

# Project 1

Τρίτη, 12 Οκτωβρίου 2021 1:27 μμ



Project1...

## DEPARTMENT OF MATHEMATICS & STATISTICS UNIVERSITY OF CYPRUS

DSC 530  
FALL SEMESTER 2021  
PROJECT 1

1. This project represents 25 % of your total grade in the course and focuses on learning some basic elements of R and how it can be used for data analysis. In addition, some theoretical problems will illustrate your basic understanding in probability theory.
2. You can work in groups of 3, at most. Ideally, each student in the group should be coming from a different background (i.e. one student from Business Administration, one student from Computer Science and one student from Math & Stat).
3. Your work will consist of 6 pages and will contain all the names as well as ID numbers of the participants in the group. You are responsible for presenting the relevant programs and their results.
4. You can use any word processor you want but you will send the final work in `latex` pdf format by e-mail to `fokianos@ucy.ac.cy`
5. **DEADLINE: 27/10/2021 UNTIL 20.00. NO ASSIGNMENTS ARE ACCEPTED AFTER THIS DEADLINE.**

1. (5 points) A school contains students in grades 1, 2, 3, 4, 5, and 6. Grades 2, 3, 4, 5, and 6 all contain the same number of students, but there are twice this number of students in grade 1. If a student is selected at random from a list of all the students in the school, what is the probability that she will be in grade 3? Cross-check your answer by simple simulation.
2. (5 points) Study the properties (both theoretically and computationally) of the  $t$  and  $\chi^2$  distributions. Make a report of your findings and compare the theoretical results with results obtained by R.
3. (5 points) Three different machines 1, 2, and 3 were used for producing a large batch of similar manufactured items. Suppose that 20 % of the items were produced by machine 1, 30% percent by machine 2, and 50% by machine 3. Suppose further that 1% of the items produced by 1 are defective, that 2% percent of the items produced by machine 2 are defective, and that 3% of the items produced by 3 are defective. Finally, suppose that one item is selected at random from the entire batch and it is found to be defective Determine the probability that this item was produced by machine 2 (do this theoretically and by writing a simple code).

4. (5 points) A civil engineer is studying a left-turn lane that is long enough to hold seven cars. Let  $X$  be the number of cars in the lane at the end of a randomly chosen red light. The engineer believes that the probability that  $X = x$  is proportional to  $(x + 1)(8 - x)$  for  $x = 0, \dots, 7$  (the possible values of  $X$ ).
- (a) Find the p.m.f. of  $X$  and give a plot in R.
  - (b) Find the probability that  $X$  will be at least 5, by simulation and compare it with the exact answer.
5. (5 points) Suppose that  $X$  has the uniform distribution on the interval  $[0, 5]$  and that the random variable  $Y$  is defined by

$$Y = \begin{cases} 0, & \text{if } X \leq 1, \\ 5, & \text{if } X \geq 3, \\ X, & \text{otherwise.} \end{cases}$$

Calculate and make a plot of the c.d.f. of  $Y$ .

