1 Introduction

Solve each of the following problems. Return your solutions in a single PDF document. DO NOT ZIP IT. WORD DOCUMENTS ARE NOT ACCEPTED. Make sure the final numerical answers are well highlited in bold. Provide all steps required to justify your answer. Numerical answes without proper justification do not count. This is an individual assignment. Your submissions will be checked for plagiarism using TurnitIn.

1.1 Problem 1 (4 points)

Download the file

`http://mdp.cdm.depaul.edu/csc521/static/problem1.csv`

Write a Python program to compute the mean, variance, and standard deviation of each column and the covariance and correlation of each two columnes.

Make plots of the distribution of each column. What do the distributions look like?

Write the formulas for the mean, variance, covarance, and corrlation in terms of expectation values.

Compute the following expectation values (numerically, not from modelling the data):

- $E[1]$
- $E[X]$
- $E[X^3]$
- $E[Z-(X+Y)/2]$

1.2 Problem 2 (4 points)

Consider a continuous random variable in the range [2,3] with probability mass function propoertional to $\exp(x/2)$. Compute (by performing the integrals) the expectation values of:

- $E[1]$
- $E[X]$

- $E[X^2]$
- $E[X^3]$

Show your steps. This may help: `https://www.youtube.com/watch?v=OuD8LipiTAg`

1.3 Problem 3 (4 points)

Consder a continuous random variable in the range [1,5] with probability mass function proportional to $1/x$. What is the cumulative distribution function?

Use the inverson method to write a functon that maps a uniform (random.random()) into a random X following the above dstribution.

Write a program to compute the following from a simulation:

- $E[1]$
- $E[X]$
- $E[X^2]$
- $E[X^3]$

Compare your results with expected theoretical values for 10 random numbers, 100 random numbers and 1000 random numbers.

1.4 Problem 4 (4 points)

Assume you receve phone calls with an average of 10 per hour. What is the probablity of receving two phone calls less than 1 minute apart wthin any one day? Write a program that computes the answer. Explain your reasoning and your program.

1.5 Problem 5 (4 points)

Your office bulding has a single corridor with an infinite number of rooms. The first woom is 1m from the entrance. The second room is 2m from the entrance. The 3rd room 3m, etc. When a person enters the building he/she has a 50% probability of entering the first room, 25% of entering the second room, etc. The probability of enterng room k if 1/2 of the probability of entering room $k-1$.

If 100 people enter the building every day, what is the average number of people who enter the first room?

For a generic person, what is the average room number (does not have to be an integer)?

You install a detector between the 3rd and 4th room which counts how many people enter rooms with number greater or equal to 4. In one day that detector measures 40 people. Estimate how many people entered the office building (assume that people enter the door but they never exit or exit from a back door undetected).

Provide exact answers to the questions above but also write a program to answer/confirm numerically.