### Reflection

You know how to do the basics:

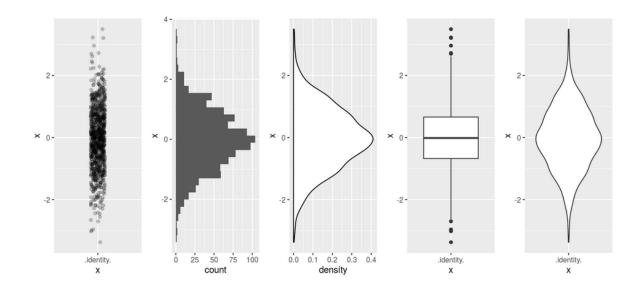
- read data into R,
- explore the data set,
- count some statistics,
- create and interpret basic plots,
- describe the plots with labels, change the style, save them.

#### Some additions...

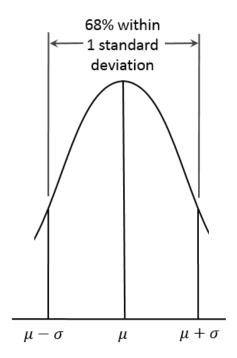
- Where do I get help?
- In cheat sheets.
- What type of graph should I choose?
- Look in R Graph Gallery.
- What colors should I use?
- Look at Color Brewer.
- See section Resources at the website for more details...

### Normal distribution

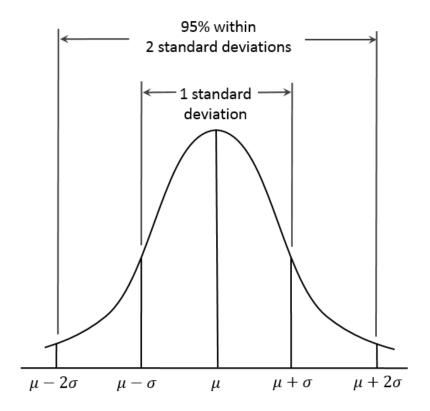
bell-shaped curve, Gaussian distribution



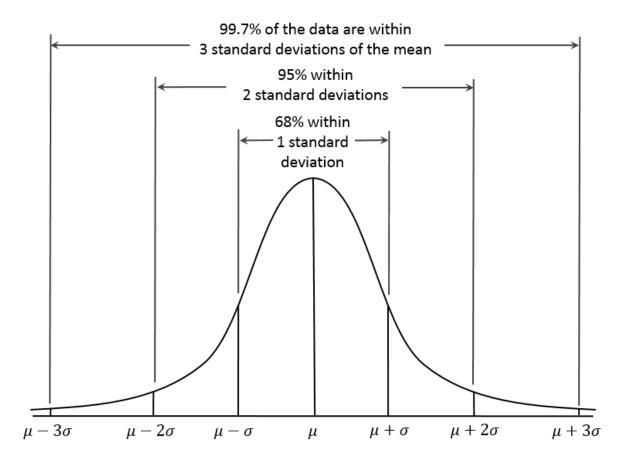
# One standard deviation (one sigma)



# Two standard deviations (two sigma)



# Three standard deviations (three sigma)



## Is my distribution normal?

### Visual aids

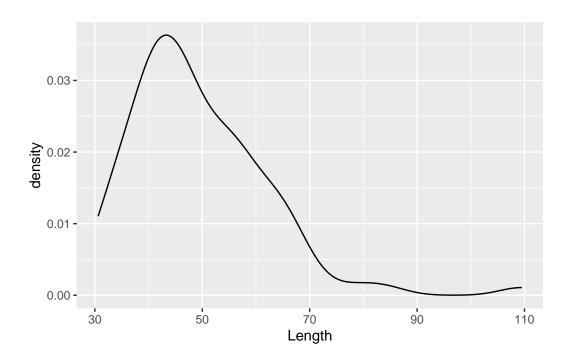
- Density plot
- Q-Q plot (quantile-quantile plot) qqnorm() or ggplot(data) + aes(sample = x) + stat\_qq()

### Statistical hypothesis test

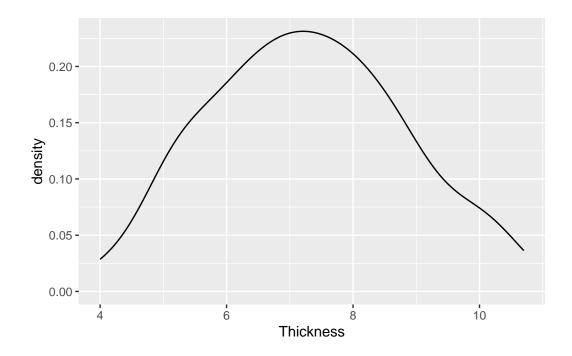
• Shapiro-Wilk test shapiro.text()

• Kolmogorov-Smirnov normality test

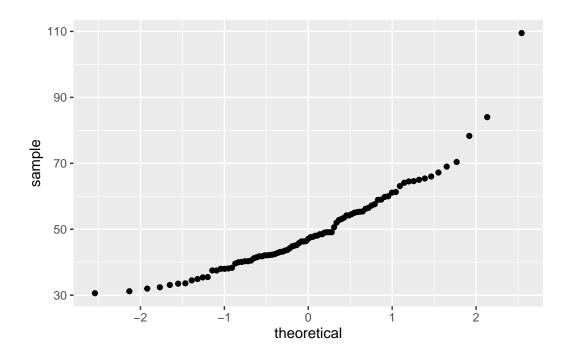
# Q-Q plot



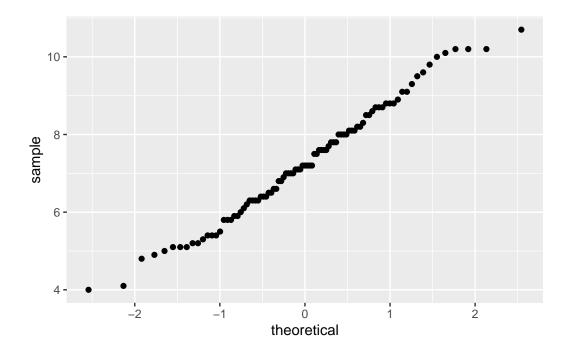
ggplot(dartpoints) + aes(x = Thickness) + geom\_density()



# ggplot(dartpoints) + aes(sample = Length) + stat\_qq()



### ggplot(dartpoints) + aes(sample = Thickness) + stat\_qq()



## Shapiro-Wilk normality test

- $H_0$  (null hypothesis): Values fit normal distribution.
- $H_A$  (alternative hypothesis): Values do not fit normal distribution.
- p-value: probability of the event that observed values fit normal distribution
- p > 0.05: Fail to reject null hypothesis.
- Significance level = 0.05 Event occurs in less than 5% of cases

### shapiro.test(dartpoints\$Length)

Shapiro-Wilk normality test

data: dartpoints\$Length
W = 0.90277, p-value = 4.852e-06

## shapiro.test(dartpoints\$Thickness)

Shapiro-Wilk normality test

data: dartpoints\$Thickness
W = 0.98623, p-value = 0.4559

## Other shapes of distributions

### **Normal distribution**

(Hill/mound shapes, symmetric, Bell shaped curve)

### Left skewed

(Tail is on the left hand side)

### Right Skewed

(Tail is on the right hand side)

### Multimodal

(There is more than one peak)

