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Quiz #4, Quality control 2018 Fall [+ 8 points]

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Data, $X_{ij}, i=1, \dots, m, j=1, \dots, n \sim N(\mu, \sigma^2)$, are collected as follows:

					Mean	Range
i=1	12	16	10	10	12	6
i=2	22	20	22	16	20	6
i=3	15	16	12	11	13.5	5
i=4	15	13	12	12	13	3
i=5	14	14	9	11	12	5

n=4.

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(1) [+1] Calculate $\hat{\sigma}$ by the range method.

$$\bar{R} = \frac{1}{5} (6 + \dots + 5) = 5 \quad n=4$$

$$\hat{\sigma} = \frac{\bar{R}}{d_2} = \frac{5}{2.059} = 2.4284 \#$$

$$\bar{x} = 14.1 \quad \bar{R} = 5 \rightarrow \frac{1}{5} (6+6+5+3+5)$$

$$\rightarrow \frac{1}{5} (12+20+13.5+13+12)$$

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(2) [+3] Calculate center, UCL and LCL for $\bar{X}$ -chart (3-sigma quality performance)

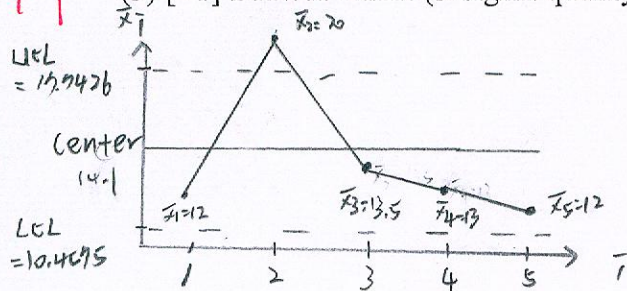
center: $\bar{x} = \frac{1}{5} \sum_{i=1}^5 \bar{x}_i = 14.1 \#$, $A_2 = \frac{3}{d_2 n} = \frac{3}{2.059 \cdot 4} = 0.7285$

$$UCL = \bar{x} + 3 \cdot \frac{\hat{\sigma}}{\sqrt{n}} = \bar{x} + A_2 \bar{R} = 14.1 + 0.7285 \cdot 5 = 12.7426 \#$$

$$LCL = \bar{x} - 3 \cdot \frac{\hat{\sigma}}{\sqrt{n}} = \bar{x} - A_2 \bar{R} = 14.1 - 0.7285 \cdot 5 = 16.4575 \#$$

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(3) [+1] Draw $\bar{X}$ -chart (3-sigma quality performance) with your conclusion



The process is out of control,

Since $\bar{x}_2 = 20 > UCL = 12.7426$ #

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(4) [+3] Draw R-chart (3-sigma quality performance) with your conclusion

$$\bar{R} = \frac{1}{5} \sum_{i=1}^5 R_i = 5$$

$$UCL = \bar{R} + 3 \cdot \frac{d_3}{d_2} \bar{R} = 5 + 3 \cdot \frac{0.88}{2.059} \cdot 5 = 11.4108$$

$$LCL = \bar{R} - 3 \cdot \frac{d_3}{d_2} \bar{R} = 5 - 3 \cdot \frac{0.88}{2.059} \cdot 5 = -1.4108 \Rightarrow LCL=0$$

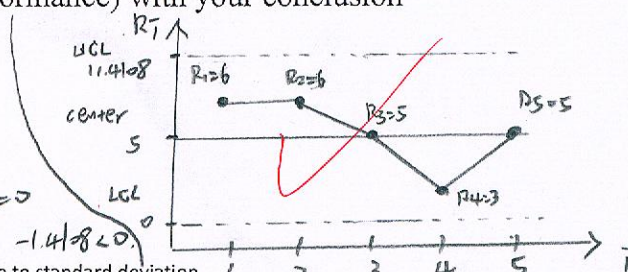


Table: Conversion of range to standard deviation

n	2	3	4	5	6
d_2	1.128	1.683	2.059	2.326	2.534
d_3	0.853	0.888	0.880	0.864	0.848

The process is in control

Since $LCL < R_i < UCL$

for $i=1, \dots, 5$ #