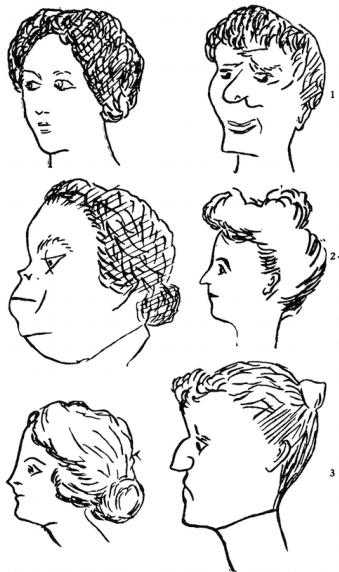


# E-411-PRMA

## Lecture 1

Christopher David Desjardins

17 August 2015



THE PSYCHOLOGICAL CLINIC is indebted for the loan of these cuts and those on p. 225 to the courtesy of Dr. Oliver F. Corman, Associate Superintendent of Schools of Philadelphia, and Chairman of Committee on Backward Children Investigation. See Report of Committee, Dec. 31, 1910, appendix.



*Extreme desespoir.  
Eufferste Verzweiffung.*



*Colere meslée de Crainte.  
Zorn mit Furcht vermischet.*

# SAT<sup>®</sup>

## ► **Topics**

- Statistics, Classical Test Theory, Reliability, Validity, Item Response Theory, Generalizability Theory, Equating, and assessments/issues specific to various fields

## ► **Assessments**

- R computer assignments (30%)
- Item writing activity (5%)
- Midterm exam (25%)
- **Final exam (50%)**

The screenshot displays the RStudio environment with the following components:

- Script Editor (Top Left):** Contains R code for a script named `26_june_intro_R.R`. The code includes comments and commands like `precol`, `precol[20,2:3]`, `precol[19:21, c(1,3,6)]`, `str(precol)`, and `attr( "variable.labels" )`.
- Console (Bottom Left):** Shows the R startup message, including the copyright notice for 2015 and the platform `x86_64-apple-darwin13.4.0 (64-bit)`. It also displays the R license and a list of contributors.
- Environment (Top Right):** Shows the `Global Environment` with the message "Environment is empty".
- Help Pane (Bottom Right):** Displays the documentation for the `separate` function from the `tidyr` package. The title is "Separate one column into multiple columns." The description states: "Given either regular expression or a vector of character positions, `separate()` turns a single character column into multiple columns." The usage section shows the function signature: `separate(data, col, into, sep = "[[:alnum:]]+", remove = TRUE, convert = FALSE, extra = "error", ...)`. The arguments section lists:
  - `data`: A data frame.
  - `col`: Bare column name.
  - `into`: Names of new variables to create as character vector.
  - `sep`: Separator between columns.

R: <https://www.r-project.org>  
 RStudio: <https://www.rstudio.com>

# Why should I learn R?

- ▶ It's free and open-source

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- ▶ Steep learning curve
  - ▶ Will provide nearly all the code
- ▶ No SPSS in this class



# Resources for R

- ▶ Icelandic resources

  - <http://kennslubanki.hi.is/search/efni/r>

  - <http://kennslubanki.hi.is/tolfraedi/myndbond/rrstudio-inngangur>

  - <http://kennslubanki.hi.is/tolfraedi/myndbond/rrstudio-fyrstu-skrefin>

- ▶ Please watch the last two videos before next class
- ▶ Please install R and RStudio before next class
- ▶ Next class will be an R workshop

What is **measurement**?

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**Nominal**

**Ordinal**

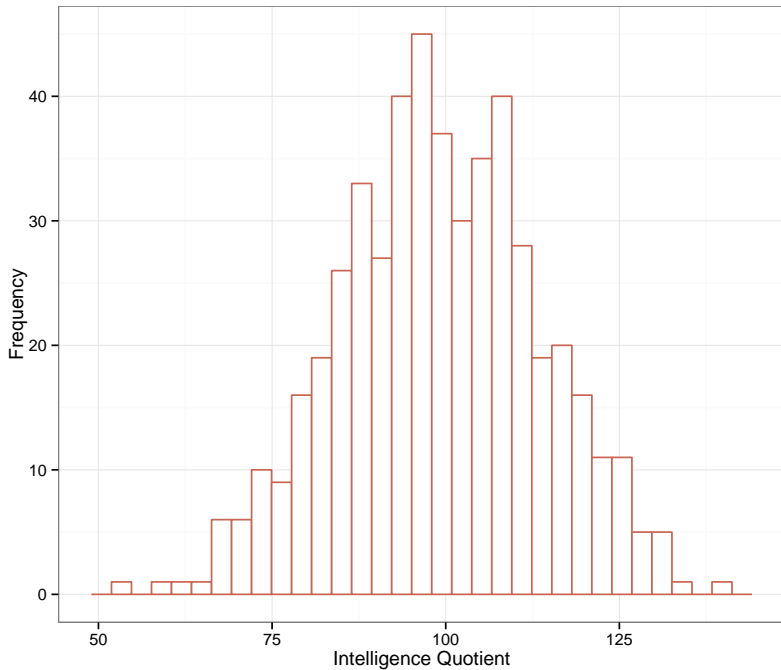
**Ratio**

**Interval**



# What kind of scales are these?

- ▶ Temperature
- ▶ Height
- ▶ Intelligence Quotient
- ▶ Color
- ▶ Ethnic group
- ▶ Likert-type items
- ▶ Job satisfaction

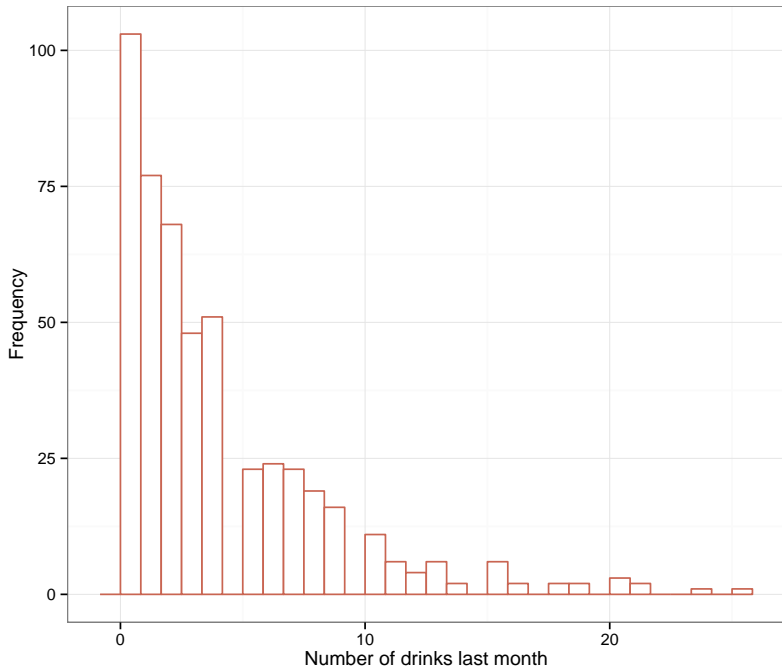


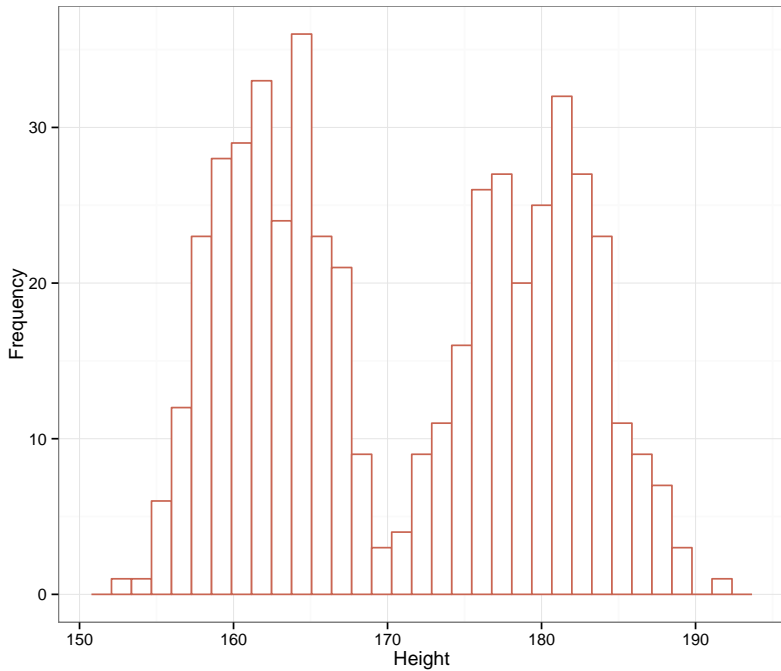
```
# Load the library
set.seed(101)
library("ggplot2")

# Set up the parameters
sample_size <- 500
mean <- 100
standard_deviation <- 15

# Generate random numbers
x <- rnorm(sample_size, mean, standard_deviation)

# Plot the data
qplot(x, fill = I("white"), color = I("#c96552")) +
  theme_bw() + xlab("Intelligence Quotient") +
  ylab("Frequency")
```





# Central Tendency Measures

## Mean

$$\bar{X} = \frac{\sum X_i}{n}$$

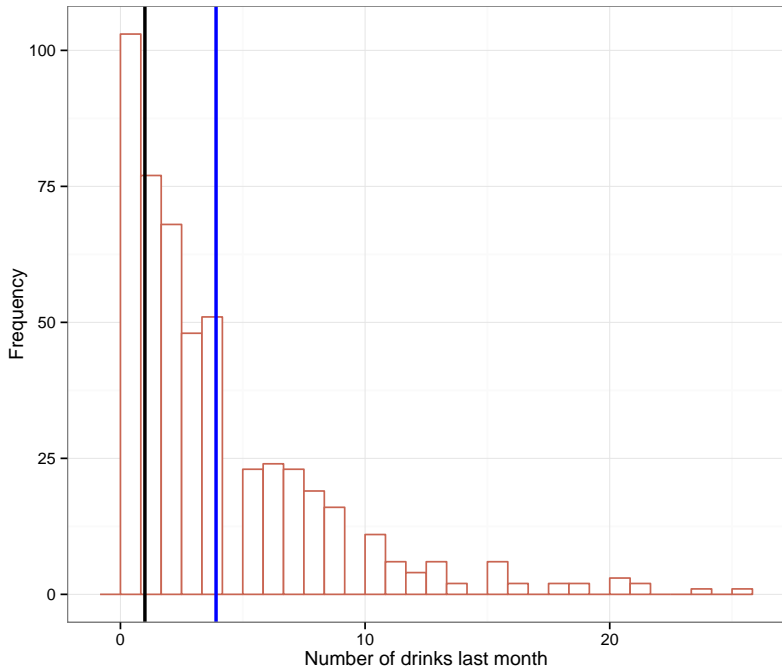
## Median

$$P(X \leq m) \geq \frac{1}{2} \text{ and } P(X \geq m) \geq \frac{1}{2}$$

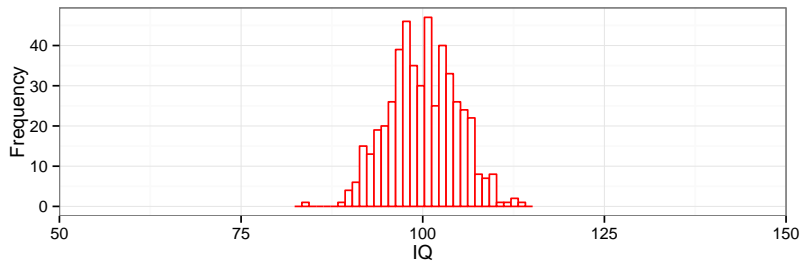
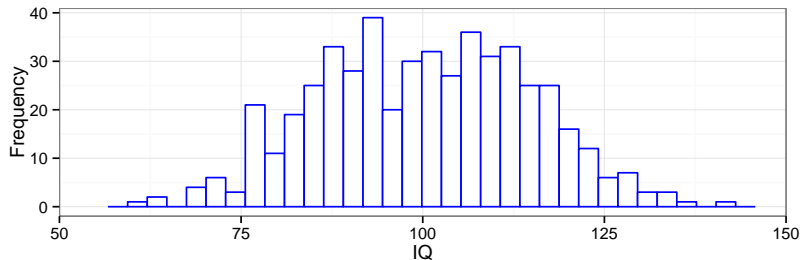
## Mode

The most frequently occurring value

Which of these statistics is most robust to outliers?



# Variability





# Measures of variability

Range

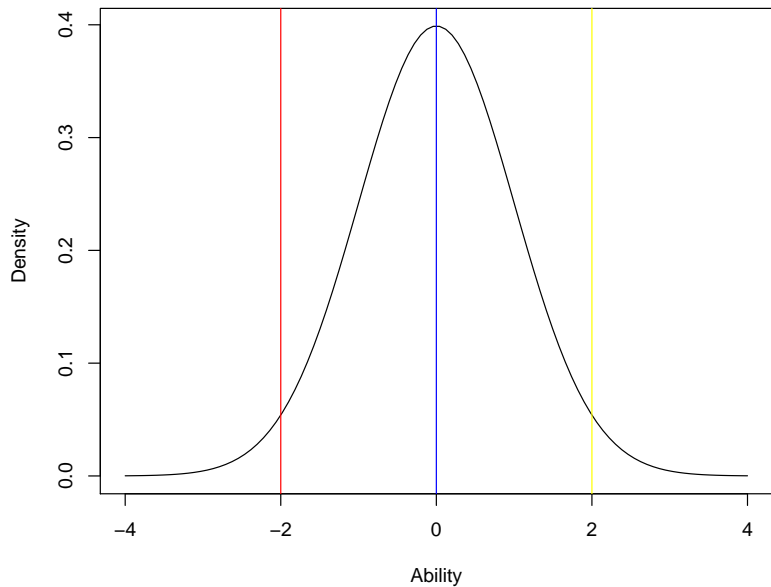
Interquartile range ( $Q_1$ ,  $Q_2$ ,  $Q_3$ )

Standard Deviation and Variance

$$s = \sqrt{\frac{\sum X_i - \bar{X}}{n - 1}}$$

$$s^2 = \frac{\sum X_i - \bar{X}}{n - 1}$$

## Normal Distribution

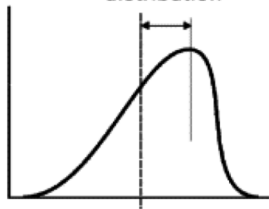


# Distributions, skewness, kurtosis

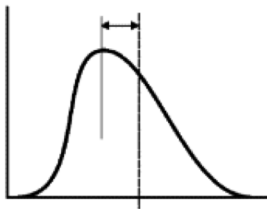
- ▶ What is a probability distribution
  - ▶ Assigns a probability, likeliness of occurrence, of a score of all possible scores
  - ▶ May be parametric or non-parametric
- ▶ What skew might you expect these outcomes to look like?
  - ▶ Reaction time in a psychological experiment
  - ▶ Number of children in a family
  - ▶ Scores on an easy test
  - ▶ Height in Iceland
- ▶ Platykurtic, mesokurtic, and leptokurtic
- ▶ Plot your data, rely less on statistics!

# Shapes of distributions

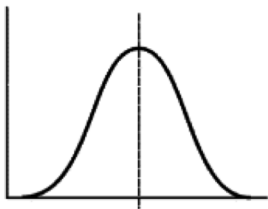
**a** Negatively skewed distribution



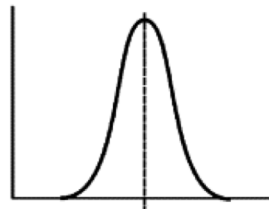
Positively skewed distribution



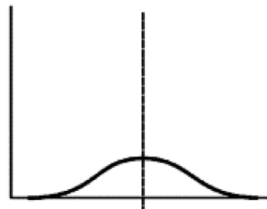
Normal distribution



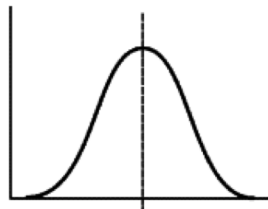
**b** Leptokurtic distribution



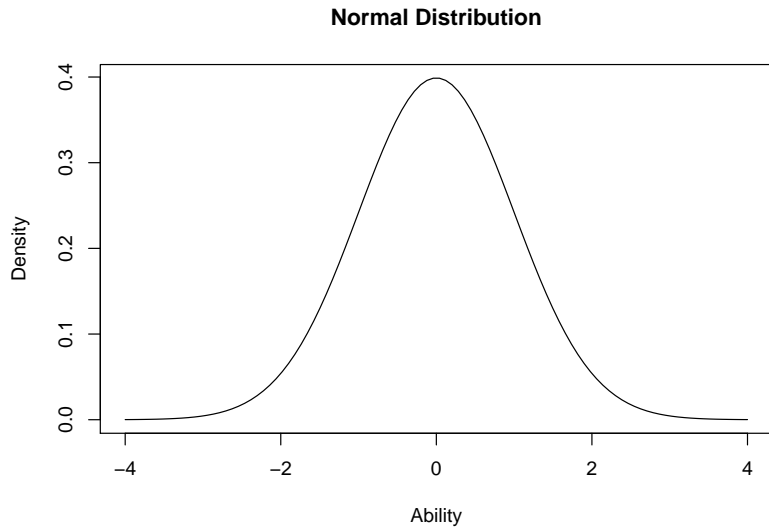
Platykurtic distribution



Normal distribution



# Normal Distribution

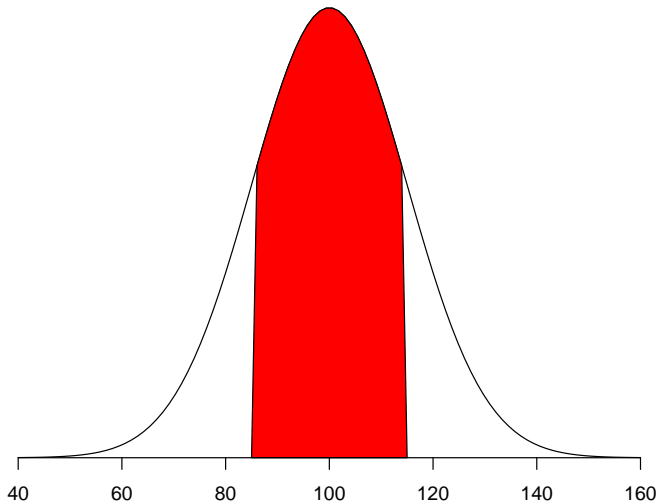


# R Normal distribution applet

# IQ - 1 Standard Deviation

## Normal Distribution

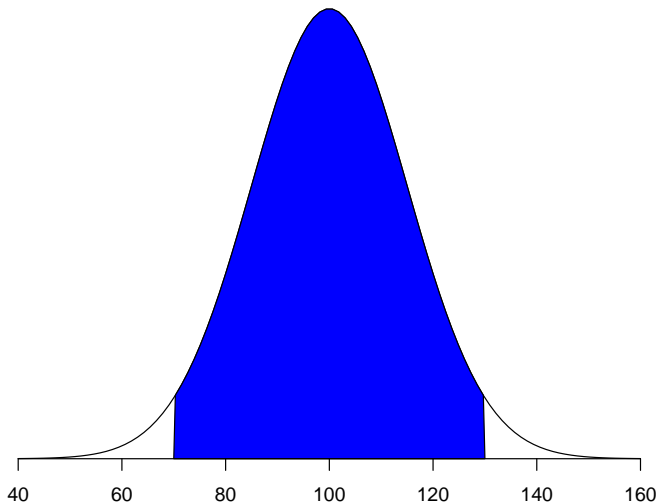
$$P(85 < IQ < 115) = 0.683$$



# IQ - 2 Standard Deviation

## Normal Distribution

$$P(70 < IQ < 130) = 0.954$$

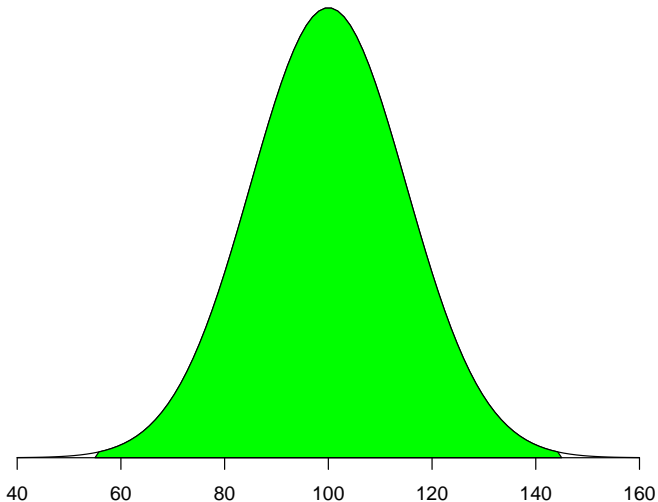




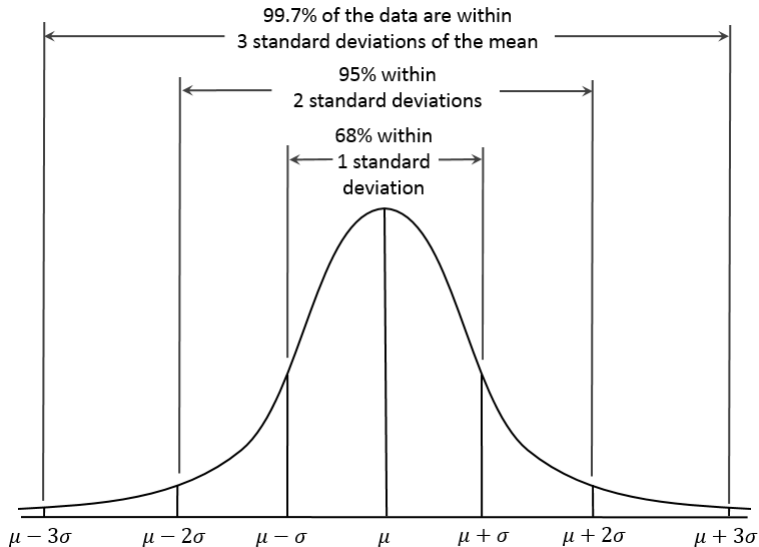
# IQ - 3 Standard Deviation

## Normal Distribution

$$P(55 < IQ < 145) = 0.997$$



# Characteristics of the Normal distribution



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$$z = \frac{x - \mu}{\sigma}$$

# SAT

The SAT is an aptitude test that high schools take. It is one of the criteria that is used in a college's decision to admit a student. It is composed of a math and a verbal section. Each has a mean of 500 and a standard deviation of 110 and is normally distributed.

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  - ▶ How many people got scores between 390 and 610?
  - ▶ If Sigga got a 350 on the math section, how many people scored below her?
  - ▶ If Einar was in the 98% percentile in math, what was Einar's score?

## Other standard scores

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  - ▶ How many people would be below you?
  - ▶ What percent of the people are between the 3rd and the 6th stanines?

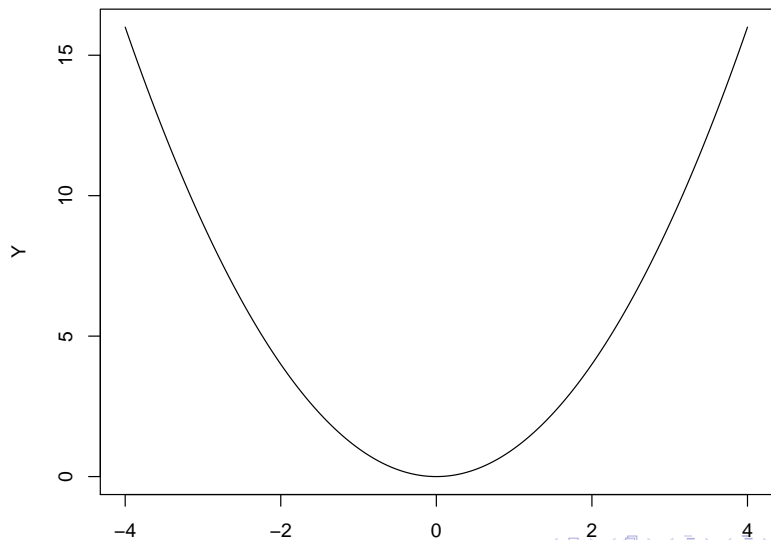
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  - ▶ What percent of the people are between the 3rd and the 6th stanines?
- ▶ Various linear and non-linear transformations are done to create scores and scores may be normalized.

# What is a correlation?

- ▶ Is it an association?
- ▶ Does it imply causation?
- ▶ Is a correlation necessary for causation?
- ▶ Does it need linearity?
- ▶ Is it affected by variability?
- ▶ Is it affected by outliers?
- ▶ Is it related to the simple linear regression?

# What is the Pearson correlation coefficient?



# Pearson correlation coefficient

$$\frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum(X - \bar{X})^2 \sum((Y - \bar{Y})^2)}}$$



# Calculating Pearson correlation coefficient

	X	Y
	5	6
	3	0
	1	0
Mean	3	2

```
x <- c(5, 3, 1)
y <- c(6, 0, 0)
cor(x, y)
```