

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:

Use the X and MR chart to monitor different aspects of variation

More on the X and MR Chart

- A very flexible chart for use in a wide range of circumstances
- **Any** statistic can be plotted with an X and MR chart

More on the \bar{X} and MR Chart

- Very useful when within subgroup variation will not properly estimate between subgroup variation

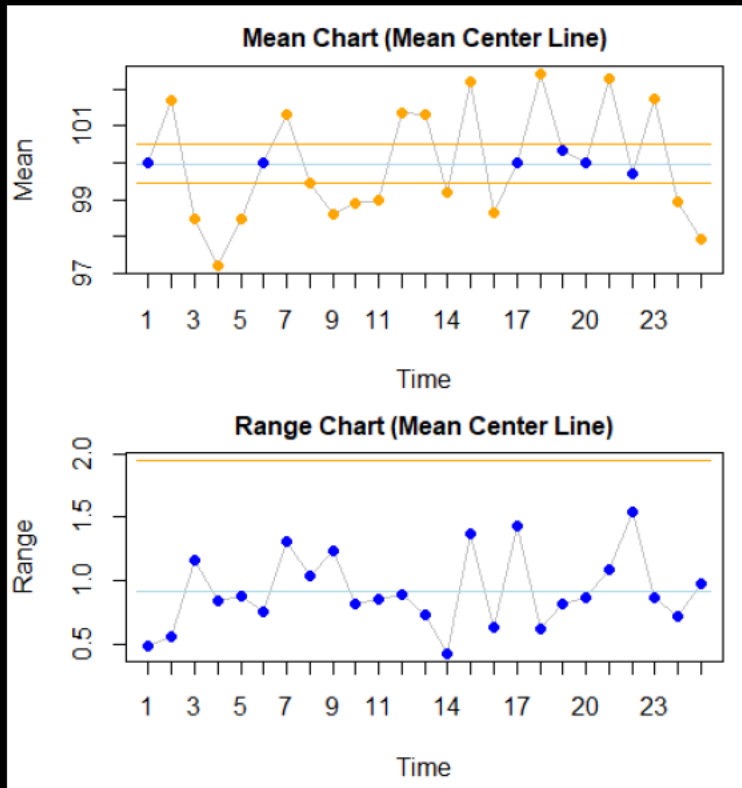
Example: Treating Averages as Individuals

- Assume you have a process that is “setup” dominant – the largest source of variation is found setup-to-setup
- In addition, you would like to monitor “within setup” process variation so multiple items are sampled per setup

Example: Treating Averages as Individuals

- The process is to be monitored with an X-Bar and R chart

Multiple Setup \bar{X} and R



Why is the mean chart out of control? Why are the limits so small?

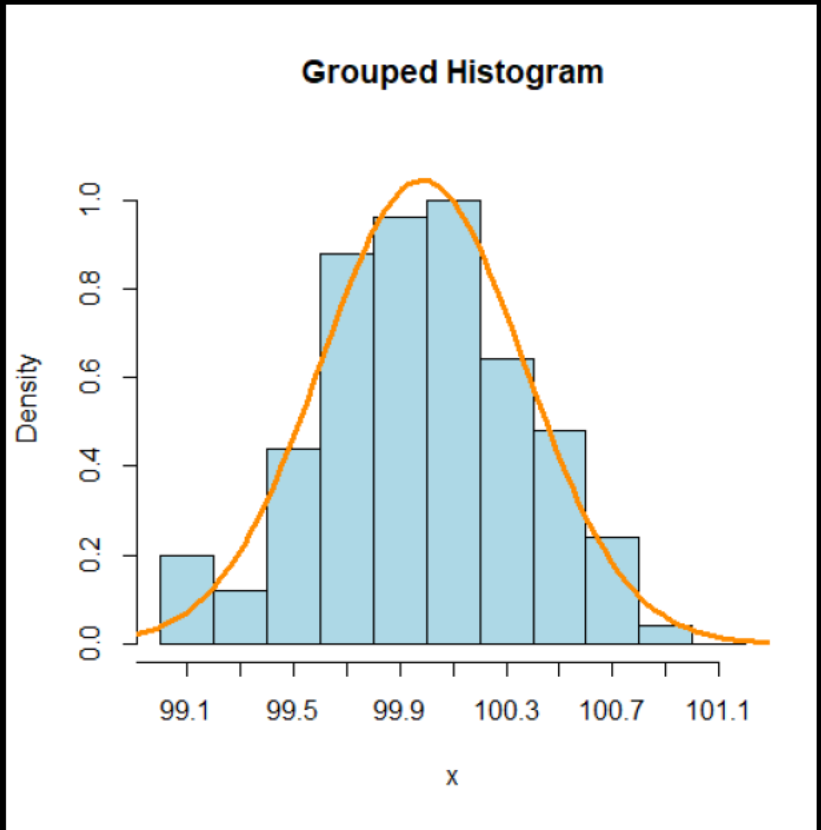
The range appears to be in control.

Multiple Setup Histogram

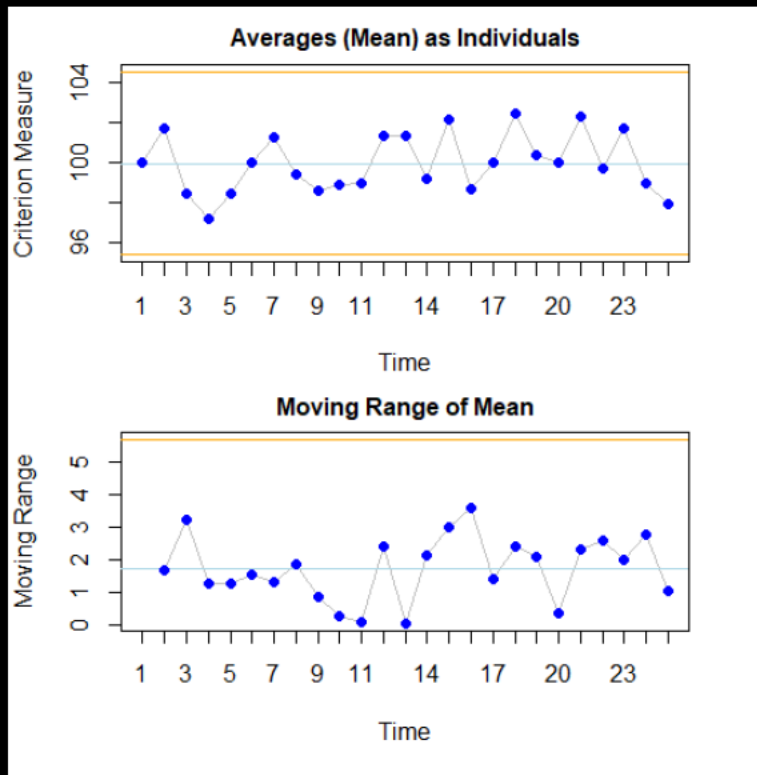
The individual values appear to be symmetric. Why doesn't the control chart work?

```
nqtr(summary.continuous  
(dataframe.col$measure),5)
```

n	125
mean	99.96227
var	2.24106
g3.skewness	0.15049
g3test.p	0.47694
g4.kurtosis	-0.92878
g4test.p	0.00015



Moving Range of Means used for Control Limits of Means



This demonstrates that the variation between runs is generally predictable

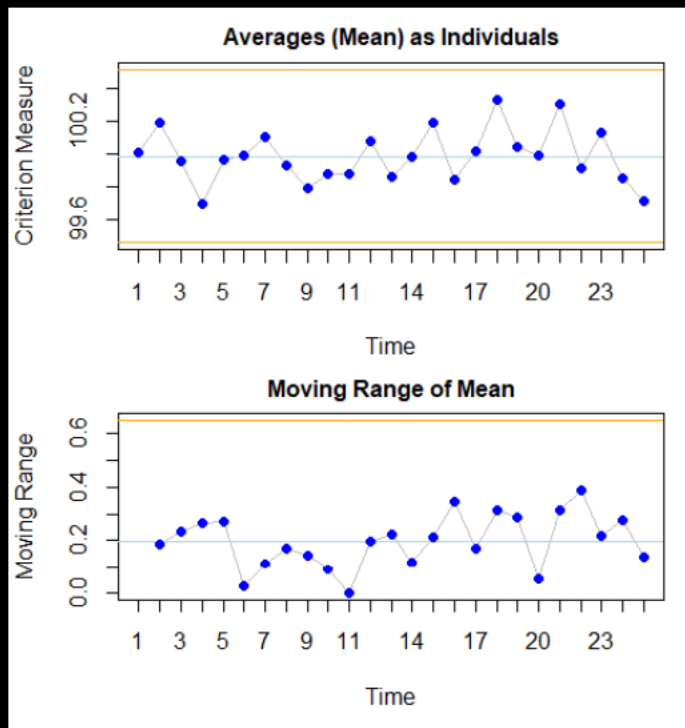
This demonstrates that the range between setups is generally predictable

Three Charts Needed

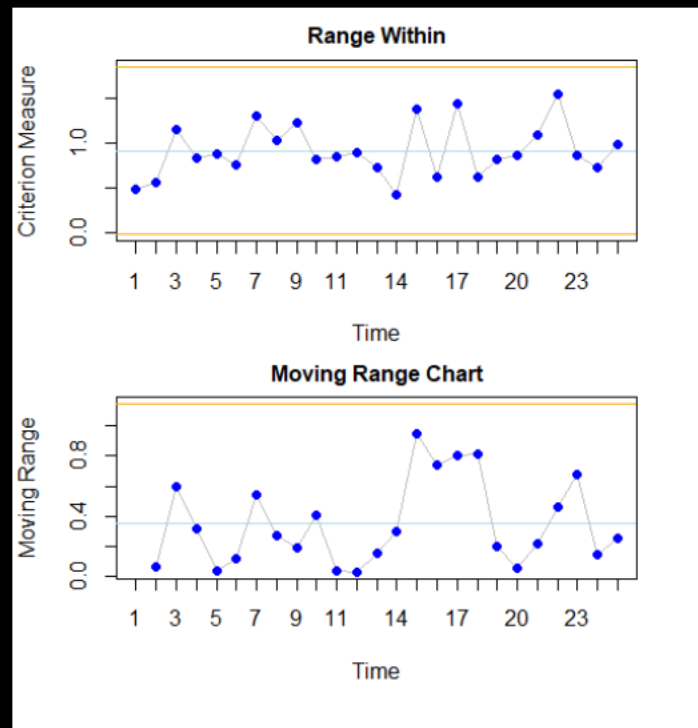
- The X-bar plotted on an X chart would be used to monitor setup-to-setup variation
- The standard Range chart would be used to monitor within setup variation
- The Moving Range of the X-bars could be used to monitor setup-to-setup changes

Three Charts

1



2



3

Averages as Individuals Notes

- Each setup is to the same target, but due to factors you cannot yet control the within-setup output variation is smaller than the between-setup variation.

Averages as Individuals Notes

- If you suspect this to be the case, you can use a random effects ANOVA to test for a significant difference within versus between lots or samples. This procedure is available R.

Averages as Individuals Notes

- While the average as individuals chart answers the question of control, you are losing an opportunity to reduce process output variation if by seeing that it is in control you stop work on finding out what is causing your setup-to-setup variation.

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