Individuals and Moving Range Charts – Distribution Fitting

Data Science for Quality Management: X and Moving Range Charts for Non-Normally Distributed Data

with **Wendy Martin**

Learning objective:

Explain why data is fit with R software

X and MR Charts Non-Normal Distributions

- The underlying distribution is non-normal, cannot be transformed to a normal distribution, and does not represent an alternative known mathematical model, so the data must be ‘fitted’ by software designed to apply a model associated with a family of distributions (e.g. Johnson, Weibull, Gamma, etc.)

X and MR Charts Non-Normal Distributions

The MAP Sensor Problem:

- A major automobile manufacturer produces a Manifold Absolute Pressure Sensor (MAP) Sensor, an electronic device that links the Powertrain Control Module with the engine in all its automobiles.

X and MR Charts Non-Normal Distributions

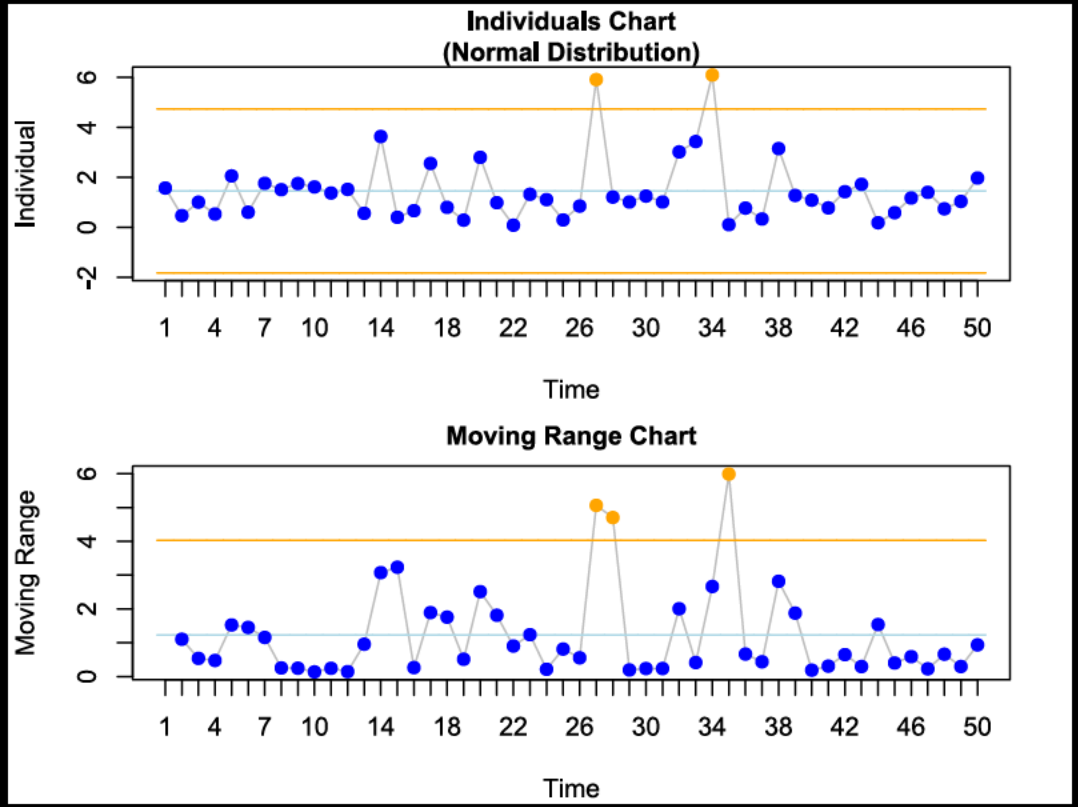
- Inside this sensor is a ceramic substrate, with surface mounted components.
- The placement of these components is critical, and their location is measured from datum reference points in the X, Y, and Z axes.

X and MR Charts Non-Normal Distributions

- The data file mapsensor.dat contains the z-axis values for one of the critical components; from 50 consecutive production lots.
- The specification for this component is 0.9500+/-0.4000 (coded data in thousandths of an inch)

X and MR Charts Non-Normal Distributions

- The initial X and Moving R chart appeared as follows:

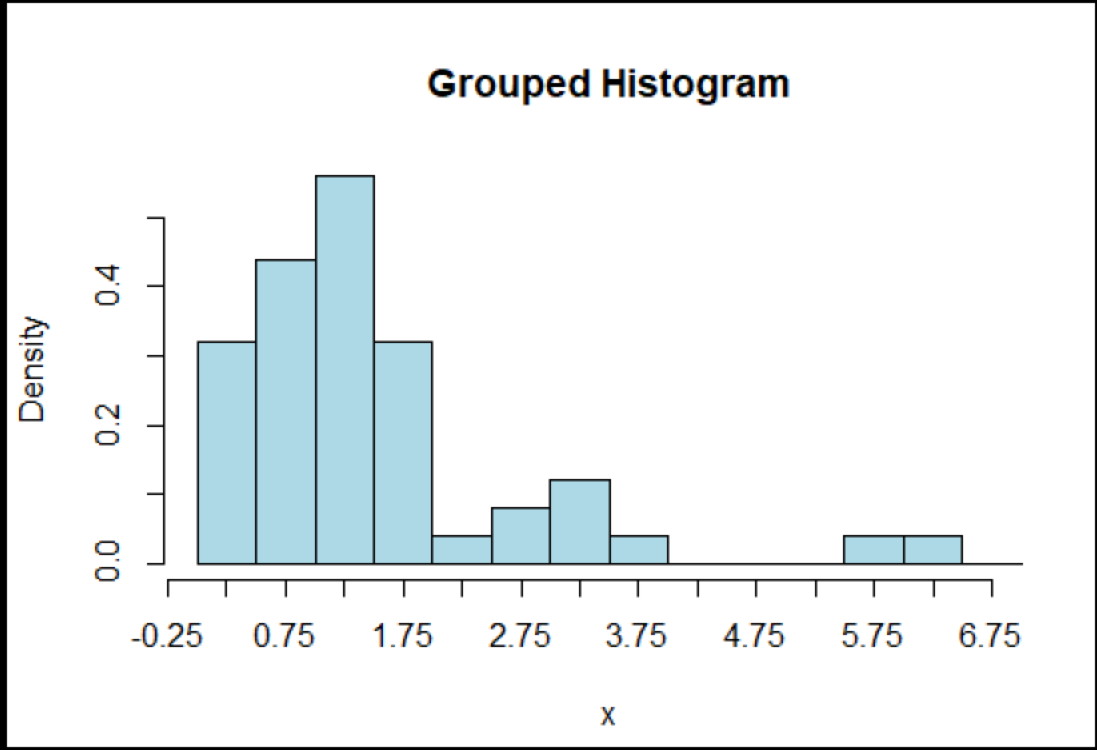


X and MR Charts Non-Normal Distributions

- A cursory view of the X chart showed a clearly suspicious LCL, as compared to the observed data. Generating a normality analysis and frequency histogram for the observed data, the reason became obvious:

X and MR Charts Non-Normal Distributions

```
nqtr(summary.continuous(mapsens
or$z_axis, stat.min=T),5)
n 50
mean      1.45956
var       1.59556
min       0.0878
g3.skew   2.11091
g3test.p  0
g4.kurt   5.28718
g4test.p 0.00039
```



X and MR Charts Non-Normal Distributions

- If no adequate transformations proved satisfactory, it would be at this point that the distribution-fitting approach might be employed to find the equivalent standard error values which can be employed with the data set.

X and MR Charts Non-Normal Distributions

- In some ways, this is a somewhat iterative process.
- Additionally, different software packages, even when fitting the identical distributions, will not necessarily yield the same ‘best fit’ result.

X and MR Charts Non-Normal Distributions

- In fact, sometimes no totally satisfactory fit can be found, in which case one chooses between sufficient fits at the extreme versus central portion of the distribution.

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
- Luftig, J. Advanced Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1984.
- Luftig, J. A Quality Improvement Strategy for Critical Product and Process Characteristics. Luftig & Associates, Inc. Farmington Hills, MI, 1991
- Luftig, J. Guidelines for Reporting the Capability of Critical Product Characteristics. Anheuser-Busch Companies, St. Louis, MO. 1994
- Spooner-Jordan, V. Understanding Variation. Luftig & Warren International, Southfield, MI 1996
- Luftig, J. and Petrovich, M. Quality with Confidence in Manufacturing. SPSS, Inc. Chicago, IL 1997
- Littlejohn, R., Ouellette, S., & Petrovich, M. Black Belt Business Improvement Specialist Training, Luftig & Warren International, 2000
- Ouellette, S. Six Sigma Champion Training, ROI Alliance, LLC & Luftig & Warren, International, Southfield, MI 2005