Individuals and Moving Range Charts – Known Mathematical Model

Data Science for Quality Management: X and Moving Range Charts for Non-Normally Distributed Data

with **Wendy Martin**

Learning objective:

Recognize and test data for exponentiality

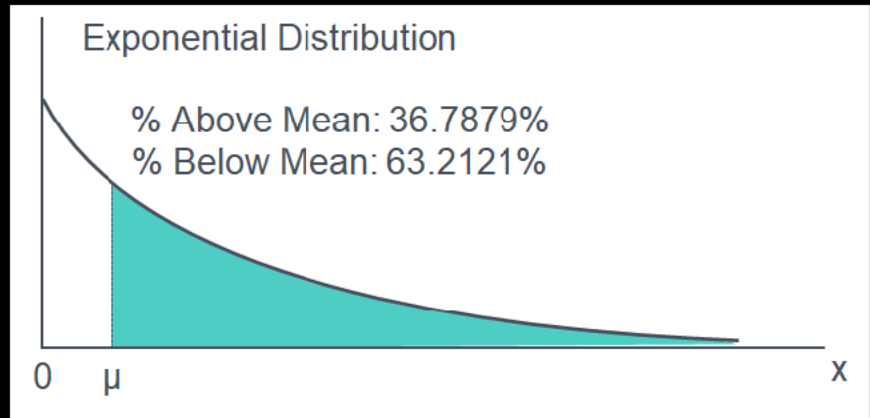# X and MR Charts Non-Normal Distributions

- The underlying distribution is non-normal, but can be represented by an alternative, known mathematical model (e.g. exponential)

The Exponential Distribution

- Although the Normal Distribution is commonly associated with many types of data sets, it is not the only continuous function which appears with great frequency in industry.

The Exponential Distribution

- The Exponential Distribution is one example of a frequently-occurring continuous function found in business and industrial situations.

Exponential Distribution

% Above Mean: 36.7879%
% Below Mean: 63.2121%

X and MR Charts Non-Normal Distributions

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.

X and MR Charts Non-Normal Distributions

- They serve industries from startup companies to large software and technology firms.

X and MR Charts Non-Normal Distributions

- 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.
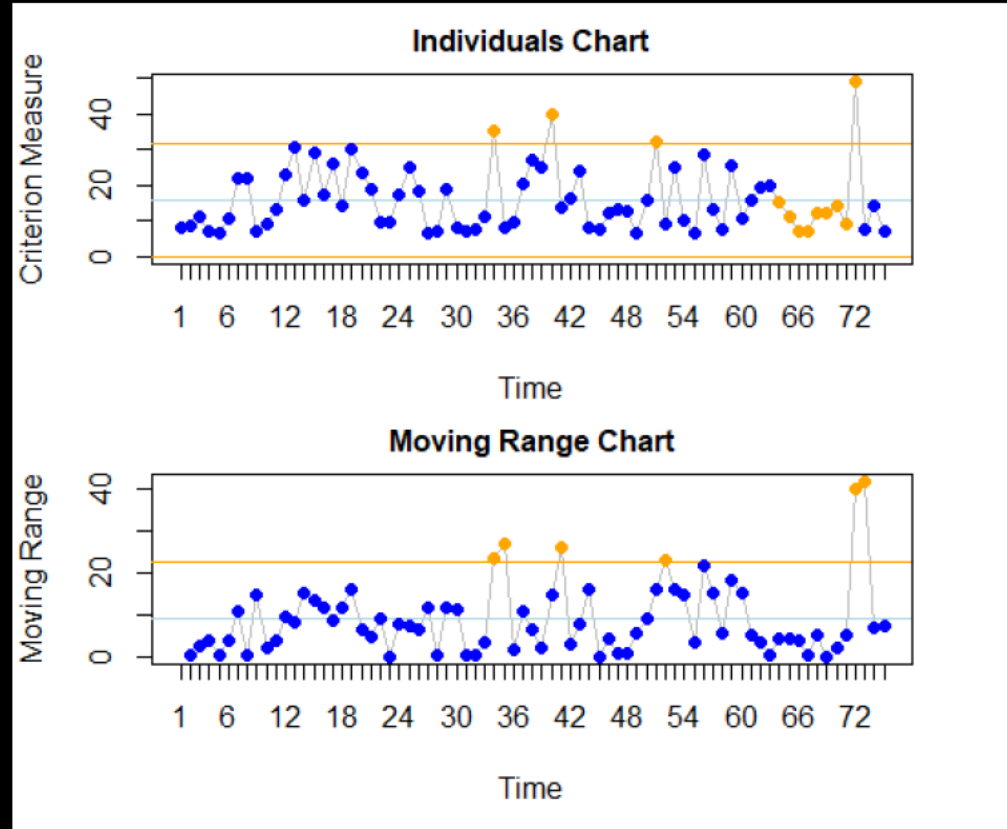
X and MR Charts Non-Normal Distributions

- Data has been collected for the last 75 RFP Responses processed, with the number of hours required for completion recorded (RFP_Response_Time.dat).

X and MR Charts Non-Normal Distributions

- In the case of these data, the worst possible decision would be to plot the data on a standard X and Moving R chart, assuming normality:
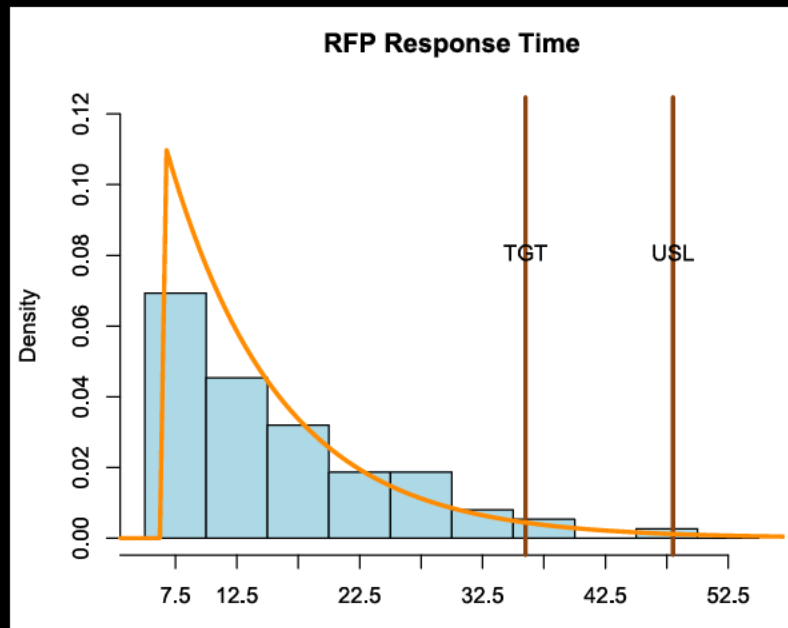
X and MR Charts Non-Normal Distributions

- ….especially after testing for normality

X and MR Charts Non-Normal Distributions: Approaches

- Conducting the moment tests for normality (n > 25)

```
nqtr(summary.continuous(RFB_Response_T
ime$Time, stat.min=T),5)
n 75
mean           15.84275
var            79.7072
min            6.76
g3.skewness    1.28236
g3test.p       0.00008
g4.kurtosis    1.72653
g4test.p       0.02277
```


RFP Response Time

X and MR Charts Non-Normal Distributions : Approaches

- Noting the data appears to be an Exponential function we could run the Shapiro-Wilks Test for Exponentiality:

```
shapiro.wilk.exponentiality.test(x = RFB_Response_Time$Time)
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
```

X and MR Charts Non-Normal Distributions

- This would cause us to infer that the RFP Response Time data was drawn from a population which could be evaluated as an Exponential Distribution.

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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- Ouellette, S. Six Sigma Champion Training, ROI Alliance, LLC & Luftig & Warren, International, Southfield, MI 2005