Homework 4

Here is the list of problems constituting the fourth homework assignment. First, please, try to find your own solutions and after this effort consult these solutions with the ones presented during tutorials and, finaly, check the solutions that will be posted on the course webpage. Remember that problems can have several different but correct ways of solving them.

Multiple choice questions

1. The central horizontal line on the control charts

   A is computed as the overall average all available data;

   B is computed by taking the midpoint between maximal and minimal value in the data;

   C is not affected by the values in the data that are close to it;

   D is computed by eliminating the effect of unusually large or small values;

   E is evaluated by properly scaling the standard deviation.

2. The upper and lower control limits

   A are approximately set up so that more than 99% data falls in between them if process is in control;

   B are approximately set up so that more than 99% data falls in between them irrespectively if process is or is not in control;

   C are based only on the value of the overall mean;

   D do not vary for different subsample sizes in $\bar{X}$ charts;

   E are obtained by using the largest and the smallest data points.

3. The occurrence of an 'out-of-control' point on a control chart

   A is said to be a false alarm if it not as extreme as other cases of 'out-of-control' occurences;

   B is not likely to happend so is considered statistically significant for detecting an assignable cause of variation;

   C is said to be statistically significant only if the process was not properly centred in the first place;

   D is less likely when using "2-σ limits" than when using "3-σ limits";

   E is less likely when the process is off centre than when it is properly centred.

4. When using numbers of defective items in subgroups sampled from a process as the basis for a control chart, which one of the following is correct?

   A *np* charts are so called because the false alarm rates are based on normal probabilities, even though the Normal model is not strictly correct;

B *np* charts are so called because the expected number of defects is n times the proportion of defects characteristic of the process;

C the lower control limit in an np chart calculated from the standard formula can never be less than 0;

D it is not possible to get a value below the lower control limit when using an np chart because the lower control limit cannot be less than 0;

E it is not possible to calculate an accurate standard error formula for use in an np chart because there is no σ involved.

Problems

1. A certain process is observed and recorded daily.
   - How improbable is a point outside the 3σ limits when the process is in control?
   - How often will such a point occur when observed daily (find expected frequency in terms of days)?
   - How improbable is a point outside the 2σ limits when the process is in control?
   - How often will such a point occur?

2. Suppose that for the above process $\bar{X}$ and R control charts have been created based on the subsample means of weekly observation (thus the subsample size is $n = 7$).
   - Using the AIAG chart that is presented in Figure 4.6 of the textbook, identify the values of A_2, D_3 and D_4 for this process (see also our lecture slides where these values have been presented).
   - After analysing twelve month data it have been found out that the process has been in control for the entire year and the average value of the range has been found to be 6.3 while the mean value was 78. Find the control limits for the $\bar{X}$ and R charts and present them on a graph for a weekly control chart.
   - From the obtained data calculate the standard deviation for this process.
   - Using the obtained values compute the percentage of the items that will not fell within the $\bar{X}$ control belt.

3. Assuming a value of 7.3 [mm] for σ, use the Normal table to predict the proportion of clips whose gaps fail to meet the specification limits of 50[mm] to 90[mm]
   - when the process mean is 74[mm],
   - when the process mean is 67[mm].

4. The data on volume measurements for a sample of 50 glasses are given below

```
Sample Run 1
1 503.5
2 507.7
3 506.1
4 505.6
5 504.1
6 504.2
7 504.3
8 503.0
9 504.2
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10 507.1
11 500.2
12 509.2
13 506.2
14 501.3
15 506.4
16 506.0
17 506.1
18 505.0
19 504.4
20 504.0
21 505.0
22 502.8
23 502.4
24 506.5
25 504.0
26 503.5
27 502.2
28 502.5
29 505.3
30 507.8
31 507.7
32 506.2
33 506.9
34 502.5
35 505.0
36 505.4
37 507.3
38 506.2
39 507.6
40 506.5
41 504.1
42 506.5
43 505.2
44 504.9
45 503.6
46 506.5
47 506.6
48 503.4
49 504.3
50 507.7
```

The mean and standard deviation were calculated as 505.1 and 1.9, respectively.

- Calculate control limits,
- Make a control chart for the individual measurements and plot the above values on it.
- Report on the state of statisticatl control of the process.

The following values can be found useful when working out this problem: the sum of the above values is 25254.7 and the sum of their squares is 12756174.