Graduate Course – Term 1, Sept-Dec 2018
30.502: Research Methods

SUTD

SINGAPORE UNIVERSITY OF
TECHNOLOGY AND DESIGN

Established in collaboration with MIT

Problem Set 1

Due: Wed 10thth Oct, 17:00
Delivery method: E-dimension
Format: Portable Document Format (PDF)
Python problems: For all the python based questions in this problem set, please copy and past the code that you used for each function/operation and the result of the calculation.

Problem 1

i. Write a function to calculate the expectation value for the occurrence of doubles (i.e. two dice have the same value) when two dice are then thrown n times.

ii. Write a function to predict the variance in the value a double when two dice are thrown n times.

iii. Use your functions to predict mean and variance in the number of doubles after 50 throws

iv. Plot a bar chart/histogram that shows how the occurrence of a double changes with n throws.

Problem 2

The mean number of patients arriving at the emergency room of Changi Hospital on Saturday nights between 10:00 and 12:00 is 6.5. Assuming that the patients arrive randomly and independently, write a python program to compute the probability that on a given Saturday night, two or fewer patients arrive at the emergency room between 11:00 and 12:00. Define your own python function for the most suitable probability distribution function. You may use the numpy library functions for exponentials, trigonometric functions, factorial, and physical constants.

Problem 3

Between 8 am and 9 am the elevators and staircases in the SUTD lobby are very busy. Typically 75% of people use the staircases whilst 25% of the people use the lifts. Last Wednesday morning I counted 283 people using the elevators and 752 people using the staircases.

i. Write a function to predict the uncertainty for a binomial distribution.

ii. Use your function to model the standard deviation in the distribution of lift and stairs users.

iii. Use your function to calculate the standard deviation in the distribution of lift and stairs users enchanted last Wednesday.

iv. Noting that the sample size is very large and that the normal distribution is applicable, find the probability of obtaining a result that is as far, or farther from the mean than the result encountered last Wednesday.

Problem 4

It is known that if the mean of a Poisson distribution is a large enough, the distribution is well approximated by a normal distribution, but how large does the mean need to be? Write a program that calculates and plots the R^2 between the a Poisson and Normal distribution as a function of the distribution mean.