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:

Understand the limitations associated with X and MR Charts

Introduction to X and MR Charts

- The X chart is often called the “Individuals” chart

- Sampling often consists of taking single observations

X and MR Charts Used When:

- The process changes too slowly, and repeated measures yield essentially the same value
- The measures are extremely homogeneous
- Individual values do not fall into logical subgroups
- The measures are expensive, as with destructive testing

X and MR Charts Used When:

- The X Chart and its associated formulas are also useful when assessing descriptive statistics in situations where standard control limit formulas are not useful; this can occur in cases where the sample sizes (n) employed are extremely large.

Issues & Concerns Associated with X and MR Charts

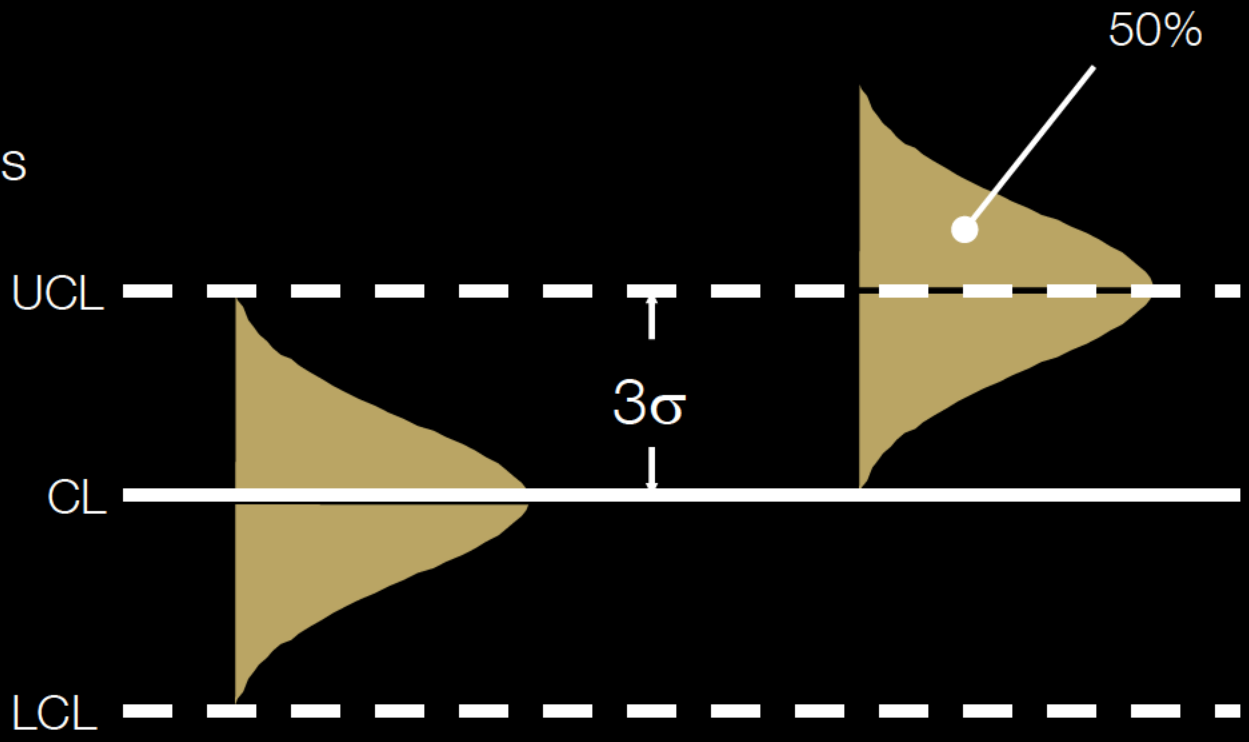
- The chart's sensitivity to changes in the process / population
- The effect of the shape of the process / population distribution
- The relationship between successive points

X and MR Charts - Sensitivity

3-Sigma Shift

3-Sigma Limits

$A = 3$

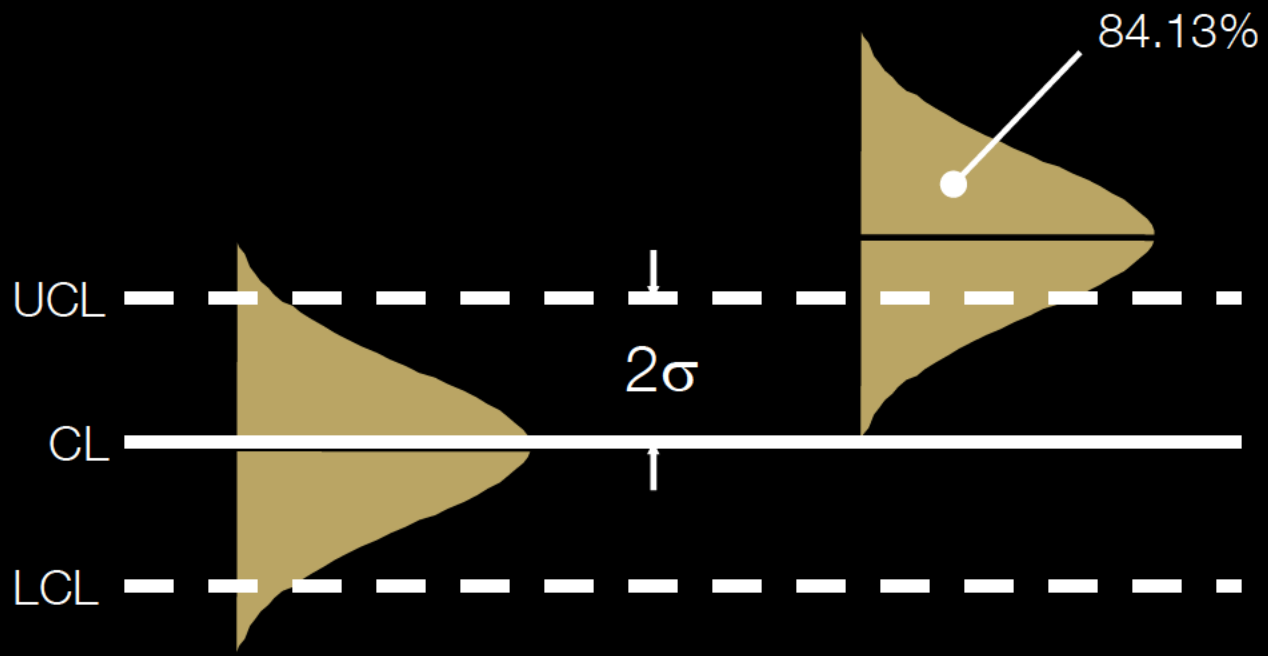


X and MR Charts - Sensitivity

3-Sigma Shift

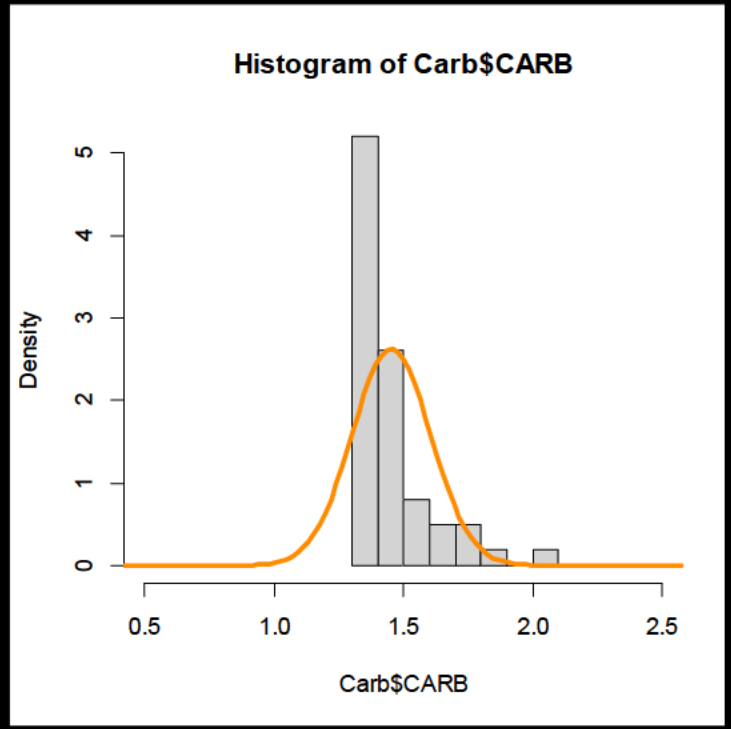
2-Sigma Limits

$A = 2$

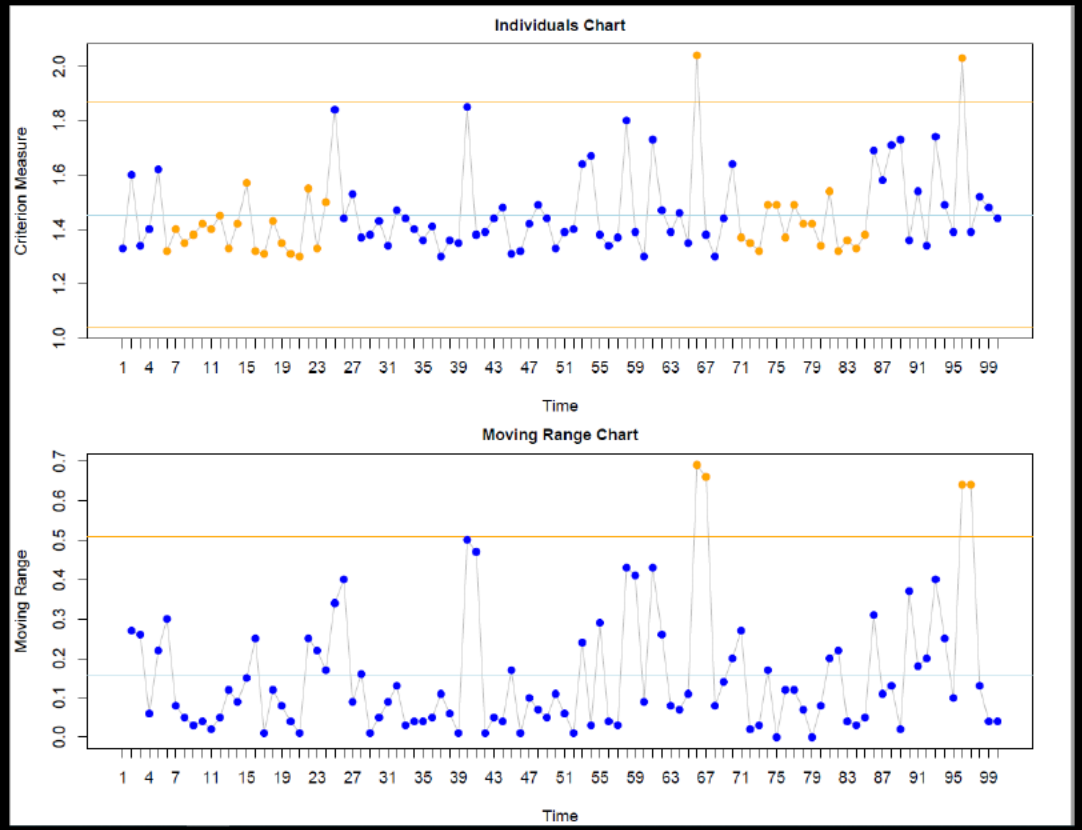


X and MR Charts
Distribution Shape – Assuming Normality

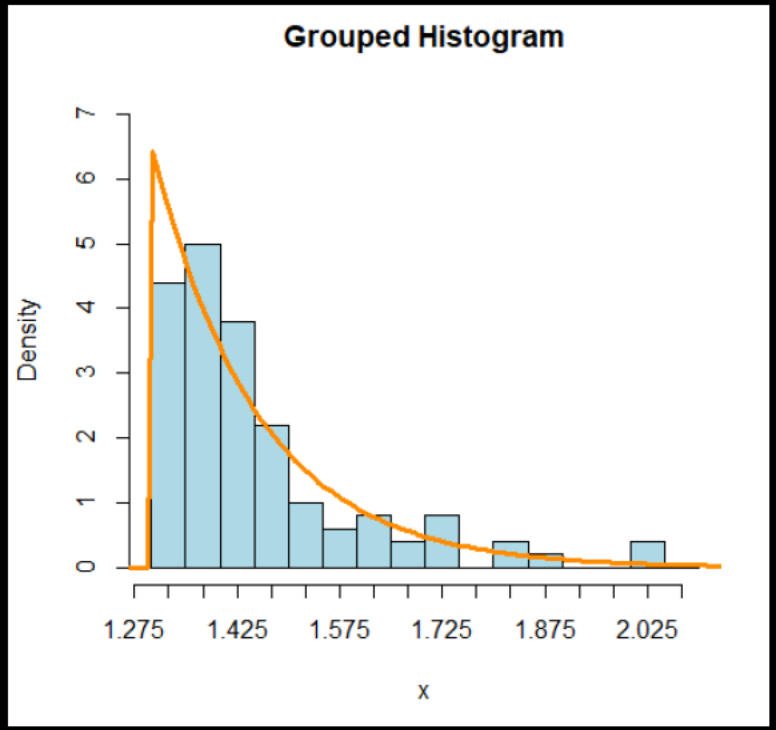
```
> nqtr(summary.continuous(Carb$CARB),4)
                1
dv.name        fx
n             100
missing         0
mean        1.453
var        0.0231
g3.skewness 1.8367
g3test.p        0
g4.kurtosis 3.6142
g4test.p    0.0002
```



X and MR Charts
Distribution Shape – Assuming Normality

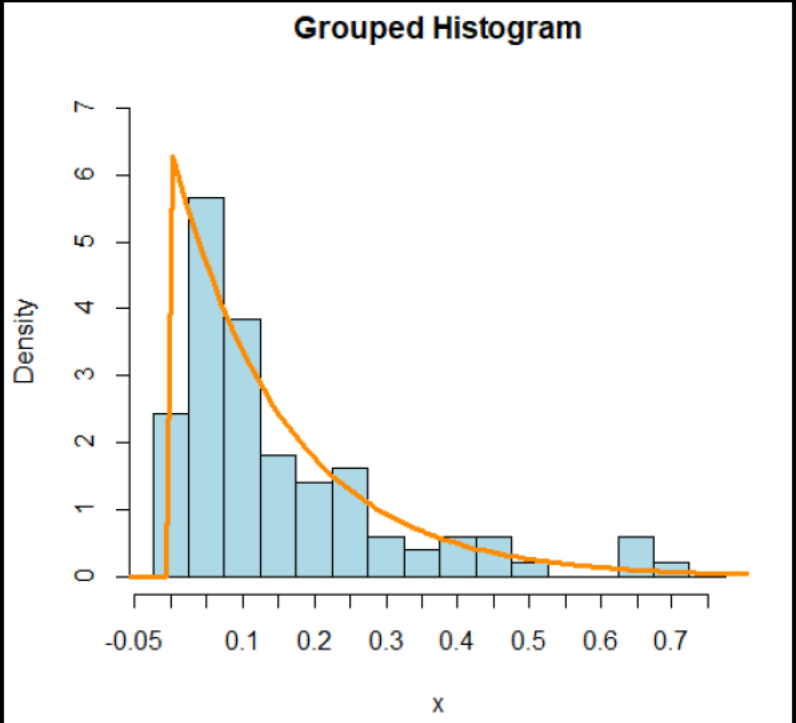


X and MR Charts Distribution Shape
Fitted Distribution - Individuals



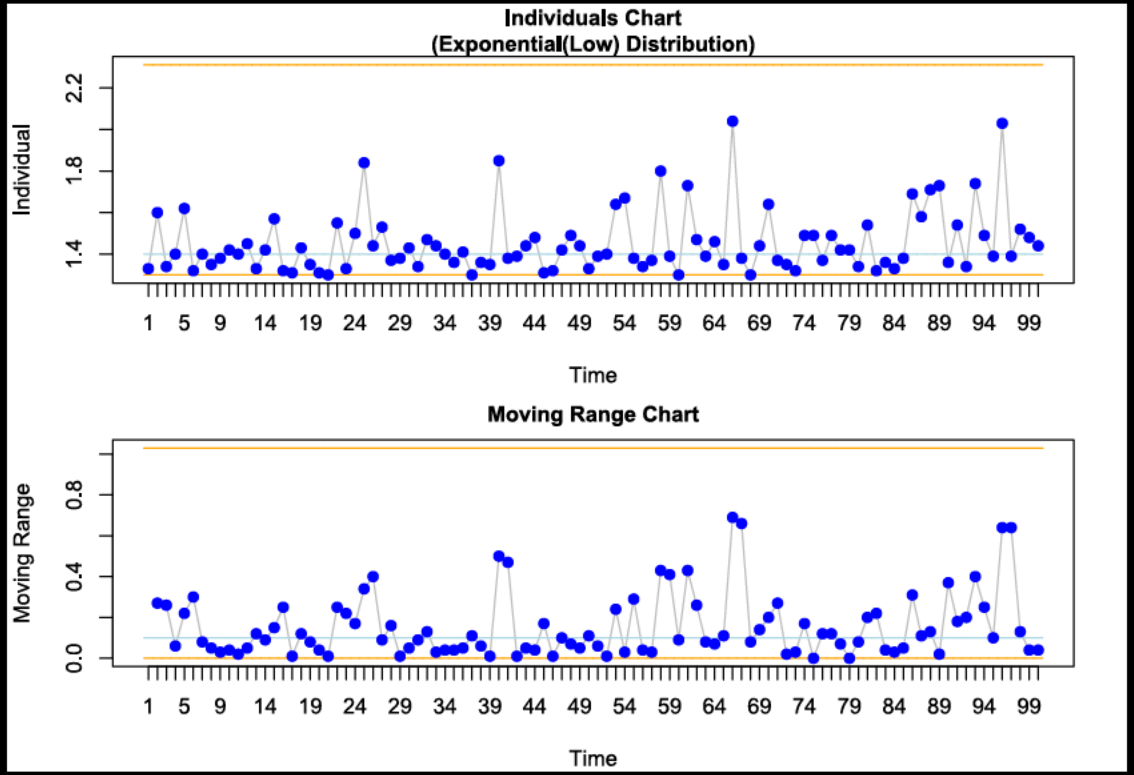

```
> nqtr(natural.tolerance.exp.low(x = Carb$CARB,
low = min(Carb$CARB)),5)

natural.tolerance    1.01076
lower.limit          1.30021
upper.limit          2.31097
lower.area           0.00135
upper.area           0.00135
```

X and MR Charts Distribution Shape
Fitted Distribution – Moving Ranges

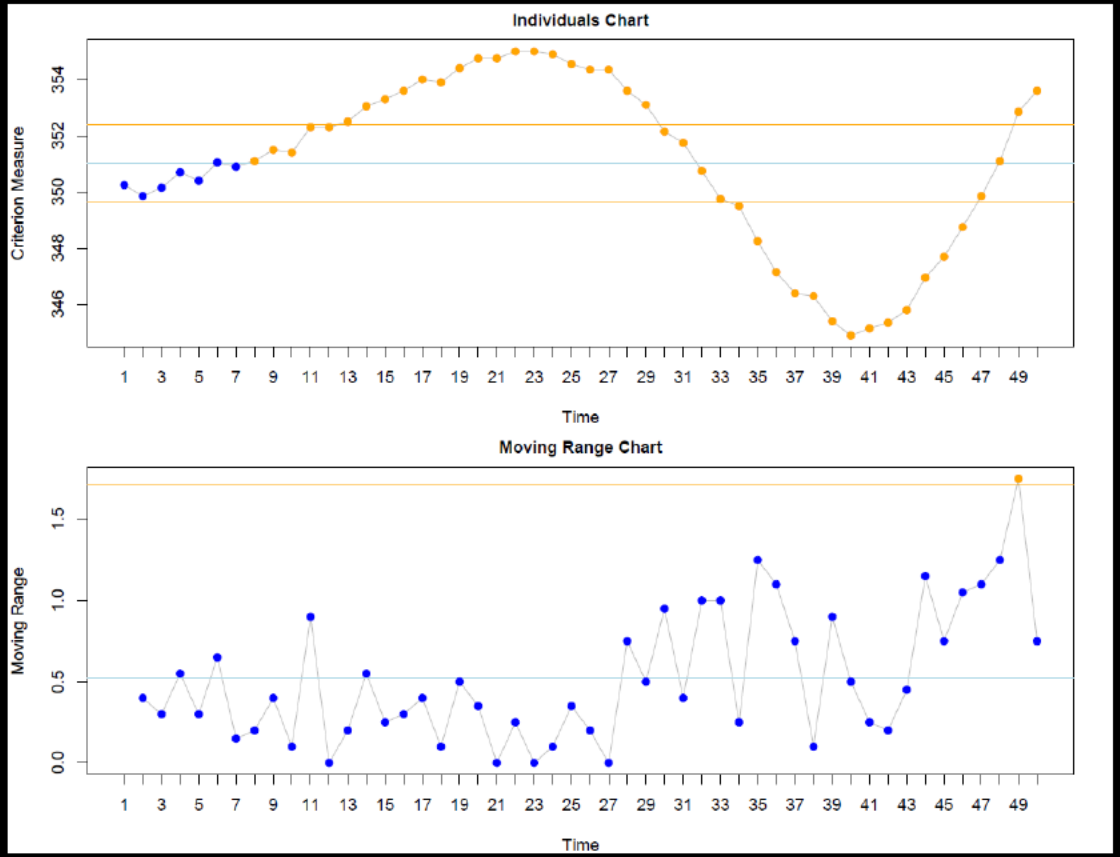



```
> nqtr(natural.tolerance.exp(x = expmr),5)
natural.tolerance 1.02831
lower.limit       0.00021
upper.limit       1.02852
lower.area        0.00135
upper.area        0.00135
```

X and MR Charts Distribution Shape
Fitted Distribution



X and MR Charts - Autocorrelation



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.
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- 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