin tossing with the computer for (a) and (b)

(e) computer code for (c). PHYS 239 only

problem 3 PHYS 139/239

(a) Simulate draws from two 7-sided dice whose faces show 1:2:3:5:7:8:9 and the sides are equally probable. What is the probability that the sum of the two dice equals 8?

(b) Simulate draws from two weird 7-sided dice whose faces have probabilities proportional to 1:e:π:4:5:6:e$^{\pi}$ respectively. What is the probability that the sum of the two dice equals 8? PHYS 239 only

problem 4 PHYS 139/239

Example: The Monty Hall or
Let's Make a Deal Problem

- Three doors
- Car (prize) behind one door
- You pick a door, but don't open it yet
- Monty then opens one of the other doors, <u>always revealing no car</u> (he knows where it is)
- You now get to switch doors if you want
- Should you?
- Most people reason: Two remaining doors were equiprobable before, and nothing has changed. So doesn't matter whether you switch or not.

(a) Write computer code which demonstrates the difference between the two strategies to 0.1 percent accuracy

(b) PHYS 239 only: generalize the problem to 5 doors where Monty opens 2 doors.

problem 5 PHYS 139/239

Simulate the Knight/Troll/Gnome bridge crossing problem repeatedly in your computer code.

The code counts the number of safe crossings of the Knight when only gnomes are under the bridge after one of the five creatures is captured. Show that the fraction of counts for safe crossings agrees with the theoretically expected number.

problem 6 PHYS 139/239

Prove on your own that the 3 Kolmogorov axioms are not compatible with assigning non-zero probability to null-event