Creating a Control Chart

Data Science for Quality Management: Process Control and Control Charts

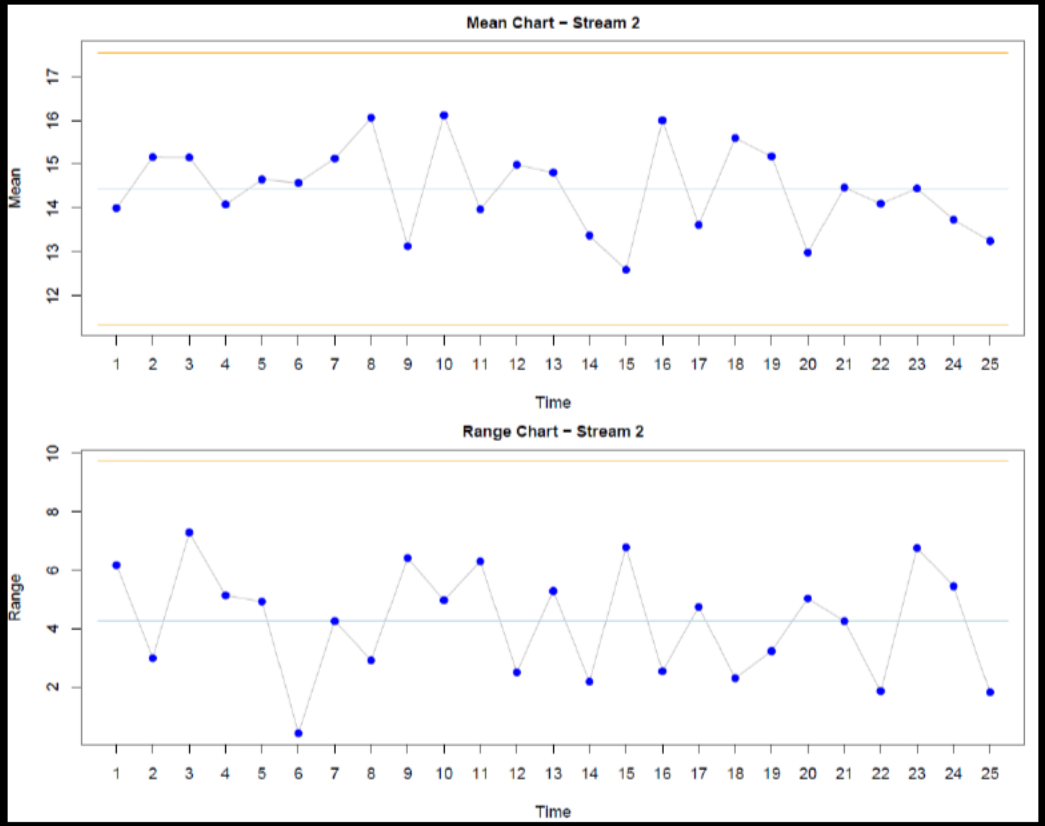
with **Wendy Martin**

Learning objectives:

Describe the 7 step process to create a control chart

Identify out of control conditions and patterns on a control chart

5. Generate the Chart



Steps Required to Generate a Control Chart in lolcat

1. Import the data file
2. Select the chart type
3. Select the method used to generate control rules
4. Select the centerline method (mean or median)
5. Plot the chart

Plotted Sample Statistics

- Average
- Range
- Standard Deviation
- Moving Range
- Proportion
- Count

Plotted Centerline(s)

- Measure Location of Sample Statistics
- Mean of the means: $\bar{\bar{X}}$
- Mean of the ranges: $\bar{R}$
- Mean of the p: $\bar{p}$
- Centerlines can be the mean or median

Plotted Control Limits

- Based on the sample data and sample size
- Established by the process and sampling methodologies
- Reflect common causes only (after the process is brought into a state of control)

Plotted Control Limits

- Monitoring limits vs. control limits
- Ongoing control limits
- Generally ±3 standard error limits

6. Assess the Process for Control

- Evaluate the chart
- The chart is not in or out of control, the process is!

6. Assess the Process for Control

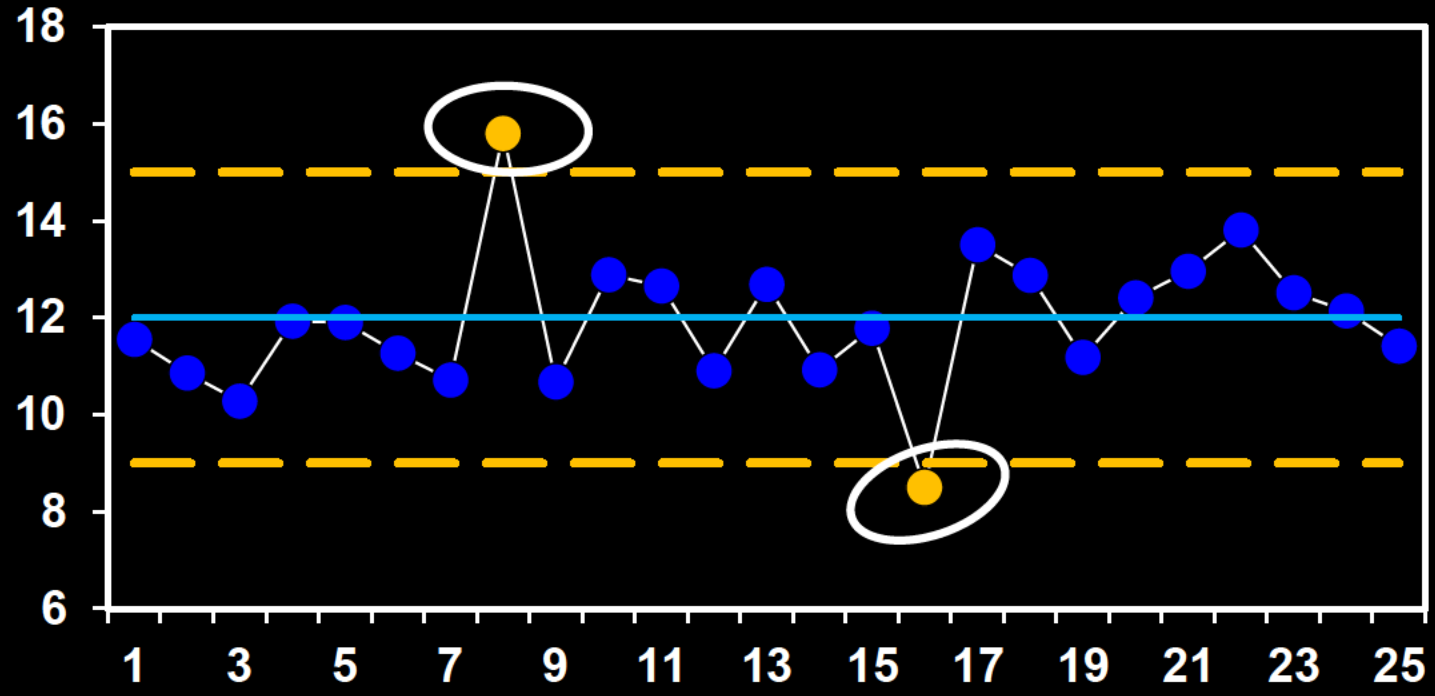
- Use control chart pattern rules:
- Points outside the limits
- Runs
- Trends
- Cycles (to include alternating points)
- Hugging and/or Avoiding the Centerline

Chart Rules

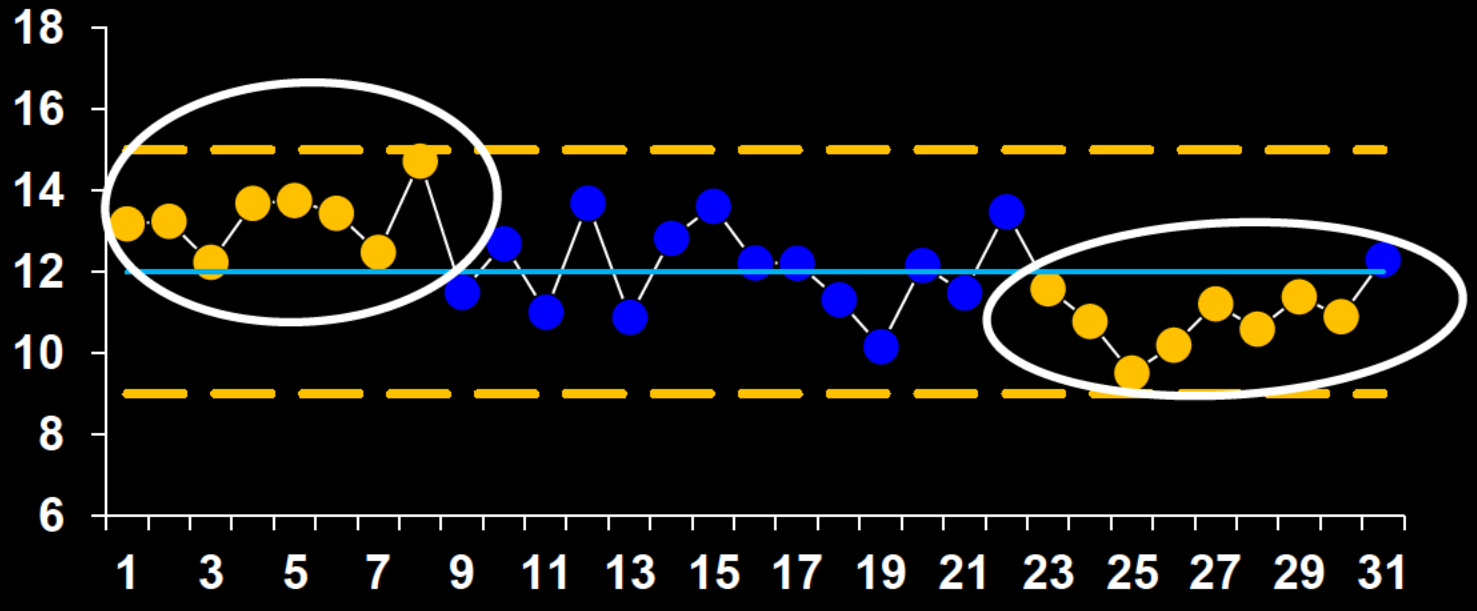
- Nelson Rules
- https://github.com/burrm/lolcat/blob/master/R/spc.rulesets.nelson.1984.test.1.2.3.4.5.6.7.8.R

Out of Control Signals

Points Outside the Limits Chart Rule 1

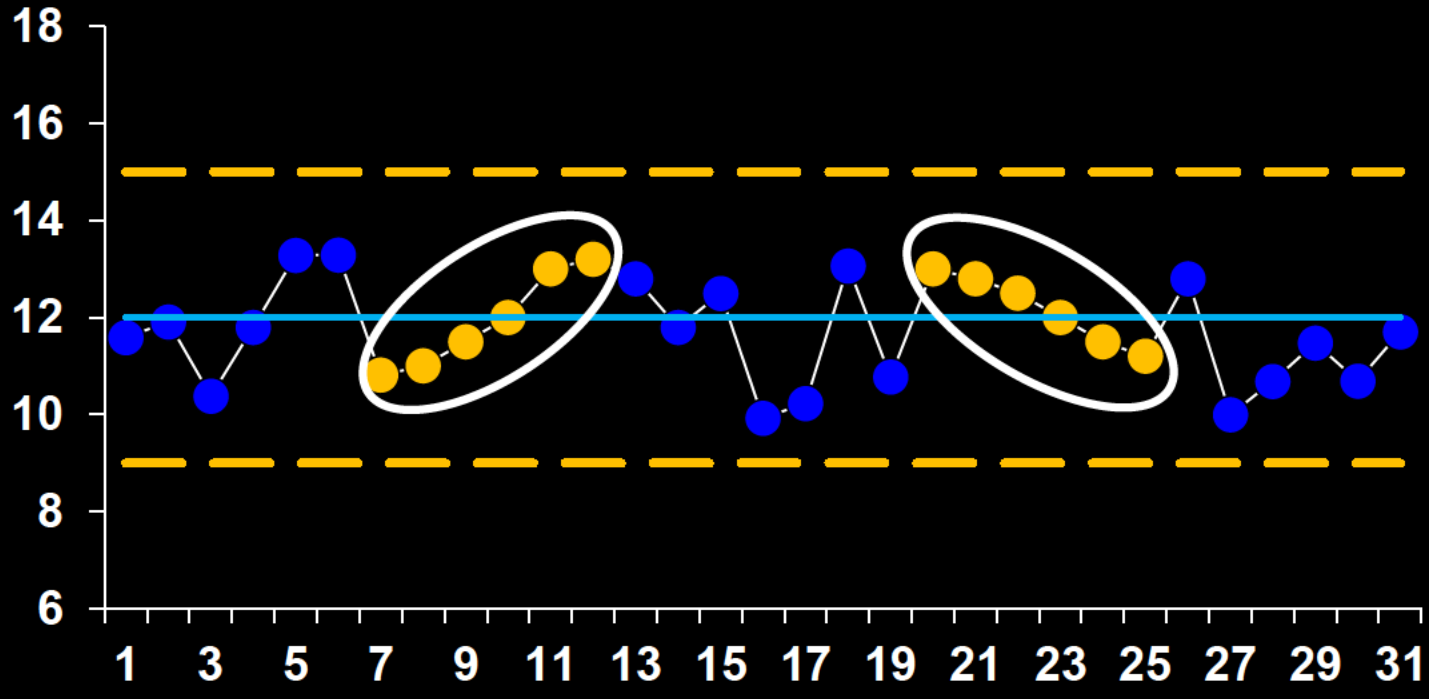


Runs Chart Rule 2



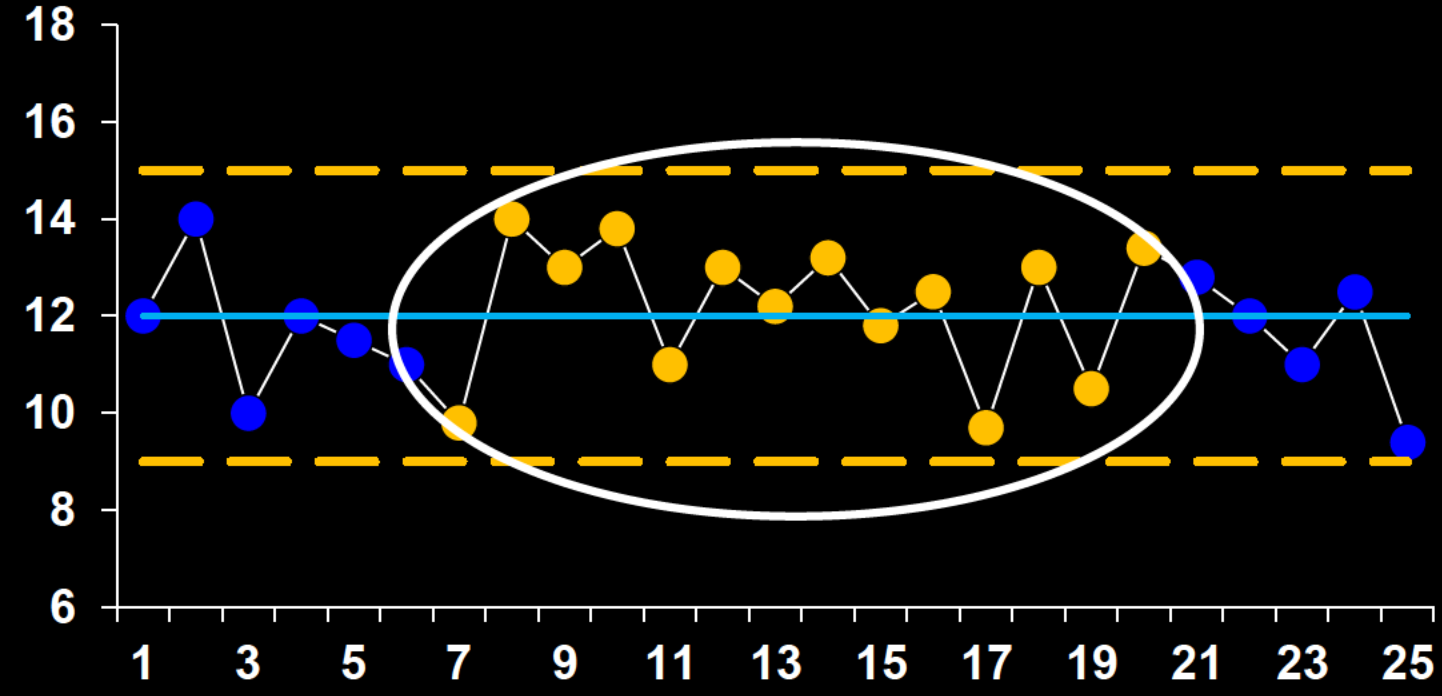
8 consecutive points above or 8 consecutive below the centerline

Trends
Chart Rule 3



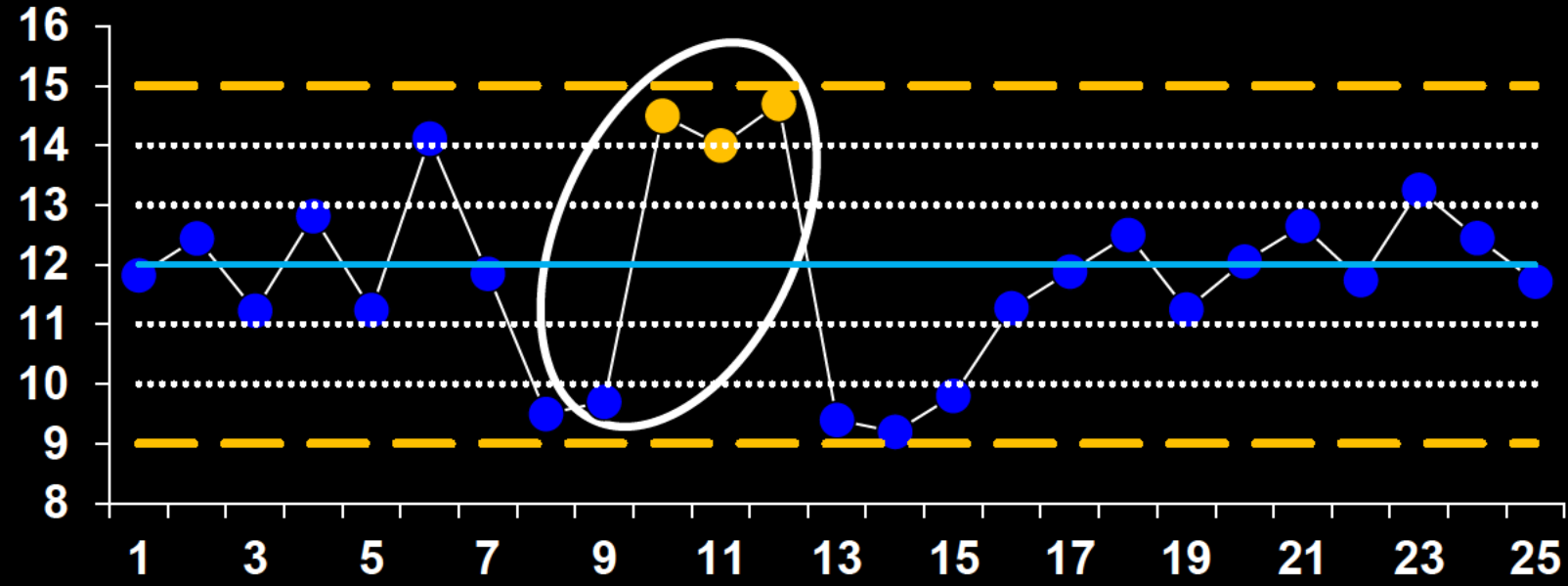
6 consecutively increasing or 6 consecutively decreasing data points

Alternating Values Chart Rule 4



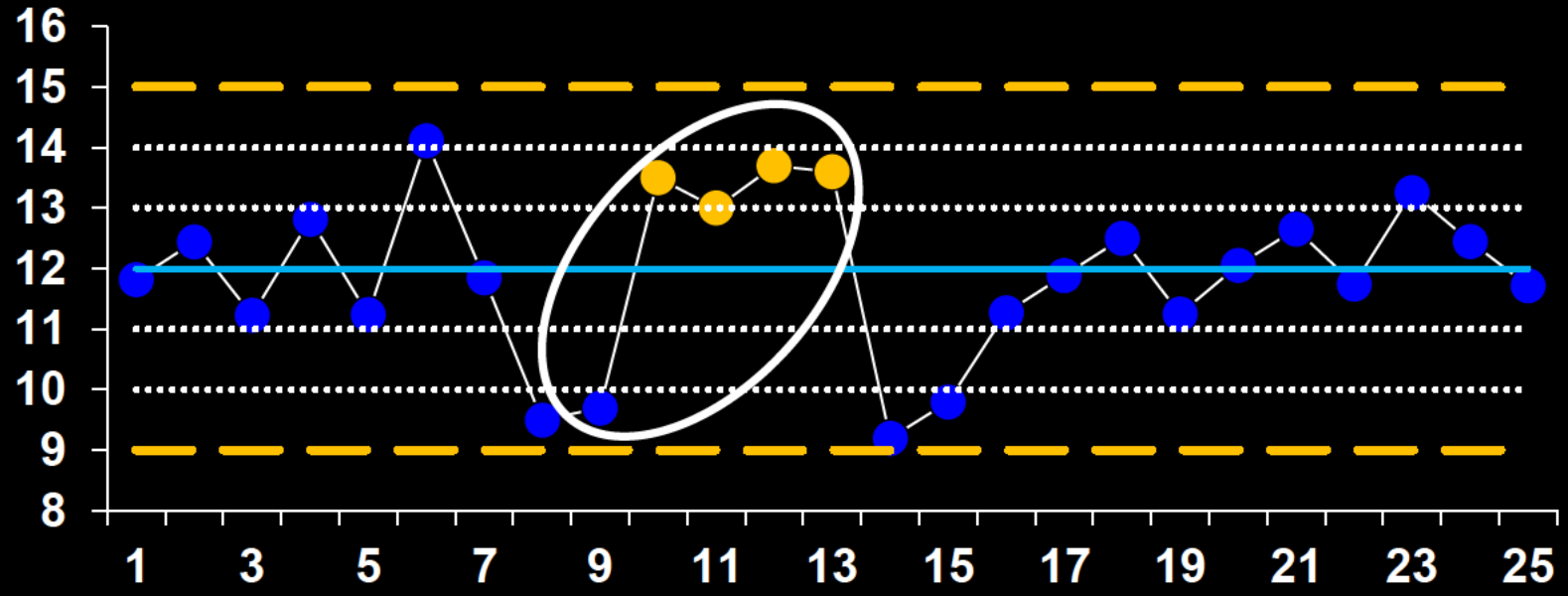
14 consecutively alternating points (changes in direction)

2 out of 3 in Zone A
Chart Rule 5



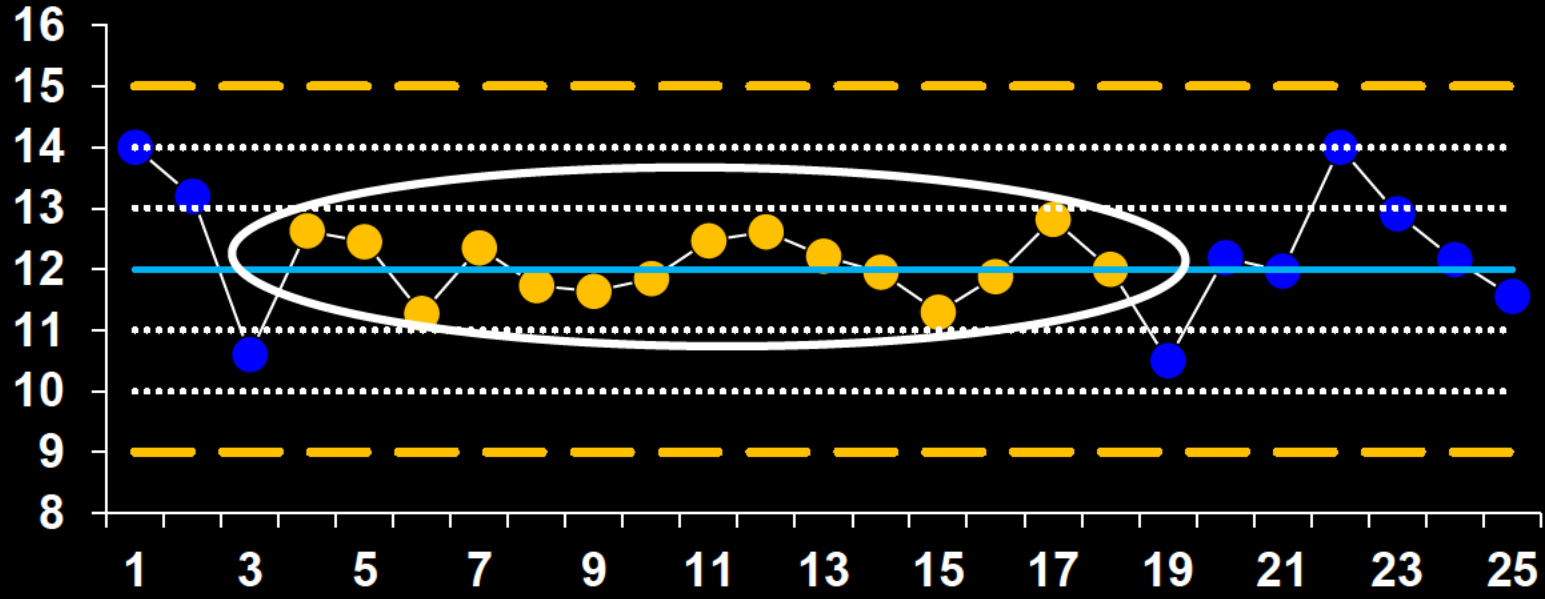
Two (or three) out of three points in a row are more than 2 standard deviations from the mean in the same direction (shift)

4 out of 5 in Zone B
Chart Rule 6



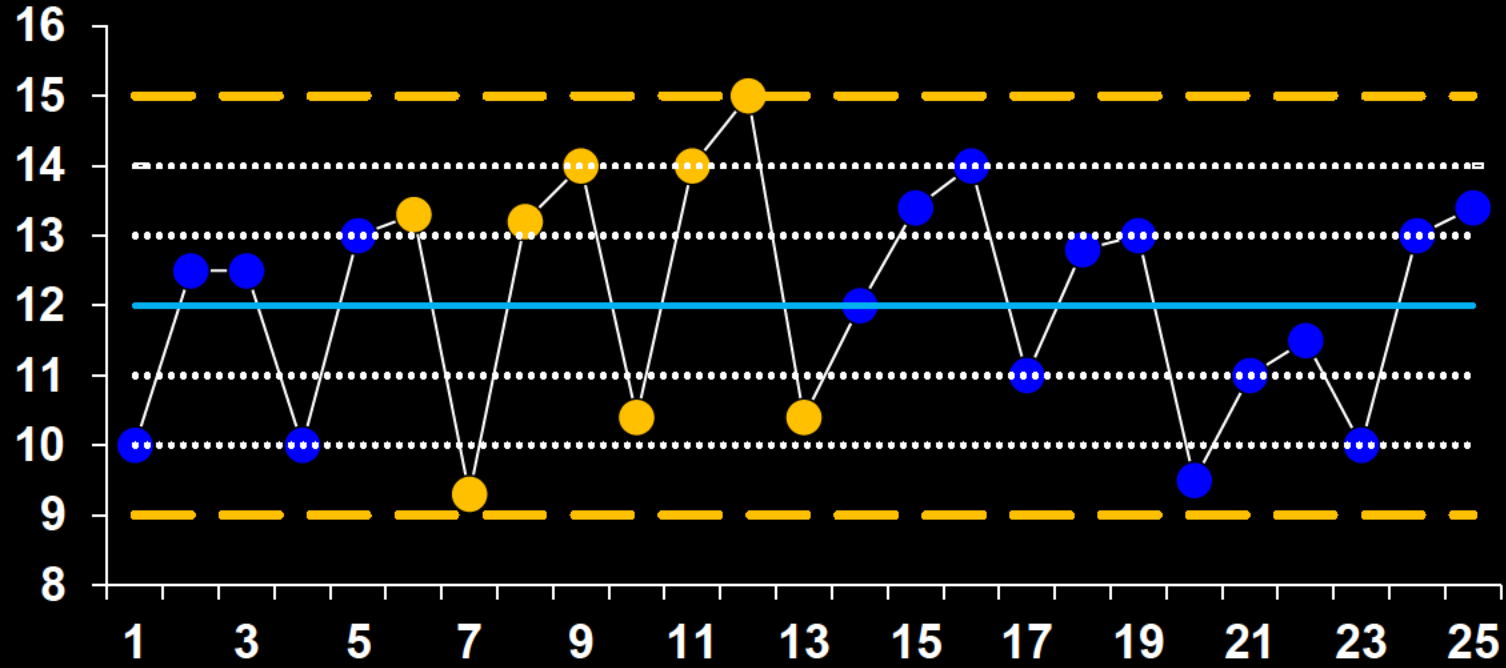
Four (or five) out of five points in a row are more than 1 standard deviation from the mean in the same direction (shift)

Lack of Variability Chart Rule 7



15 Consecutive points inside the center 1/3 (or one standard error)

Process Mixture Chart Rule 8



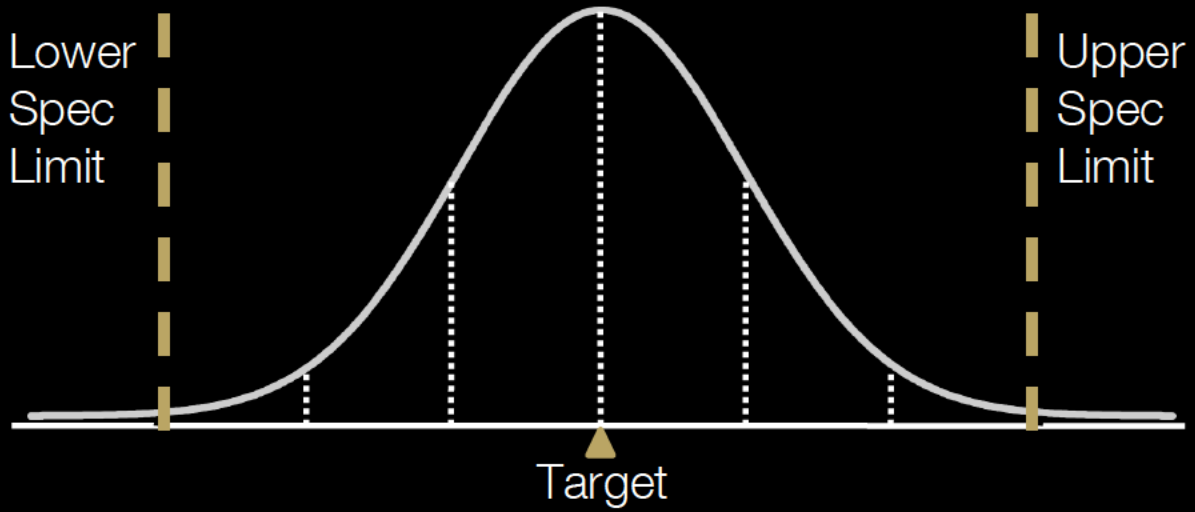
Eight points in a row avoiding Zone C (1 sigma from centerline) with points in both directions from the mean

Caution

- Using too many simultaneous decision rules requires care and could result in dramatic increase in our overall Type I error

7. Assess Process Capability

Control is **not** Capability!!!



Process Capability

- Conformance to design specifications
- Requires a state of control
- Involves spread and location for variables data
- Compares performance to standard for attributes data

Process Capability

- There are multiple measures, each tell us a different story:
  - Ability to meet Tolerance (spread)
  - Ability to produce to in Specification
  - Ability to produce to Target

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
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- 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