Essentials of Statistical Process Control

Establishing Control Charts for Variables

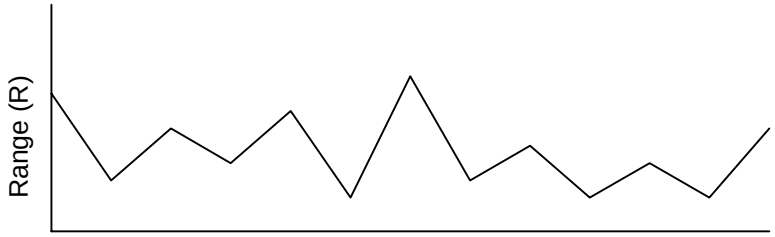
1. **Using a running and stable process:**

   Take 5 samples from the process each hour. Record the average ($\bar{X}$) and the range (R - the difference between the highest and lowest measurements) for the set of 5 samples.

   Continue until 25 sets of data are available.

2. **Range Control Charts**

   Plot the results for the range (R) on a preliminary Control Chart as below:



3. **Calculating the control limits for R:**

   Find the average of the 25 values for R. This is $\bar{R}$ and $\bar{R} = \frac{\text{Sum of R values}}{25}$

   The control limits are given by

   Lower Control Limit for R: $LCL_R = D_3 \times \bar{R}$

   Upper Control Limit for R: $UCL_R = D_4 \times \bar{R}$

   Where D_3 and D_4 are constants that vary with the sample size as below:

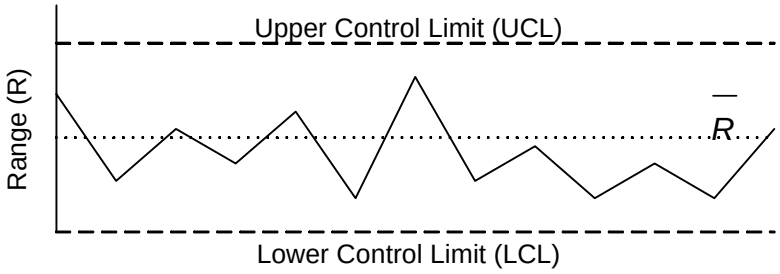
Sample Size	2	3	4	5	6	7	8	9	10
D_3	0	0	0	0	0	0.08	0.14	0.18	0.22
D_4	3.27	2.57	2.28	2.11	2.00	1.92	1.86	1.82	1.78

   For a sample size of 5, the Control Limits are then...

   Lower Control Limit for R: $LCL_R = 0$

   Upper Control Limit for R: $UCL_R = 2.11 \times \bar{R}$

4. **Plot the average for the range ($\bar{R}$) and the Upper and Lower Control Limits (UCL_R and LCL_R) on the Control Chart:**



5. **Interpret the Range Control Chart for control (see Analyzing Control Charts).**

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Establishing Control Charts for Variables

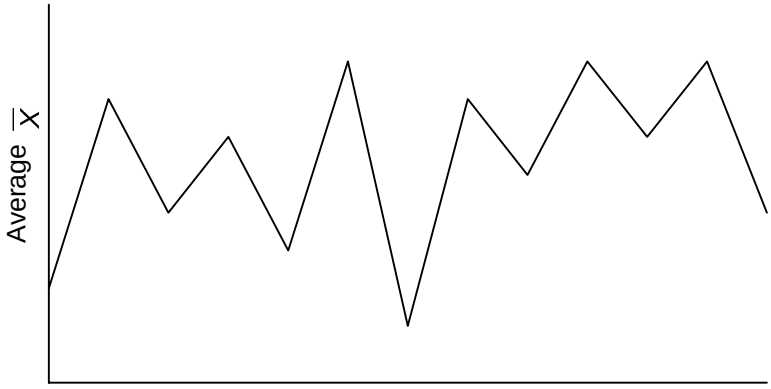
1. **Using a running and stable process:**

   Take 5 samples from the process each hour. Record the average ($\bar{X}$) and the range (R - the difference between the highest and lowest measurements) for the set of 5 samples.

   Continue until 25 sets of data are available.

2. **Average Control Charts**

   Plot the results for the average ($\bar{X}$) on a preliminary Control Chart as below:



3. **Calculating the control limits for $\bar{X}$:**

   Find the average of the 25 values for $\bar{X}$. This is $\bar{\bar{X}}$ and $\bar{\bar{X}} = \frac{\text{Sum of } \bar{X} \text{ values}}{25}$

   The control limits are given by

   Lower Control Limit for $\bar{\bar{X}}$: $LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \times \bar{R}$

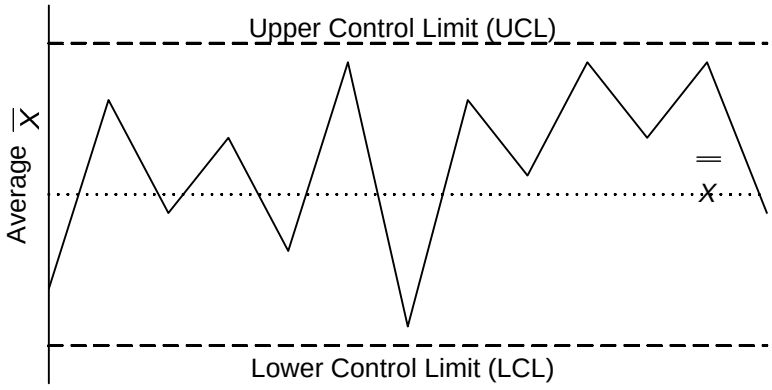
   Upper Control Limit for $\bar{\bar{X}}$: $UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \times \bar{R}$

   Where A_2 is a constant that varies with the sample size as below:

Sample Size	2	3	4	5	6	7	8	9	10
A_2	1.88	1.02	0.73	0.58	0.48	0.42	0.37	0.34	0.31

   Use A_2 = 0.58 for a sample size of 5 and calculate the Control Limits.

4. **Plot the average of the averages ($\bar{\bar{X}}$) and the Upper and Lower Control Limits ($LCL_{\bar{X}}$ and $UCL_{\bar{X}}$) on the Control Chart:**



5. **Interpret the Average Control Chart for control (see Analyzing Control Charts).**