

# Normal distribution

## Reflection

You know how to do the basics:

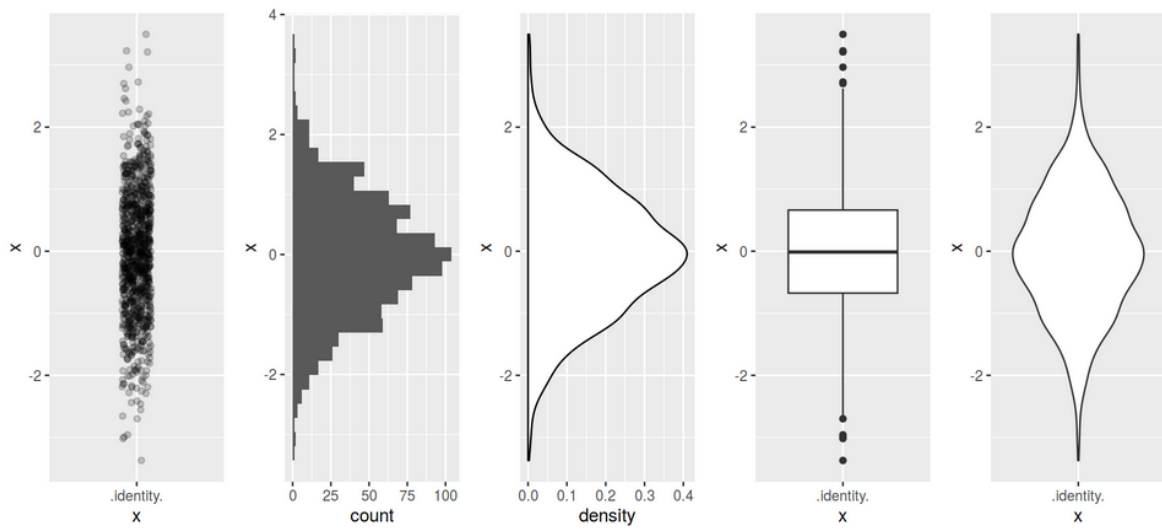
- read data into R,
- explore the data set,
- count some statistics,
- create and interpret basic plots,
- describe the plots with labels, change the style, save them.

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...

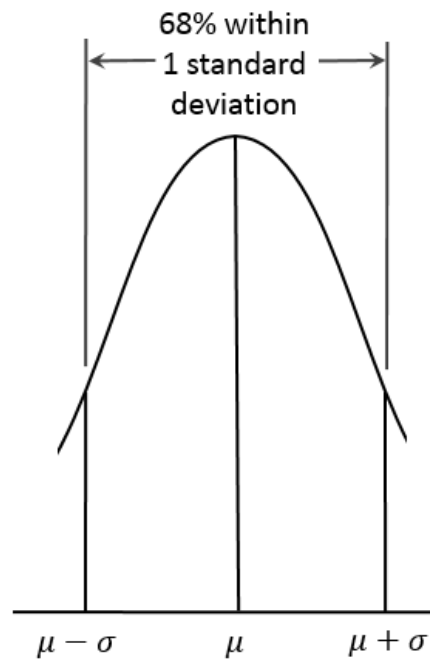
## Normal distribution

*bell-shaped curve, Gaussian distribution*



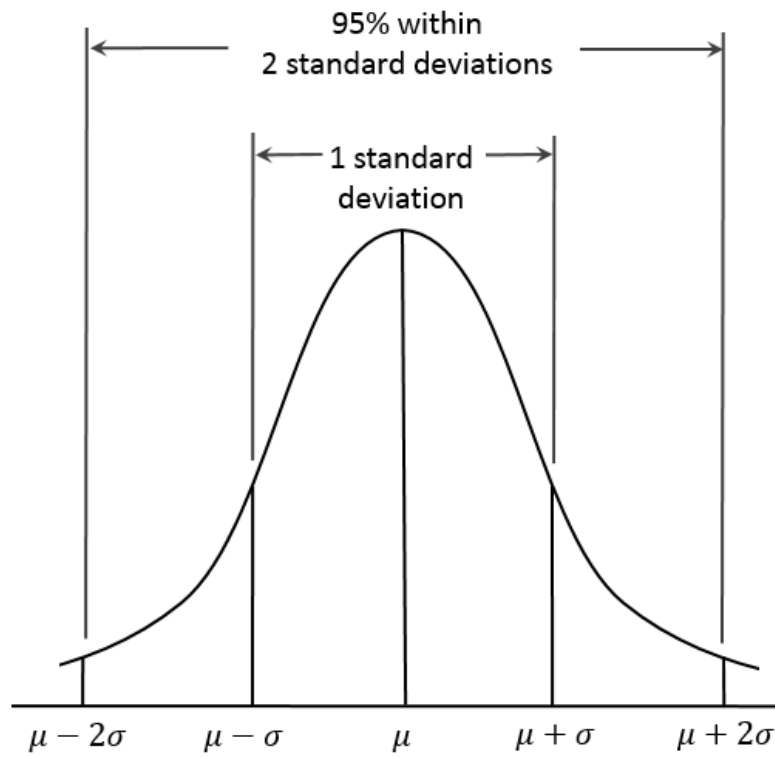
## Normal distribution

One standard deviation (*one sigma*)



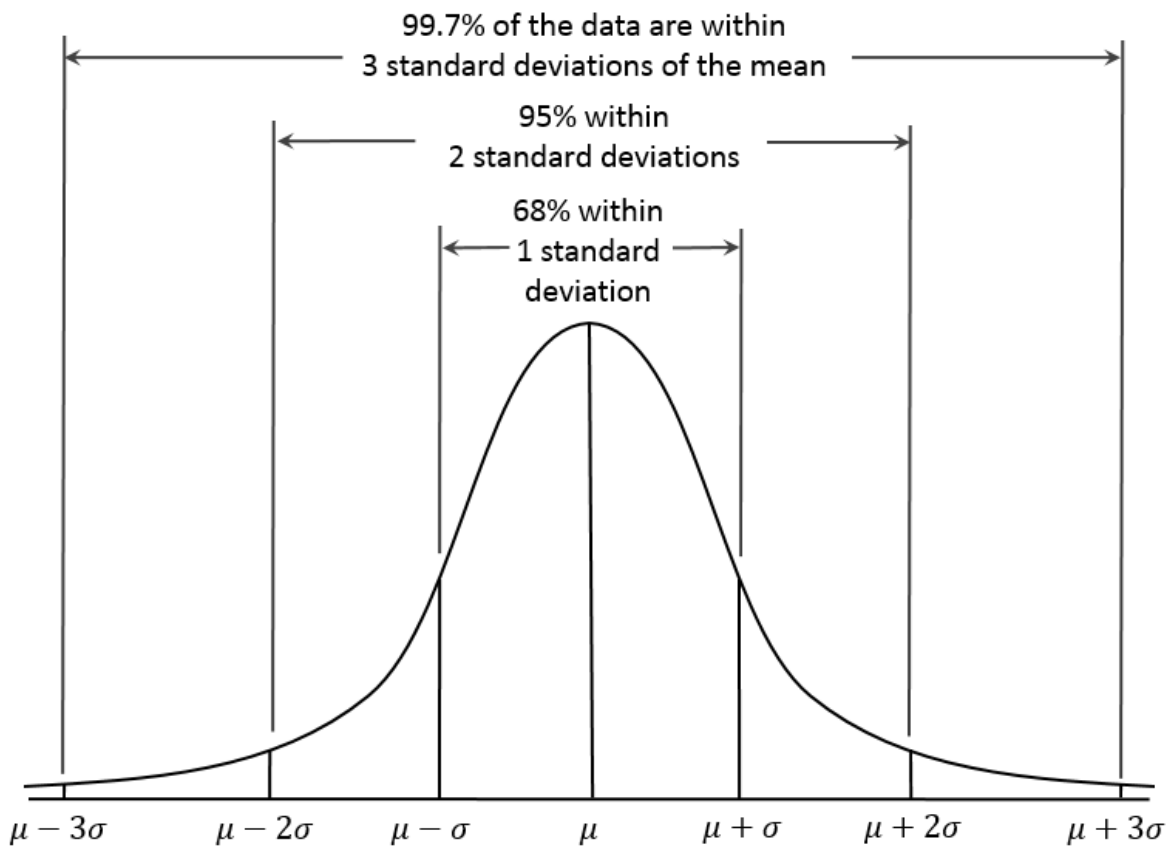
## Normal distribution

Two standard deviations (*two sigma*)



## Normal distribution

### 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()`

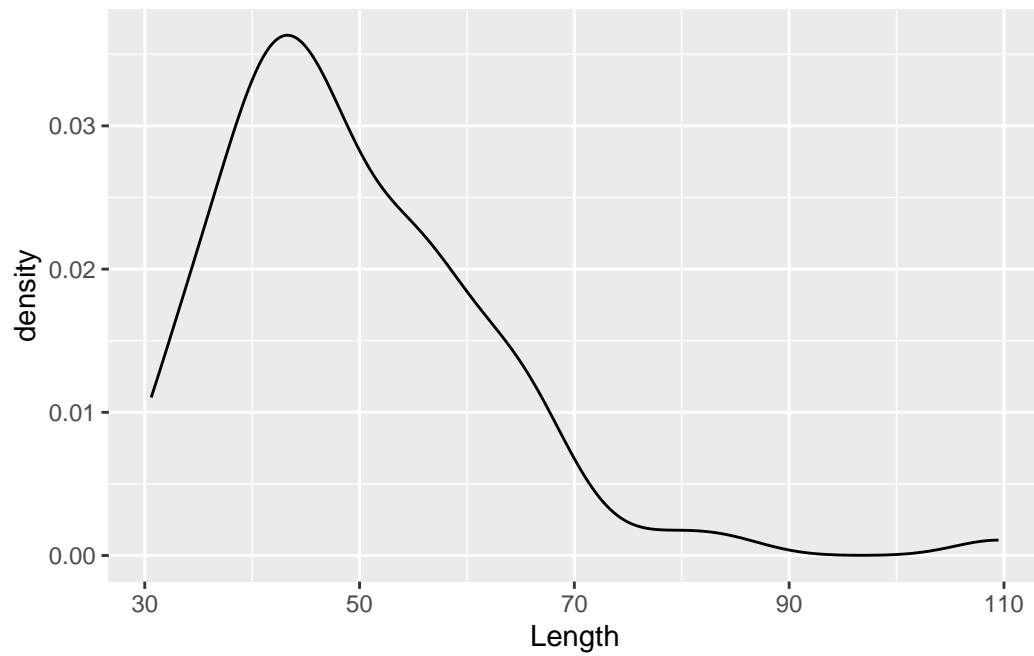
### Statistical hypothesis test

- Shapiro-Wilk test  
`shapiro.test()`

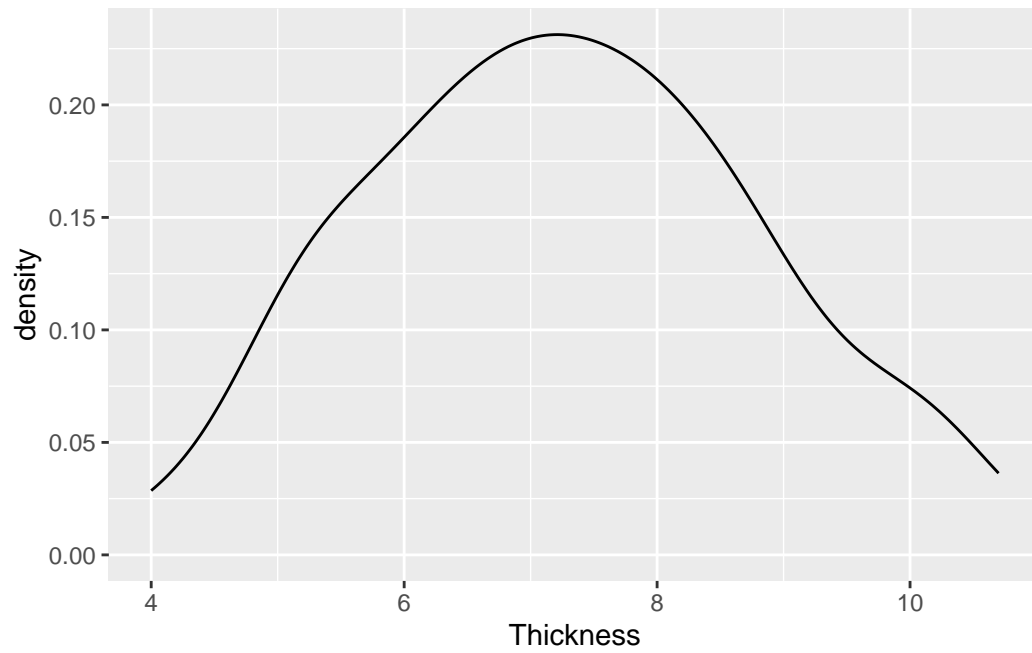
- Kolmogorov-Smirnov normality test

## Q-Q plot

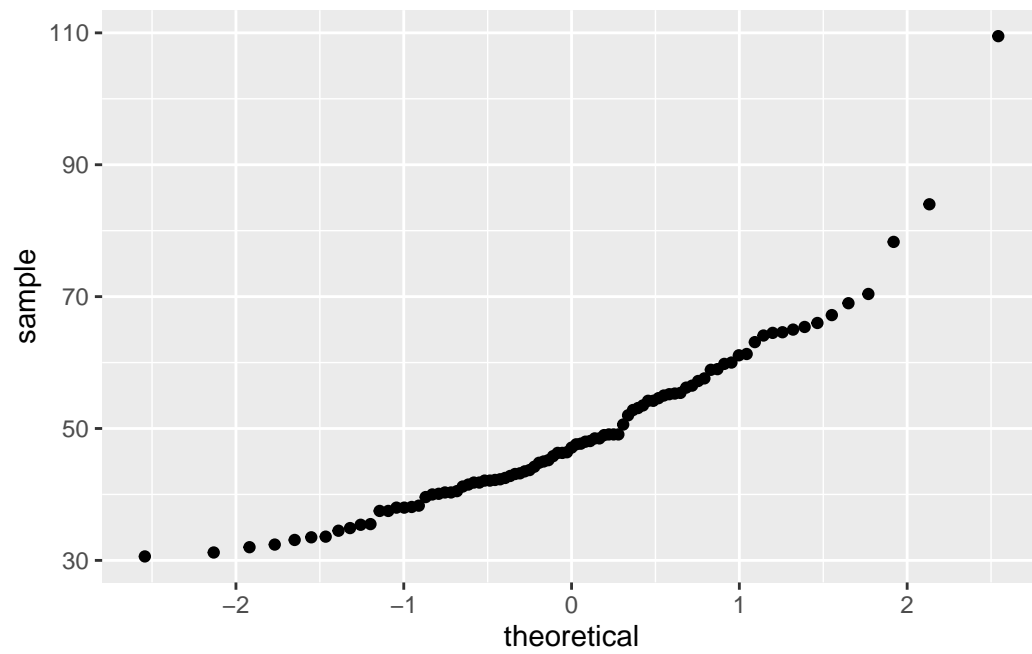
```
ggplot(dartpoints) + aes(x = Length) + geom_density()
```



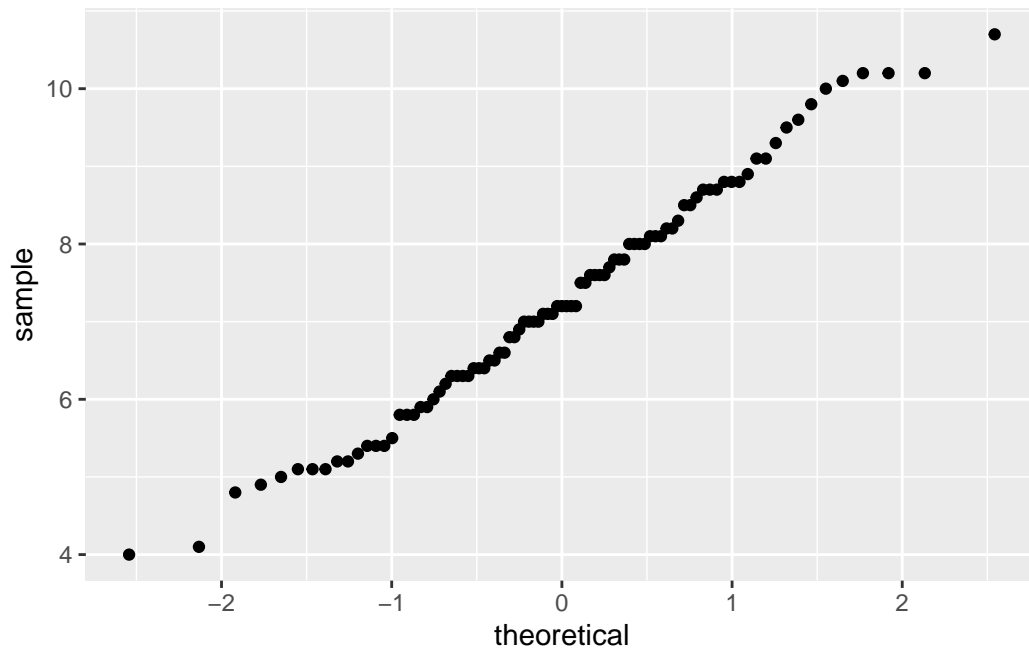
```
ggplot(dartpoints) + aes(x = Thickness) + geom_density()
```



```
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

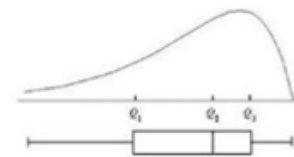
### Normal distribution

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



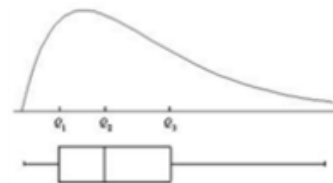
### Left skewed

(Tail is on the left hand side)



### Right Skewed

(Tail is on the right hand side)



### Multimodal

(There is more than one peak)

