Assessing Capability with Non-Normal Data - Exponential

Data Science for Quality Management: Process Capability

with **Wendy Martin**

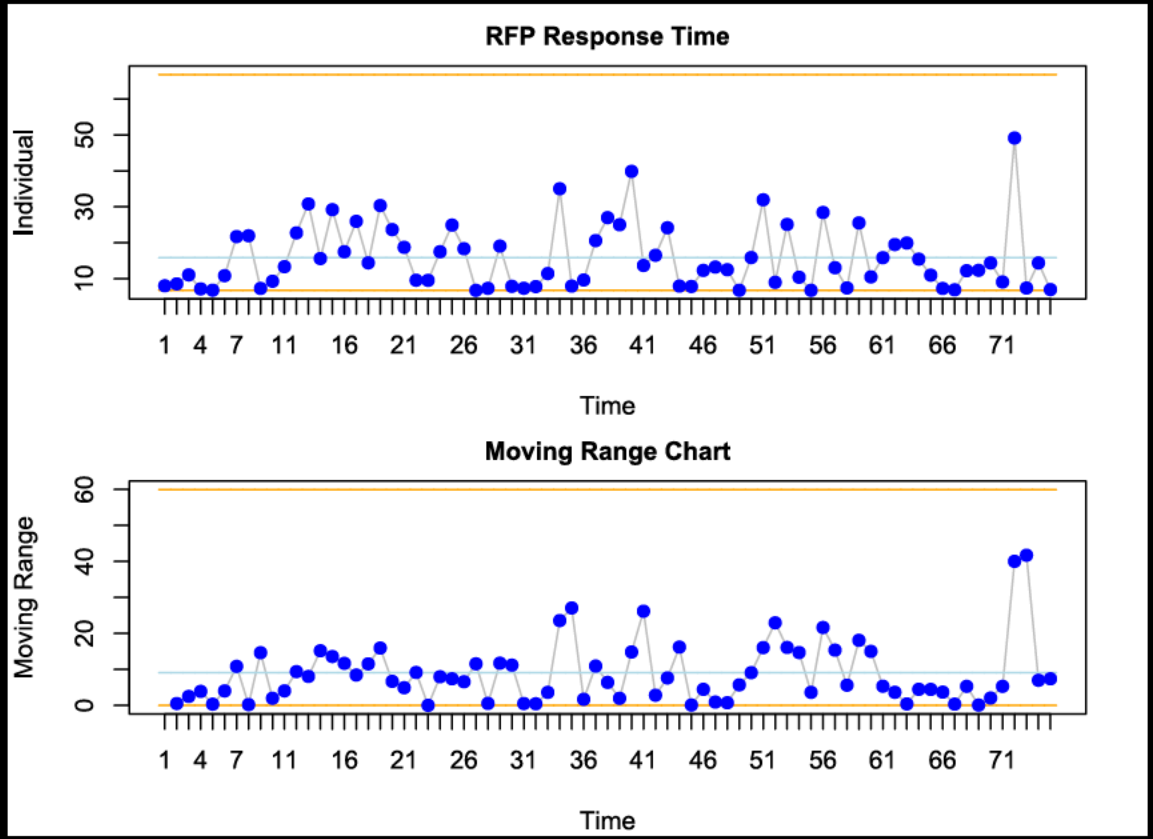
Learning objective:

Assess capability / performance from a non normal distribution with exponentially distributed data

Step 6 — Assess Process Control

- We will use the Request For Proposal (RFP) Cycle Time Problem to demonstrate calculating process capability using the exponential distribution.

Step 6 — Assess Process Control



Process Capability
Exponential Distribution

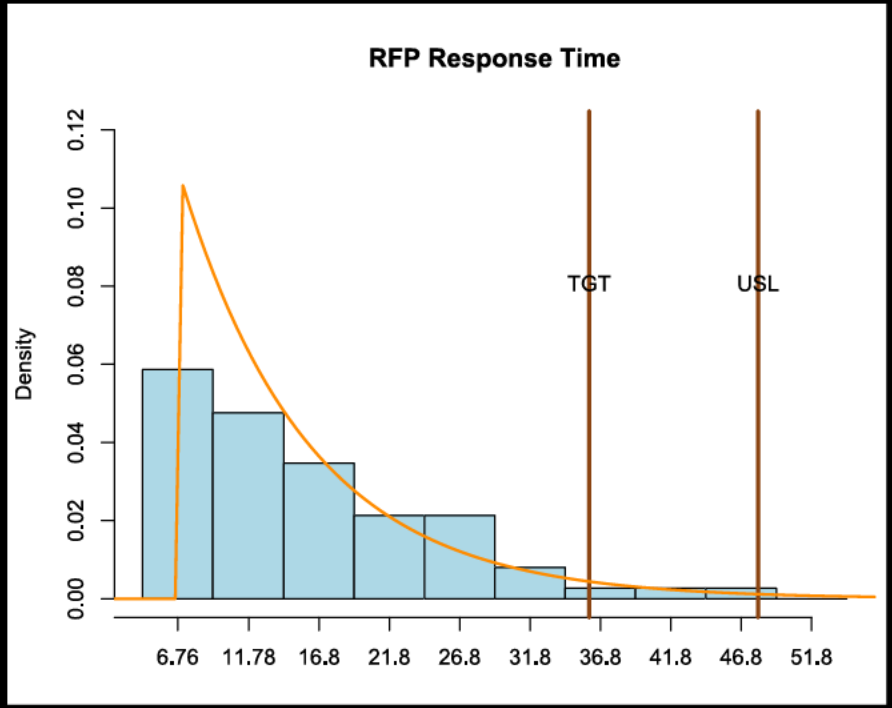
The Request For Proposal (RFP) Cycle Time Problem:

- A Brand Marketing Agency is currently the second largest agency in the country.
- Their services includes branding, website design, ecommerce solutions, graphic design, and digital marketing.

Process Capability
Exponential Distribution

- Periodically, the company receives an RFP, which must be processed and answered within 48 hours, or they lose the opportunity to acquire the business. Ideally (i.e. nominally), they would like to process a response in 36 hours.

Exponential Distribution




```
Shapiro-Wilk Test for
Exponentiality

data:  input data
W = 0.014175,
null hypothesis W statistic = 1,
p-value = 0.9287
alternative hypothesis: true W
statistic is not equal to 1
sample estimates:
          W sample.size
 0.01417539 75.00000000
```

Step 7 — Assess Potential Capability

```
# Send data to an object named “data”
data<-RFP$Time
```

Step 7 — Assess Potential Capability

```
# Get natural tolerance for Exponential Low Distribution for the individual values

nt.exp.low<-natural.tolerance.exp.low(x = RFP$Time,low = min(RFP$Time))
```

Step 7 — Assess Potential Capability

```
# Define inputs
LSL        <- NA
Target     <- 36
USL        <- 48
```

Step 7 — Assess Potential Capability

```
# Define inputs – proportion out of spec
l.out     <- pexp.low(q = LSL, low = min(data), mean = mean(data), lower.tail = T)
u.out     <- pexp.low(q = USL, low = min(data), mean = mean(data), lower.tail = F)
total.out <- l.out + u.out
```

Step 7 — Assess Potential Capability

```
# Define inputs – center, variability, NT’
median    <- median(data)
mean      <- mean(data)
nt_est    <- nt.exp.low$natural.tolerance
s         <- sd(data)
```

Step 7 — Assess Potential Capability

```
# Define inputs – Actual out of spec
obs.above.spec <- sum(data > USL)
obs.below.spec <- sum(data < LSL)
totaln         <- length(data)
```

Step 7 — Assess Potential Capability

```
spc.capability.summary.ungrouped.nonnormal.simple.R()
```

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