SINGAPORE UNIVERSITY OF
TECHNOLOGY AND DESIGN

Established in collaboration with MIT

Practice Questions

This PSET is optional. You do not need to submit. However, if you do submit it, I will mark it. I will then use your 5 (out of 6) best scores to compute your pset mark for the course. If you want this to be marked, **please submit by 16th Dec** so that I can give you a mark for the course.

Problem 1

For cities with populations greater than 100,000 inhabitants, the number of violent crimes per 1,000 residents is normally distributed with a mean equal to 30 and standard deviation equal to 7. If a sampling distribution is created with a sample size of four, then describe the sampling distribution (i.e. shape, mean, and standard deviation).

Problem 2

A tyre manufacturer claims that the mean mileage for their premium brand tyre is 60,000 miles. A consumer organisation doubts the claim and decides to test it.

 i What is the purpose of the research from the perspective of the consumer organization?

 ii State the null hypothesis

 iii State the alternative hypothesis.

 iv Should the consumer organisation perform a one or two tailed test?

 v Suppose it is known that the standard deviation of tyre mileage for this type of tyre is 7,000 miles. If a sample of 49 tyres are road tested for mileage and the manufacturer's claim is correct, then what is the standard error?

 vi Suppose the critical value is chosen to be two standard errors below the manufacturer's claimed mean mileage. What is the critical mean mileage of the sample below which the manufacturer's claim will be rejected?

 vii What is a probability of a Type 1 or Type 2 error occurring? Which type of error would be most serious for the tyre manufacturer?

Problem 3

Use a flow diagram to show how you would witre a Monte Carlo simulation to calculate the volumetric error of a cube with sides: $a = x \pm \Delta x$, $b = y \pm \Delta y$ cm, and $c = z \pm \Delta z$ cm. (Remember to specify the distribution that you are using to generate the pseudo-random noise and the equation that you are modelling)

Problem 4

A state environmental study concerning the number of scrap-tyres accumulated per tyre dealership during the past year was conducted. The null hypothesis is H_0: $\mu = 2500$ and the alternative hypothesis is $H_a : \mu \neq 2500$. For a random sample of 85 dealerships, the mean is 2750 and the standard deviation is 950. Conduct the hypothesis test at the 5% level of significance.

Problem 5

The mean number of patients arriving at the emergency room of University Hospital on Saturday nights between 10:00 and 12:00 is 6.5.

i Which probability distribution will you used to calculate the probability of a patient arriving

ii What is the probability that on a given Saturday night, 5 or fewer patients arrive at the emergency room between 10:00 and 12:00?

iii What assumptions were necessary to apply the chosen probability distribution to patient arrivals

iv Draw a flow diagram to show how you might design an Igor Pro program to calculate the probability of a patient arriving in some specified period of time

Problem 6

Snell's law relates the angles of frefaaciton θ_2 of a light ray in a medium of refractive index n_2 to the angle of incidence θ_1 of a ray travelling in a medium of index n_1 through the equation $n_2 sin\theta_2 = n_1 sin\theta_1$. Find n_2 and its uncertainty from the following measurements:

$\theta_1 = 22.02 \pm 0.02°$
$\theta_2 = 14.45 \pm 0.02°$
$n_1 = 1.0000$