Assessing Capability with Non-Normal Data - Lognormal Transformation

Data Science for Quality Management: Process Capability

with **Wendy Martin**

Learning objective:

Assess capability / performance from a non normal distribution with lognormal transformed data

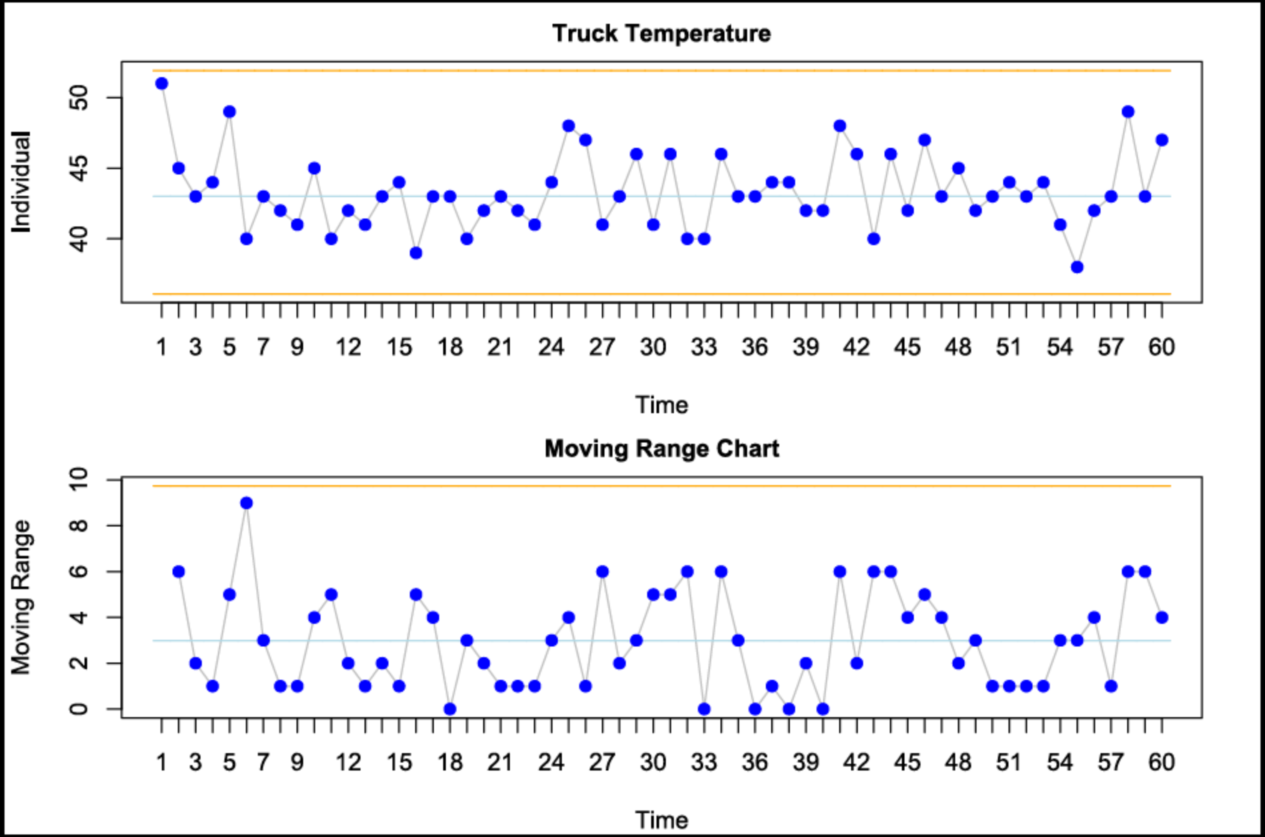
Step 6 — Assess Process Control

- We will use the Food Distributor Delivery Problem to demonstrate calculating process capability using the lognormal transformation.

Assess Process Control for Non-Normal Data

- Regardless of the type of chart used, process capability must consider the shape of the underlying distribution.

Step 6 – Assess Process Control



Process Capability

Lognormal Transformation

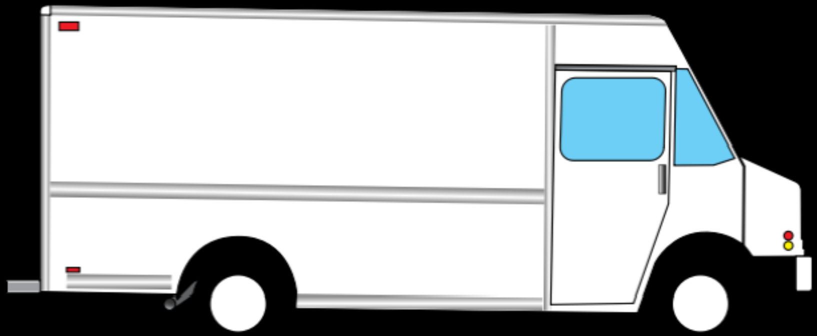
The Food Distributor Delivery Problem:

- Currently, for the food category in question, the temperature of the refrigeration unit upon delivery is supposed to be between 37 and 49 degrees, and ideally (Nominal) at 43 degrees.

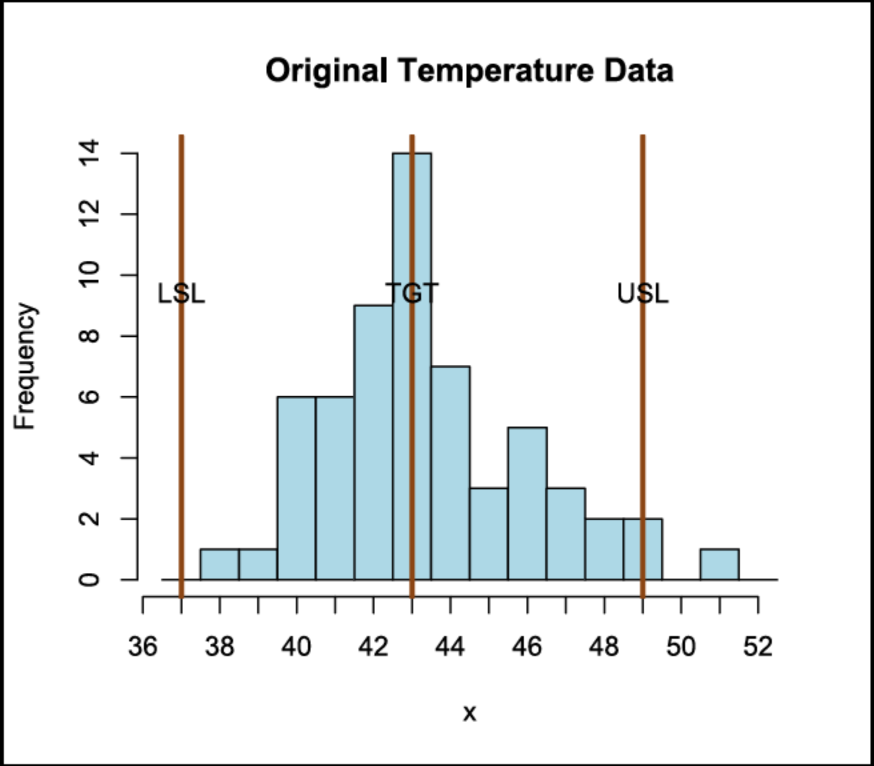
Process Capability

Lognormal Transformation

- Each time a truck arrives with a temperature outside of these limits, the truck is rejected; the food is declared to be "spoilage", and a claim filed against the Distributor.

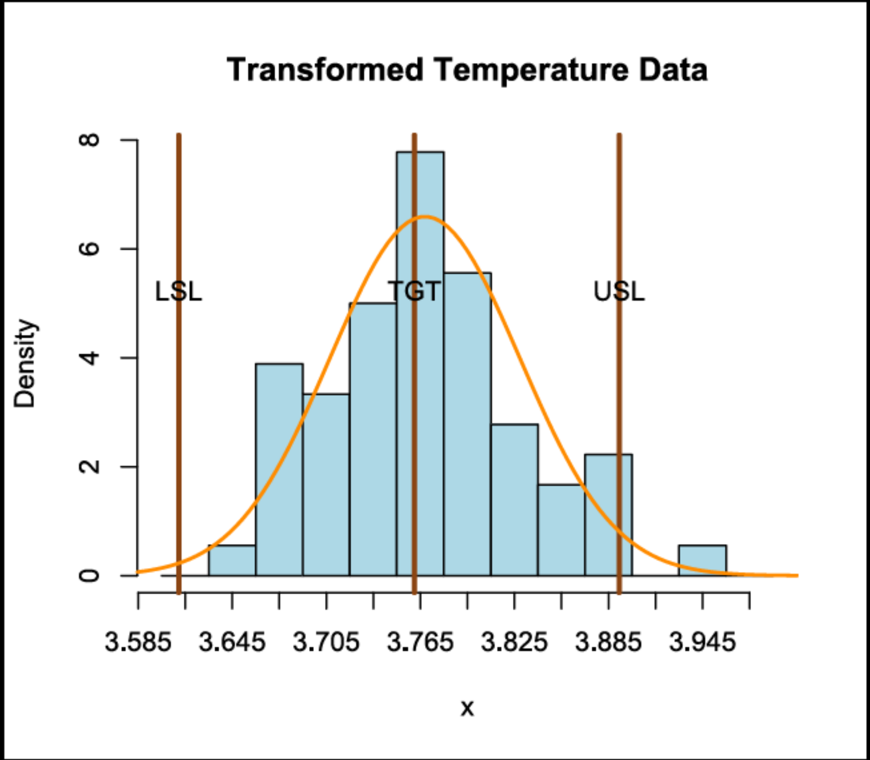


Transforming Non-Normal Distributions




```
nqtr(summary.continuous(Delivery$Temp)
, 5)
n            60
mean         43.36667
var          7.08362
g3.skewness  0.63363
g3test.p     0.04312
g4.kurtosis  0.31915
g4test.p     0.47427
```

Transforming Non-Normal Distributions




```
nqtr(summary.continuous(Delivery$lntemp)
,5)
n            60
mean         3.76788
var          0.00366
g3.skewness  0.46738
g3test.p     0.12596
g4.kurtosis  0.11273
g4test.p     0.68757
```

NOTE: Specifications were transformed!

```
> Delivery$lntemp<-
log(Delivery$Temp)
```

Step 7 — Assess Potential Capability

```
# Send data to an object named “data”
data<-Delivery$Temp
```

Step 7 — Assess Potential Capability

```
# Get natural tolerance for Lognormal Distribution for the individual values

f<-function(p,lower.tail)

{

  qlnorm(p = p, meanlog = mean(log(data)), sdlog = sd(log(data)), lower.tail = lower.tail)

  }
```

Step 7 — Assess Potential Capability

```
# Define inputs
LSL       <- 37
Target    <- 43
USL       <- 49
```

Step 7 — Assess Potential Capability

```
# Define inputs – proportion out of spec

l.out     <- plnorm(q = LSL,
meanlog = mean(log(data)),
sdlog = sd(log(data)),lower.tail = T)

u.out     <- plnorm(q = USL,
meanlog = mean(log(data)),
sdlog = sd(log(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    <- 
natural.tolerance(f)$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.
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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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- 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