

QUALITY DATA ANALYSIS

Exam Simulation

15/06/2020

General recommendations:

- write the solutions on paper and show (qualitatively) all the relevant plots;
- avoid (if not required) theoretical introductions or explanations covered during the course;
- always state the assumptions, formulas/expressions and the final results (when using hypothesis tests provide the numerical value of the test statistic and the test conclusion in terms of p-value).

Exercise 1 (max score 10)

Two variables are monitored to keep under control a chip manufacturing process. The two variables are called X and Y. The values observed during 30 consecutive inspections are shown in the table below:

Inspection	X	Y	Inspection	X	Y	Inspection	X	Y
1	0,267	15,056	11	3,869	14,145	21	0,801	16,364
2	0,257	16,348	12	3,255	15,903	22	3,180	19,093
3	1,964	13,304	13	0,000	14,028	23	6,260	15,590
4	0,011	13,290	14	6,166	17,215	24	0,019	15,302
5	0,071	13,145	15	1,555	15,309	25	5,840	13,559
6	1,034	16,151	16	0,362	15,042	26	1,446	12,012
7	3,137	15,771	17	0,134	15,056	27	2,958	13,518
8	3,230	15,763	18	3,277	14,607	28	14,502	14,962
9	1,958	15,926	19	3,113	12,642	29	0,995	15,454
10	0,016	15,420	20	0,011	15,155	30	1,469	14,608

- 1) Design a control chart for the bivariate mean with $\alpha = 0.02$. Discuss the result assuming the existence of assignable causes for possible out-of-control observations.
- 2) A new set of data was acquired in the same process conditions:

X	Y
1,891	18,553
0,294	18,446
0,802	18,017
2,834	17,805
3,279	18,755
4,172	17,574
1,144	18,940
0,012	18,320
0,100	16,994
0,124	19,188

Is the process still in control? (use the control chart designed at point 1)

Exercise 2 (max score 15)

A new facility for metal powder management has been installed, and the company needs to keep under control the amount of volatile powder particles in the environment. An air-quality index is monitored every week, and the values measured on 40 consecutive weeks are shown below (the higher the value, the higher the powder concentration):

Week	Index	Week	Index	Week	Index	Week	Index
1	8,22	11	8,32	21	8,65	31	8,95
2	8,15	12	8,30	22	8,60	32	9,00
3	8,25	13	8,30	23	8,67	33	8,92
4	8,25	14	8,45	24	8,58	34	8,93
5	8,07	15	8,60	25	8,53	35	8,97
6	8,18	16	8,45	26	8,50	36	8,90
7	8,07	17	8,53	27	8,55	37	8,88
8	7,95	18	8,65	28	8,43	38	9,00
9	8,05	19	8,47	29	9,15	39	9,03
10	8,22	20	8,55	30	9,15	40	9,15

- Design a suitable control chart to monitor the air-quality index. Discuss the results.
- An additional information is that on the 29th week, the air recirculation system was stopped for a few days because of a scheduled plant modification. How does the control chart design change if this additional information is included? Discuss the results.
- Using the model estimated at point b), design an interval prediction for the air-quality index to be expected next week.

Exercise 3 (max score 5)

The variability of a micro-drilling process is monitored by means of an R control chart applied to the hole diameter. It is known that the quality characteristic follows a normal distribution with mean $\mu = 0,95 \text{ mm}$ and standard deviation $\sigma = 0,12 \text{ mm}$. The control limits of the R control chart are: $LCL = 0.7 \text{ mm}$, $UCL = 0.9 \text{ mm}$, with $n = 10$.

Determine the Type II error if the standard deviation of the process becomes 1,5 times larger than the one observed under in-control conditions.