c Charts: Control Charts for Count Data

Data Science for Quality Management: Control Charts for Discrete Data

with **Wendy Martin**

Learning objectives:

Differentiate between the Binomial and Poisson distributions

Create centerlines for a c chart

c Charts Introduction

- Used for monitoring the number of occurrences of a specified event in a specified inspection unit

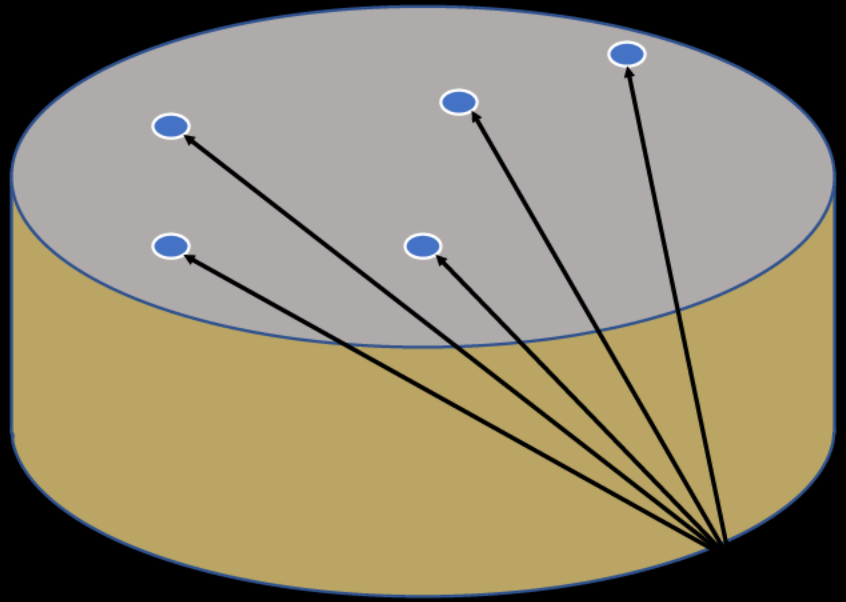
- Inspection units can be length, area, number of parts, volume, or time

c Charts Introduction

- Often used to monitor nonconformities (defects)

- Exact control limits are based on a Poisson distribution

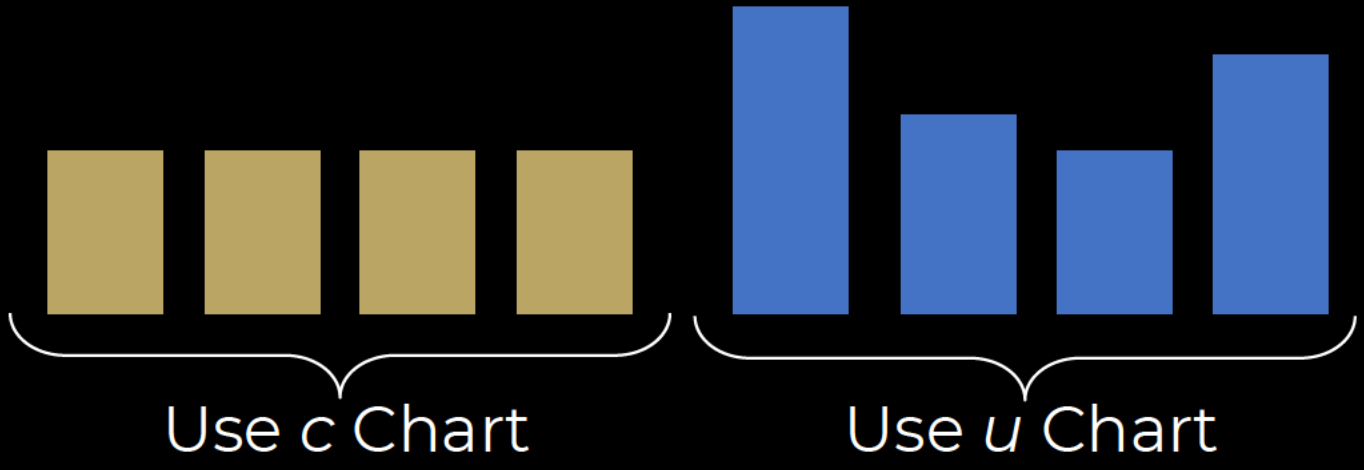
Example - Nonconformities



Nonconformities
$c = 5$

c Charts Introduction

- Use c charts with constant unit sizes
- Use u charts with varying unit sizes



Examples

- Breaks in wire insulation per 500 feet coil
- Rips and rends per yard cloth
- Cracks or scratches per plastic molding length
- Air bubbles per sheet of glass
- Customer complaints per month
- Safety accidents per worker hour
- Phone calls per hour
- Line stoppages per hour

c Charts Introduction

- Make sure to distinguish between charts for nonconforming or defective units, and nonconformities per unit
- In the case of p and np charts, you can count both conforming and nonconforming / defective units
- In the case of c and u charts, you can have more nonconformities / defects than the number of parts or units you inspect

The Case of the #12 Insulated Wire Supplier

- A purchasing agent asks you to help them conduct a quality assessment of material from a potential new supplier.

- In this case, the purchased material is #12 insulated wire.

Case Background

- The industry standard for this insulated wire is an average of 27.5 defects per 200 linear yards
- The new supplier promises to deliver a higher quality material at a lower price
- Coils of wire were sampled from the supplier's new process during a DFSS start-up

Case Background

- The supplier has sent 25 coils of wire, 3000 yards each, for you to inspect

- A coil was sampled from the production line every 10 minutes and was labeled with the time of production

Step 1 — Select a Characteristic

- Your concern is the number of defects in the insulation, seen as breaks in the insulation.
- You have had difficulty with suppliers in the past with this characteristic.
- You have an acceptable evaluation method for assessing this characteristic.

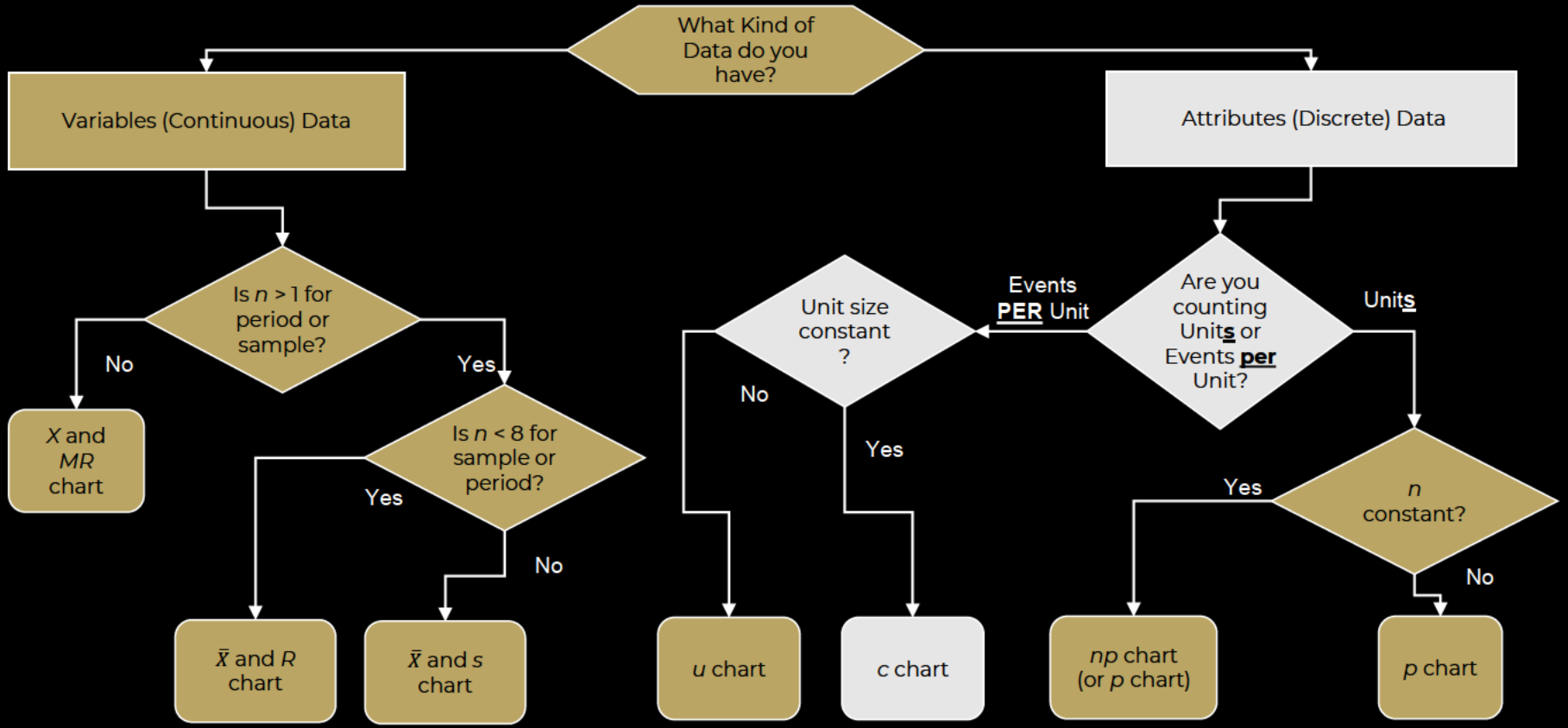
Step 2 — Sampling Plan

- Take one coil every ten minutes from a four-hour production run for a total of 25 coils.
- Inspection unit size is 200 linear yards.
- Randomly sample one 200-linear-yard section from each of the 25 coils and record the number of defects (breaks) found.

Step 3 — Select a Chart Type

- You are monitoring the number of nonconformities per inspection unit
- You have constant inspection unit sizes
- Select the c chart

Step 3: Select the Chart



Step 4 — Collect Data

- Data collected according to the sampling plan

- The file has the number of breaks per 200-linear-yard samples of insulated wire

Step 5 — Generate Chart

In Rstudio

```
spc.chart.attributes.counts.c.
poissondistribution.simple( )
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Sample Statistics

- For a c chart, the sample statistics (c) are the number of occurrences (defects / nonconformities) for each sample

Centerline(s)

- The centerline for the c chart is the average number of occurrences per inspection unit

$$\bar{c} = \frac{\sum c}{k} = 21.36$$

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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- Littlejohn, R., Ouellette, S., & Petrovich, M. Black Belt Business Improvement Specialist Training, Luftig & Warren International, 2000
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