Written test in (subject): ET2596 Simulation

Date: 2021.10.28

Name: _____

Civic number: _____

Number of sheets handed in:_____

Mark the question(s) you have answered by putting a ring around the relevant number(s)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Instructions
A student who cannot produce valid ID will not be permitted to take the examination.
No examination scripts will be accepted by the proctor during the first hour of the examination. (Students arriving late will thus be permitted to take part in the examination).
Write your name and civic number on each sheet of paper you hand in.
Examination results are posted by e-mail no later than 10 working days after the date of the examination. Exceptions to this rule can occur. In this case, students will be informed by the teacher responsible for the course/program or by the examiner.
All blank answer sheets are to be handed in to the proctor.

(To be filled in by the proctor)
ID presented: _____
Proctor's sign.
Student union fee paid: _____
Proctor's sign.
Student union fee not paid: _____
Proctor's sign.

(To be filled in by the teacher)
Number of credits gained:_____ Grade:_____ ECTS:_____Examiner´s sign:_____

(To be filled in and signed by the student, after the correction of the examination)
I hereby sign my examination script. I am aware that by signing for my script, after correction, I waive my right to contest the examiner's comments and the credits or grade awarded.

Date_____ Signature:_____

Re-Exam In

Simulation
(2021.10.28) ET2596

Wednesday: 9:00 to 14:00

Lecturer: Siamak Khatibi

Allowed items on exam: Open book

The exam includes 5 problems (100 credit points); where for grade in ECTS you should obtain as following:

F (0-32), FX (33-49),
E (50-57), D (58-64),
C (65-74), B (75-82),
A (83-100)

Each question can be answered by a mfile using Matlab (i.e. Q1sol_XXXX.m, Q2sol_XXXX.m, …) where XXXX is your personal ID number. In the header of each mfile you should write your name. In each mfile beside your code for solution of the respective problem you should write your comments/arguments (which is more important than the coding by itself). You can write/draw on the paper as complementary material to your respective mfile (please mention it in your respective mfile that you have such complementary). You can also digitize your written work in any way it is possible for you (e.g., photo, scan…) or simply leave it to the invigilator of exam.

You should zip all your digital materials (e.g., your mfiles related to each question, other used functions which are not standard Matlab functions, mat file, your scanned material, or photos …) and upload it to the Canvas under module "exam", in "Upload your answer to Exam 2021-10-28".

As far as the exam is open you can use any material you find anywhere (even the internet), however you should mention the used martial by its reference. As may you know from other exams it is not difficult to find the copied codes between students, Thus. please avoid it because with detection of any copied material it does not become possible to grade your exam.

Good Luck

Q1

For a simulation, we need to generate random variate numbers (RVN). The probability density function f is known as

$$\boldsymbol{f} = \frac{\gamma}{\beta} \ (x)^{\gamma-1} \ e^{\frac{-x^{\gamma}}{\beta}} \qquad ,0 \le x \le \infty, \ \gamma > 0, \ \beta > 0$$

a)- Generate 2000 random variate number and show the histogram of the numbers when $\beta = 2$ and $\gamma = 1.5$. (14p)

b)- Verify that your generated RVN in a) has a probability density function as $\boldsymbol{f}$. (3p)

c)- Calculate the autocorrelation of your generated RVN in a) for lags 1-10. What are your results indicating to, comment/argue about it? (3p)

Q2

By Monte Carlo simulation use

$$\partial = \int_0^{\infty} \frac{\gamma}{\beta} \ (x)^{\gamma-1} \ e^{\frac{-x^{\gamma}}{\beta}} dx \qquad ,0 \le x \le \infty, \ \gamma > 0, \ \beta > 0$$

to answer the following questions.

a)- Estimate ∂ when $\beta = 2$ and $\gamma = 1.5$. (7p)

b)- If the term under integral is a probability density function, then estimate

$$P(0.45 < X \le 2.25) \qquad \text{when } \beta = 2 \text{ and } \gamma = 1.5. \qquad (5p)$$

c)- Repeat the estimation in b) 100 times and calculate mean and variance of estimation. (3p)

d)- Use antithetic variates method and repeat the simulation in a). Compare the two simulation results in relation to variance, Argu/comment your result. (5p)

Q3

In this problem you can use the file "Qx.m" (please find it in the exam material) which runs a simulation of a M/M/1 system.

a)- According to Batch-Means method simulate M/M/1 system when the length of batches is 100, number of batches is 40, $\rho = 75\%$ (utilization), and $\mu = 10$ (service rate). You do not need to consider the warming up. Calculate the relative confidence interval of each of batches for sojourn time of customers. (4p)

b)- Repeat a) but this time the length of batches is 500 and number of batches is 40. Calculate the relative confidence interval of each of batches. Compare your result with the result from a), argue/comment. (3p)

c)- Compare your result from a) and b), argue/comment. (3p)

d)- Compare 4000 seconds of data related to sojourn time of customers between a) and b), Argue/comment your comparison result in relation to their statistical pattern, are they behaving as you expected? (3p)

e)- Modify the file "Qx.m" and call the new file as "Qxm.m" where the modification does not change the input and output of the function. By modification we can simulate a M/D/1 system. For the deterministic service time you should use the following function

$$\boldsymbol{serivce\ time} = \frac{2}{\mu} cos^2(\omega t)$$

where $\omega = 2\pi f$ and $\mu = \frac{1}{mean\ of\ service\ time}$. Assume $f = 0.001$. (7p)

Q4

In this problem you can use the file "Qxm.m" (you generated in Q3-e) which is simulation of a M/D/1 system.

a)- According to Batch-Means method simulate M/D/1 system when the length of batches is 100, number of batches is 40, $\rho = 75\%$ (utilization), and $\mu = 10$ (service rate). You do not need to consider the warming up. Calculate the relative confidence interval of each of batches for sojourn time of customers. (7p)

b) Repeat a) but this time when the length of batches is 500 and number of batches is 40. Calculate the relative confidence interval of each of batches. Compare your result with the result from a), argue/comment. (3p)

c) Compare your result from a) and b), argue/comment. (3p)

d) Compare your result from Q3c) and c), argue/comment. (4p)

e) Compare 4000 seconds of data related to sojourn time of customers between a) and b), Argue/comment your comparison result in relation to their statistical pattern, are they behaving as you expected? (3p)

Q5

In this problem we intend to simulate a situation related to the result analysis of a simulation outcome. Here you can use the file "q5sim.m" which in its turn is using the file "generateSim.p" (you can find these two files in the exam material). Using "q5sim.m", first the outcome of a simulation is generated then using regression method the residual of outcome values to the estimated mean values are calculated; with certain confidence interval, and plotted.

a)- Implement "q5sim.m" for confidence level of 95%, plot the results. (2P)

b)- Repeat as a) for 500 times and calculate the relative occurrence frequency of outliers (each outlier is shown as a red line in “Residual Case Order Plot”. Please use figFlag=0 when you use “q5sim” function. (8p)

c)- Repeat as a) for 500 times for confidence level of 90% and calculate the relative occurrence frequency of outliers (each outlier is shown as a red line in “Residual Case Order Plot”. Please use figFlag=0 when you use “q5sim” function. (5p)

d)- Argue about your results from b) and c); do you think the results are according to your expectation? If not, what is the reason? (5p)