Individuals and Moving Range Charts

Data Science for Quality Management: Xbar and R / Xbar and S charts / X and MR charts

with **Wendy Martin**

Learning objective:

Calculate Control Limits for the normally distributed X and MR chart

Control Limits

Multiple Methods Exist for the Calculation of Control Limits:

- Method 1: Use the Average MR
- Method 2: Use the Standard Deviation
- Method 3: Use the Median Moving Range
- Method 4: Use Distribution Area

Control Limits — *MR* Chart

- Typical Limits for the *MR* Chart

$$\mathrm{UCL}_{MR} = D_4\overline{MR}$$

$$\mathrm{LCL}_{MR} = D_3\overline{MR}$$

Table of Constants — MR Chart

	Charts for Individuals (X)	Charts for Moving Ranges (R_M)		
Observations in Sample	Factors for Control Limits	Divisors for Estimate of Standard Deviation	Factors for Control Limits	
n	E_2	d_2	D_3	D_4
2	2.660	1.128	---	3.267
3	1.772	1.693	---	2.574
4	1.457	2.059	---	2.282
5	1.290	2.326	---	2.114
6	1.184	2.534	---	2.004
7	1.109	2.704	0.076	1.924
8	1.054	2.847	0.136	1.864
9	1.010	2.970	0.184	1.816
10	0.975	3.078	0.223	1.777

Control Limits — X Chart Method 1

- Using the Average MR
  - The most common method; the default in most software

$$UCL_X = \bar{X} + \frac{AE_2\overline{MR}}{3}$$

$$LCL_X = \bar{X} - \frac{AE_2\overline{MR}}{3}$$

E_2 = 2.6587 for a moving range span of 2

Control Limits — X Chart Method 2

- Using the Standard Deviation
  - Best estimate if process is stable & normally distributed
  - Inflated if the process is not stable

$$\mathrm{UCL_X} = \bar{\mathrm{X}} + \mathrm{A(s)}$$
$$\mathrm{LCL_X} = \bar{\mathrm{X}} - \mathrm{A(s)}$$

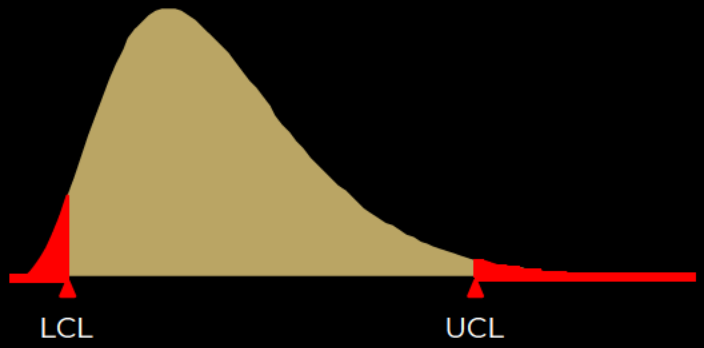
Control Limits — X Chart Method 3

- Using the Median MR ($\widetilde{\mathrm{MR}}$)
  - More robust estimate if the process is not stable
  - More sampling error

$$\mathrm{UCL_X} = \bar{\mathrm{X}} + \frac{\mathrm{A}\widetilde{MR}}{\tilde{d}_2} \qquad \mathrm{LCL_X} = \bar{\mathrm{X}} - \frac{\mathrm{A}\widetilde{MR}}{\tilde{d}_2}$$

Control Limits — X Chart Method 4

- Using an estimate of the Underlying Distribution Area
  - Used for non-normal distribution analysis



$$\mathrm{UCL}_X = \mathrm{UNPL}_{(1-\alpha/2)}$$

$$\mathrm{LCL}_X = \mathrm{LNPL}_{(\alpha/2)}$$

Sources

The material used in the PowerPoint presentations associated with this course was drawn from a number of sources. Specifically, much of the content included was adopted or adapted from the following previously-published material:

- Luftig, J. An Introduction to Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1982
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