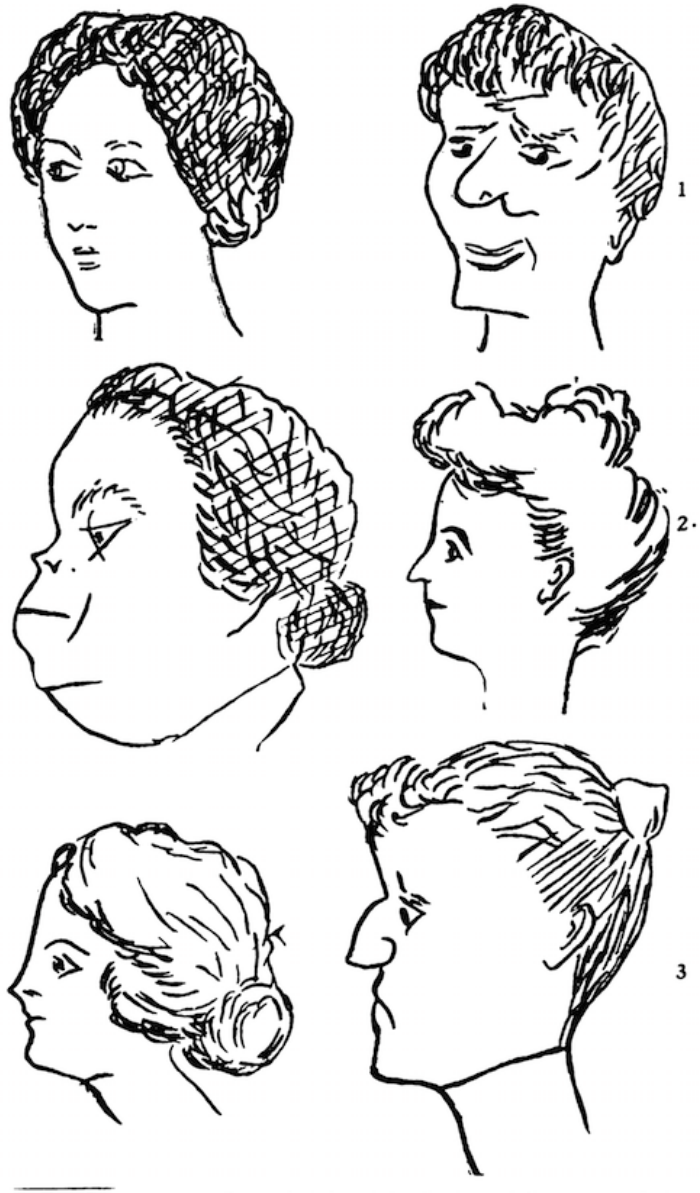
E-411-PRMA

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 P. Cornman, Associate Superintendent of Schools of Philadelphia, and Chairman of Committee on Backward Children Investigation. See Report of Committee, Dec. 31, 1910, appendix.

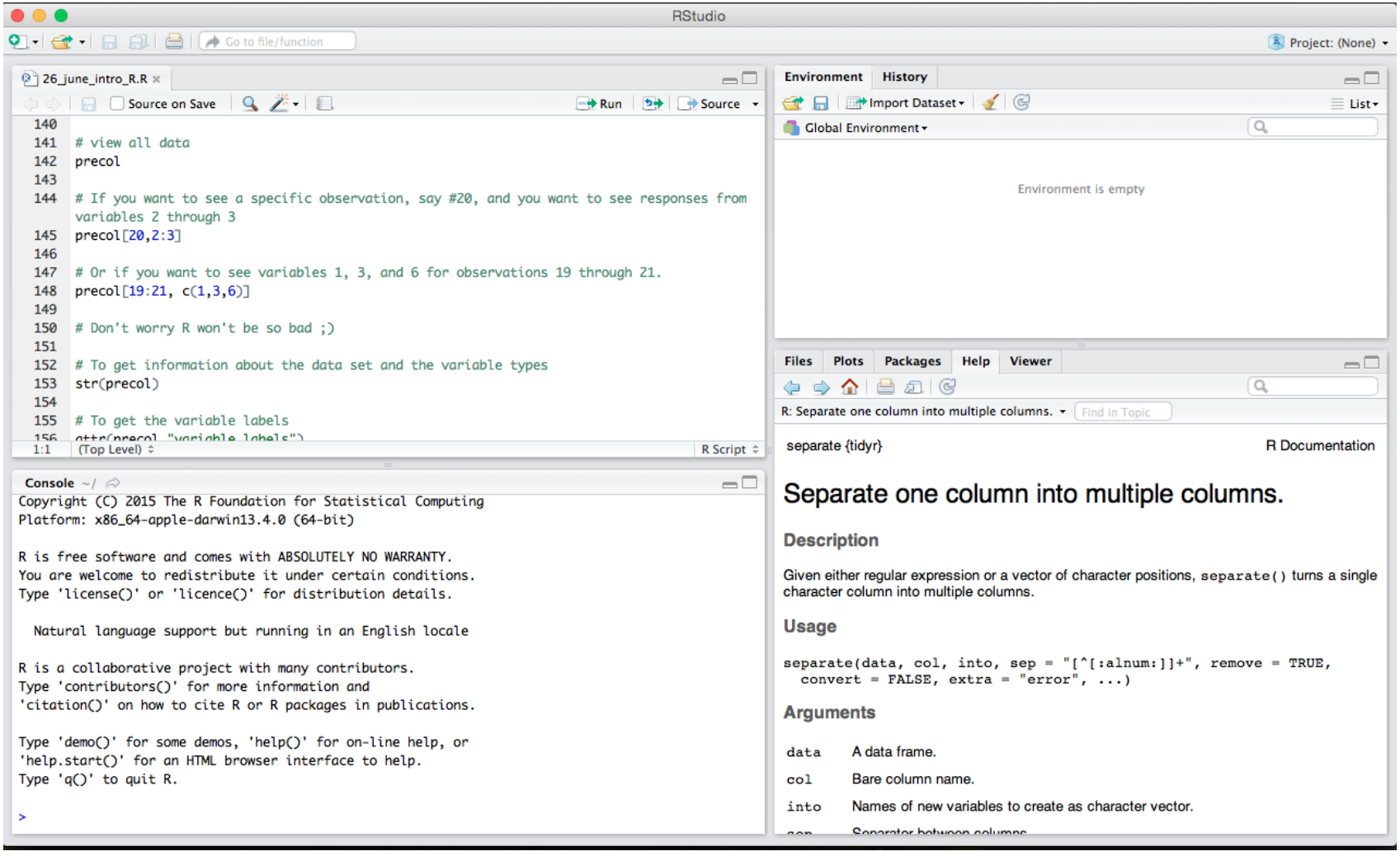
Extreme desespoir.
Euſſerſte Verzweiffung.

Colere meslée de Crainte.
Zorn mit Forcht vermiſcht.


achieve
more®
SAT®

E-411-PRMA

- **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%)



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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- Everyone is doing it
- 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

Concepts

What is **measurement**?

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What is a **test**?

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A set of numbers used to categorize or quantify variables ("things")

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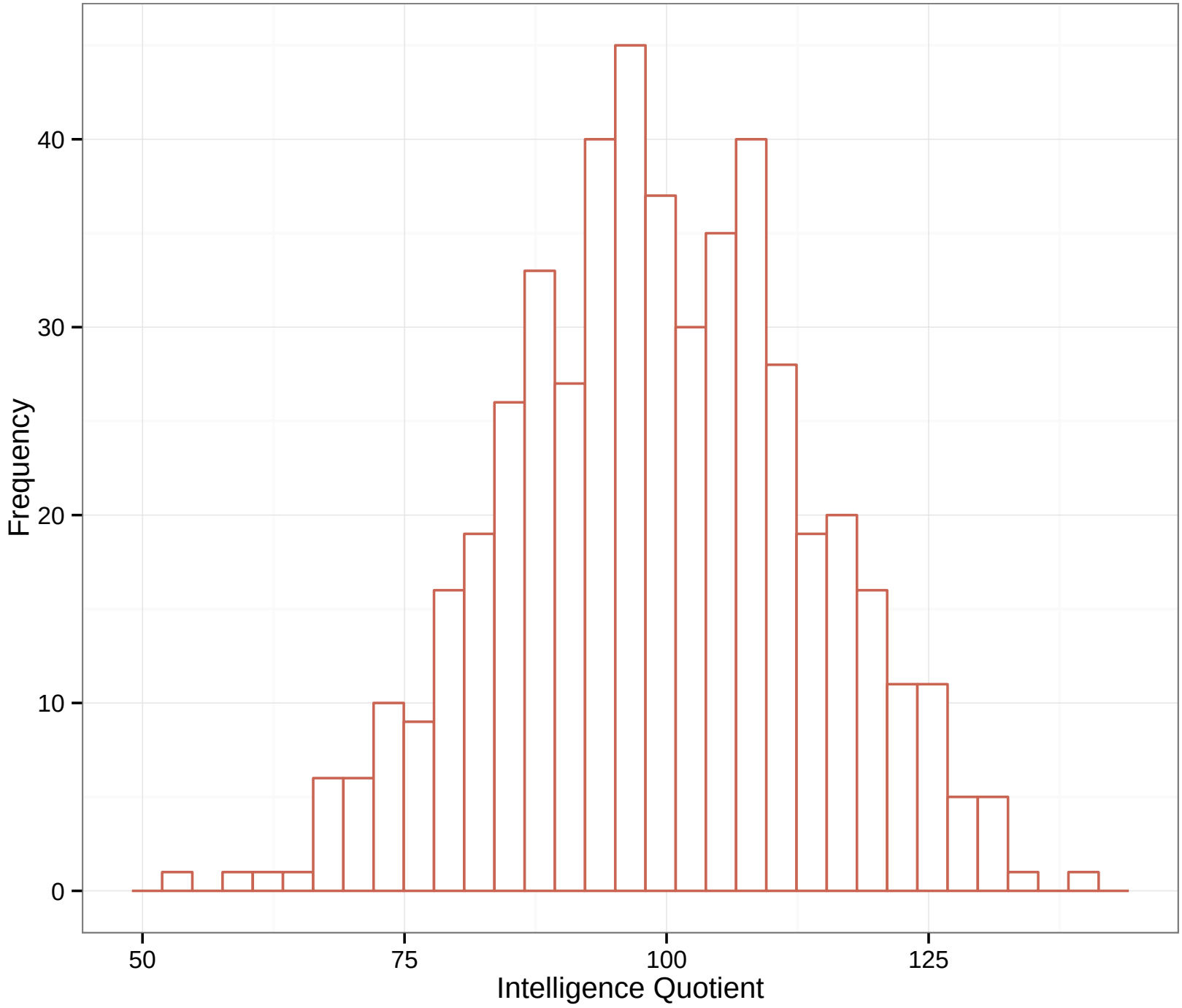
A set of numbers used to categorize or quantify variables ("things")

Nominal
Ordinal
Ratio
Interval

What kind of scales are these?

- Temperature
- Height
- Grade Point Average
- Color
- Ethnic group
- Likert-type items
- Job satisfaction

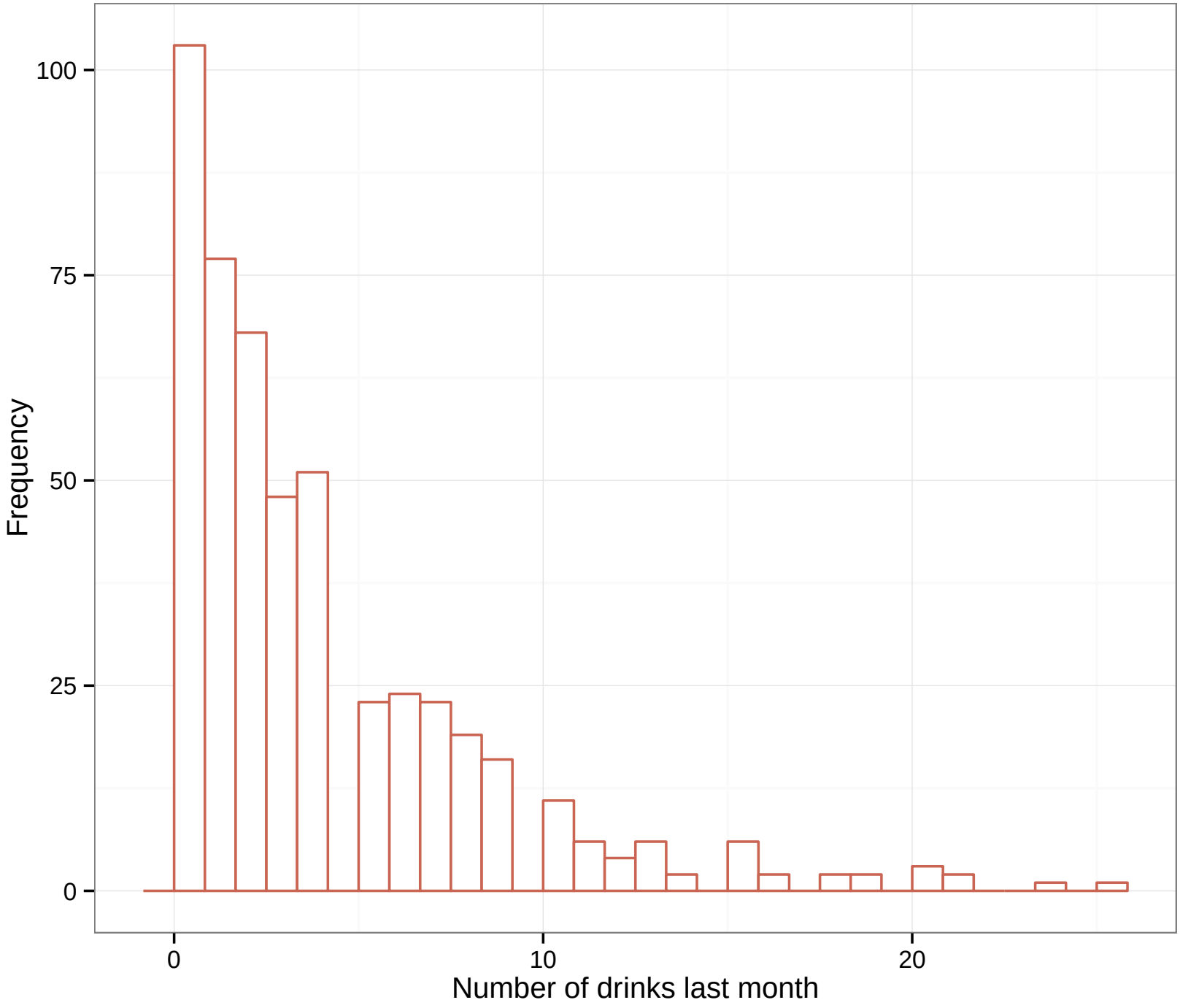

Frequency
0
10
20
30
40
50
75
100
125
Intelligence Quotient

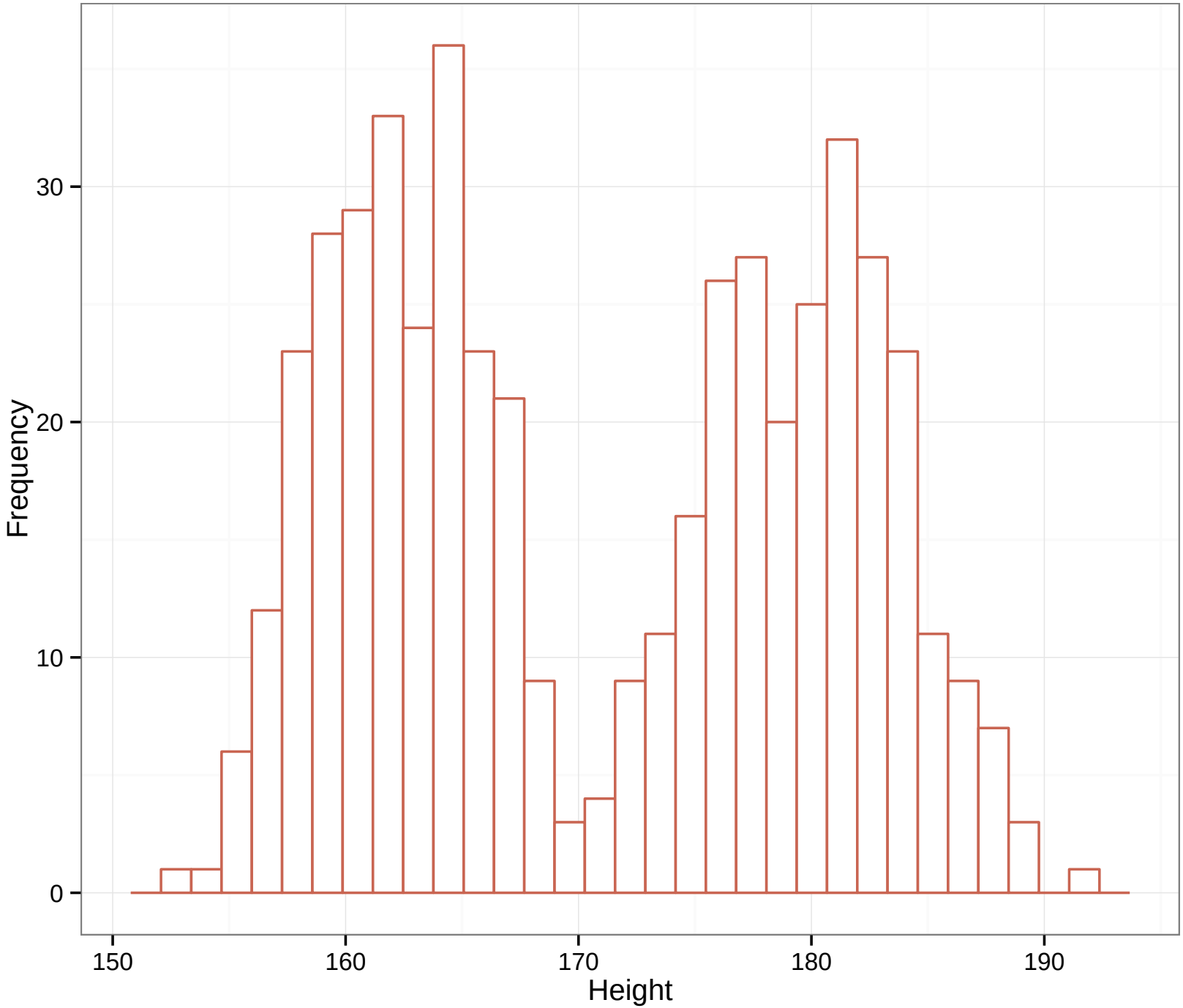
```r
# Load the library
set.seed(101)
library("ggplot2")

# 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")
```


100
75
50
25
0
Frequency
0
10
20
Number of drinks last month


Frequency
30
20
10
0
150
160
170
180
190
Height

Central Tendency Measures

Mean

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

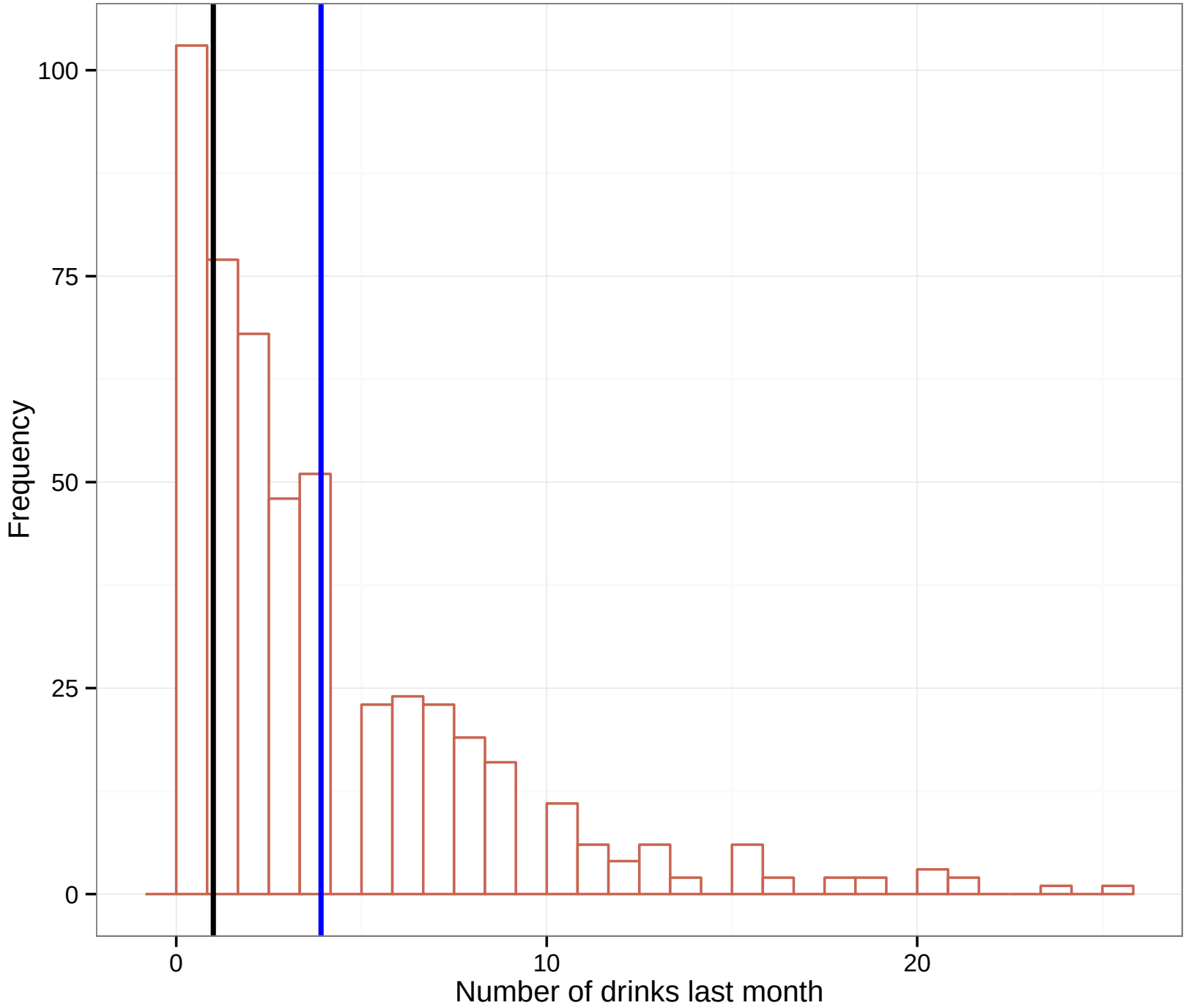
Median

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

Mode

The most frequently occurring value

Which of these statistics is most robust to outliers?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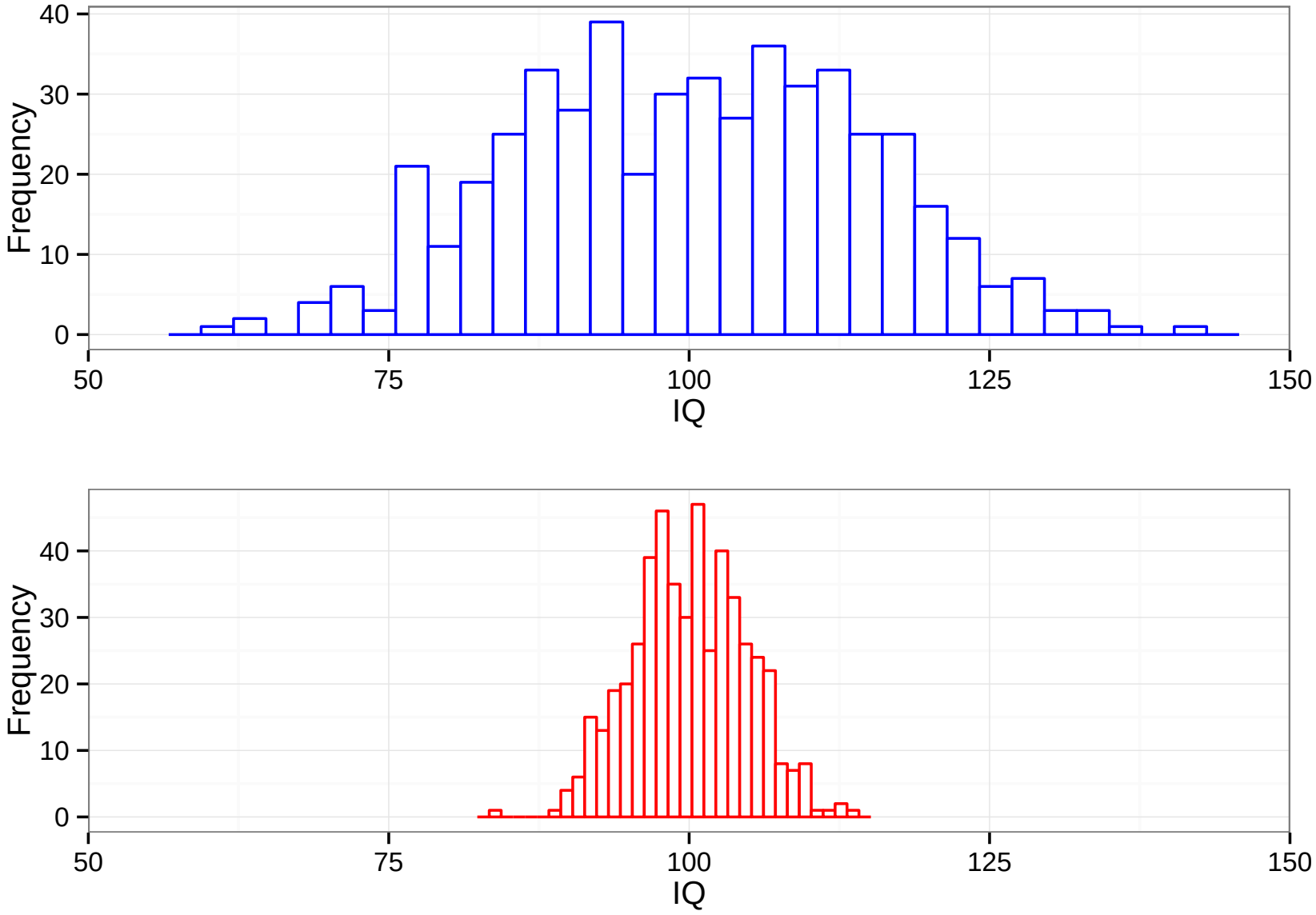
Variability



Measures of variability

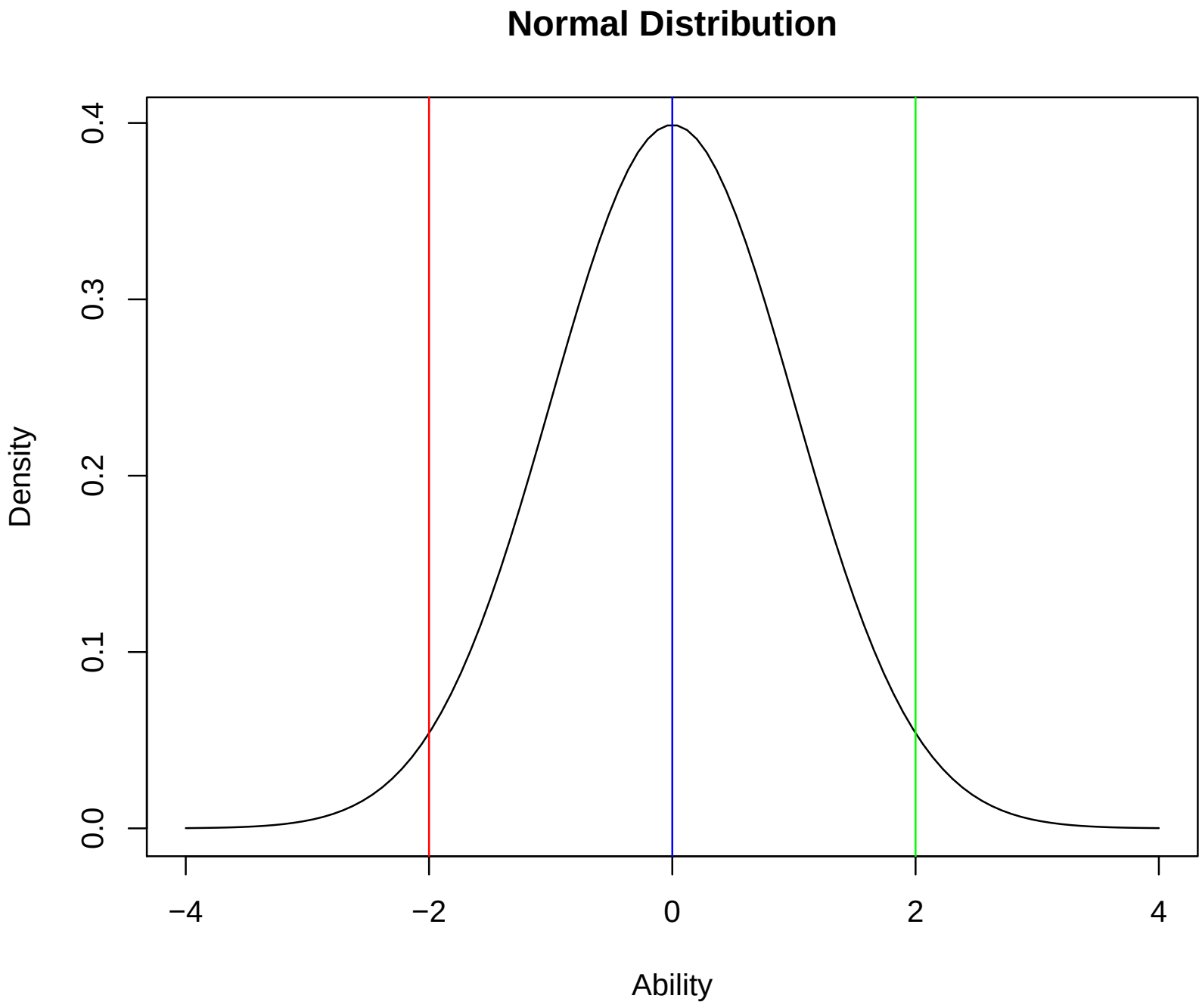
Range

Interquartile range (Q_1, Q_2, Q_3)

Standard Deviation and Variance

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

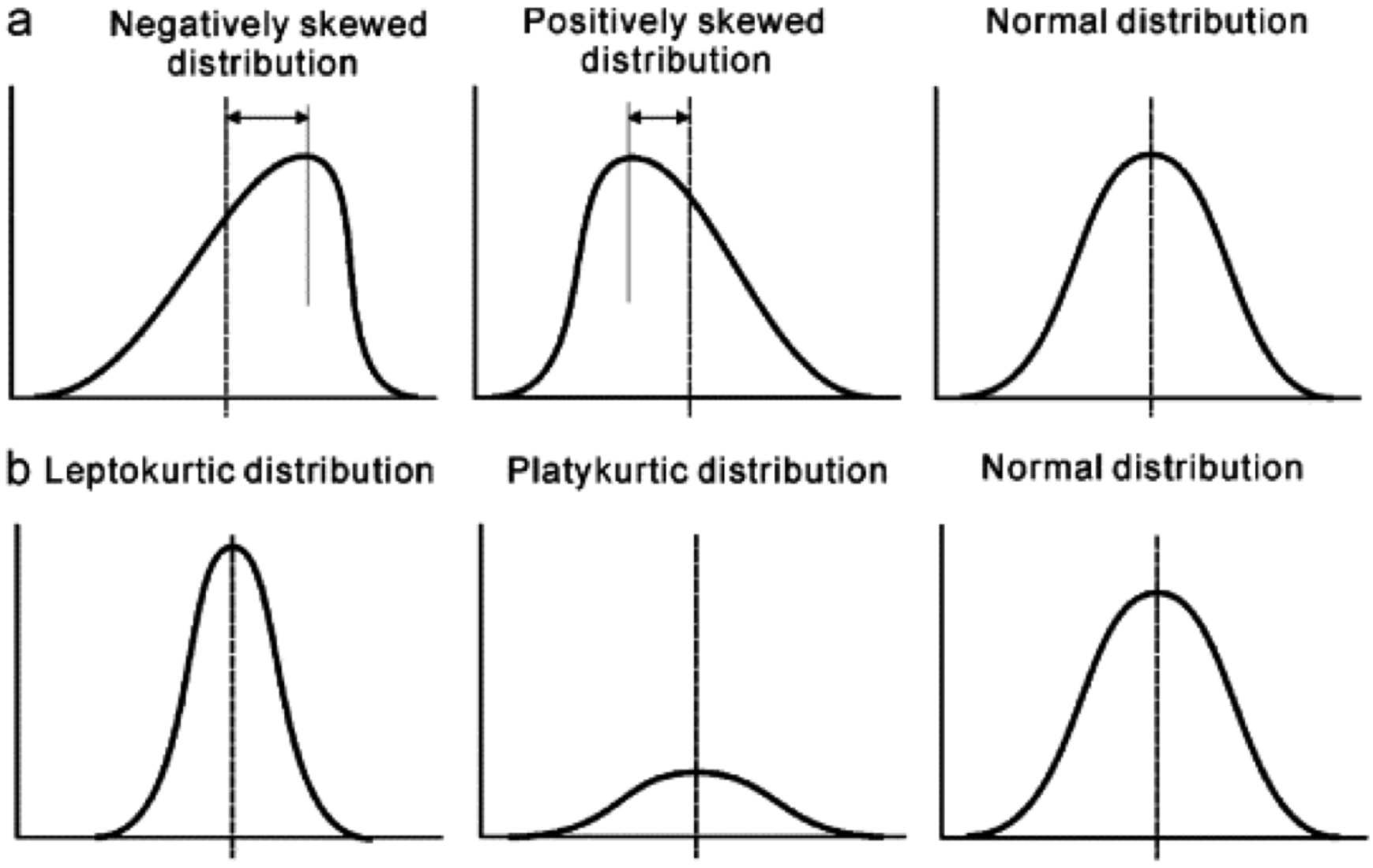
$$s^2 = \frac{\sum (X_i - \bar{X})^2}{n-1}$$


Normal Distribution
Density
0.0
0.1
0.2
0.3
0.4
−4
−2
0
2
4
Ability

Distributions, skewness, kurtosis

- What is a probability distribution
  - Assigns a probability, likeliness of occurence, of a score to 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



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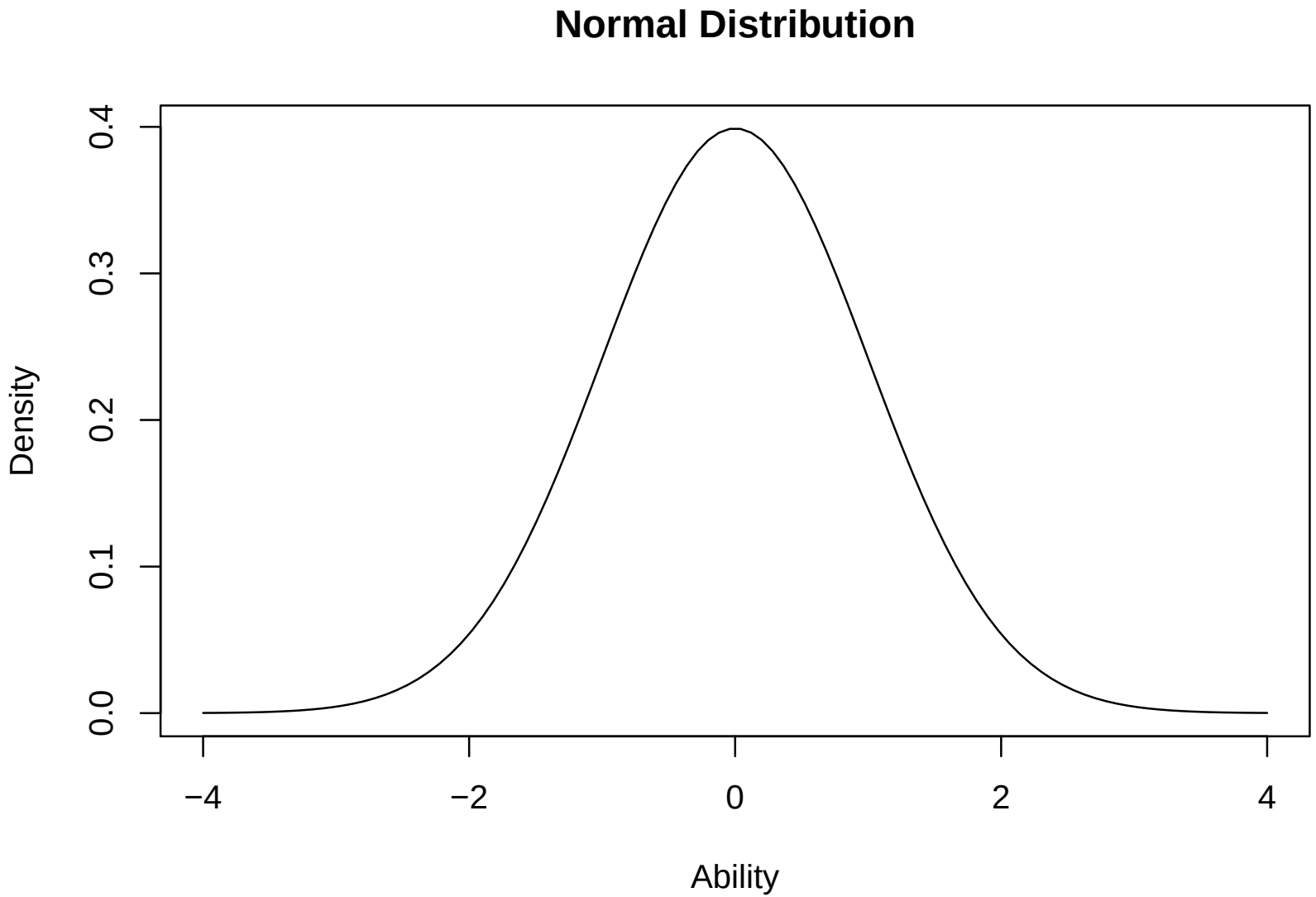
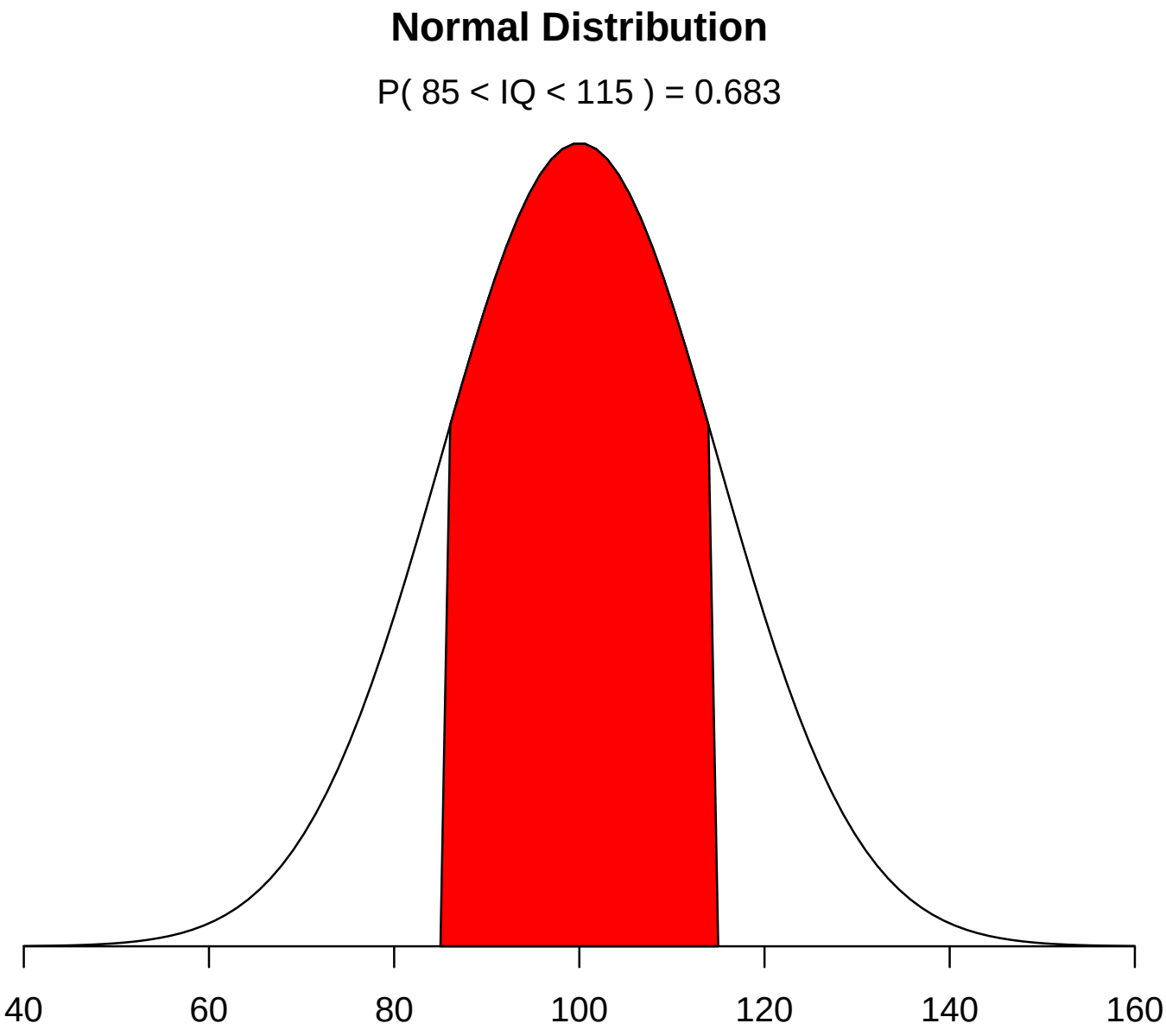


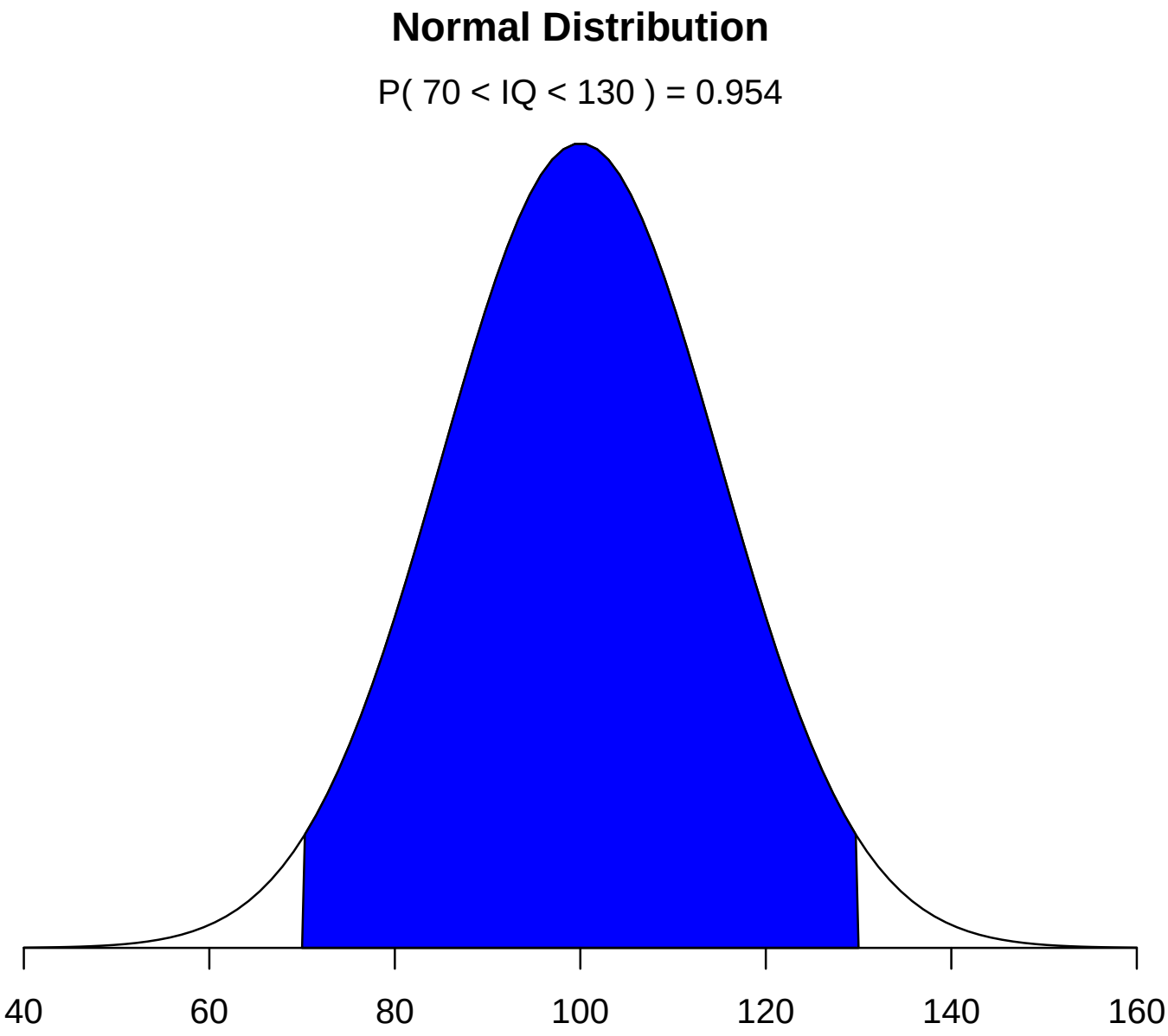
R Normal distribution applet

1. Open RStudio
2. Open normal_applet.R
3. Click the "Source" button

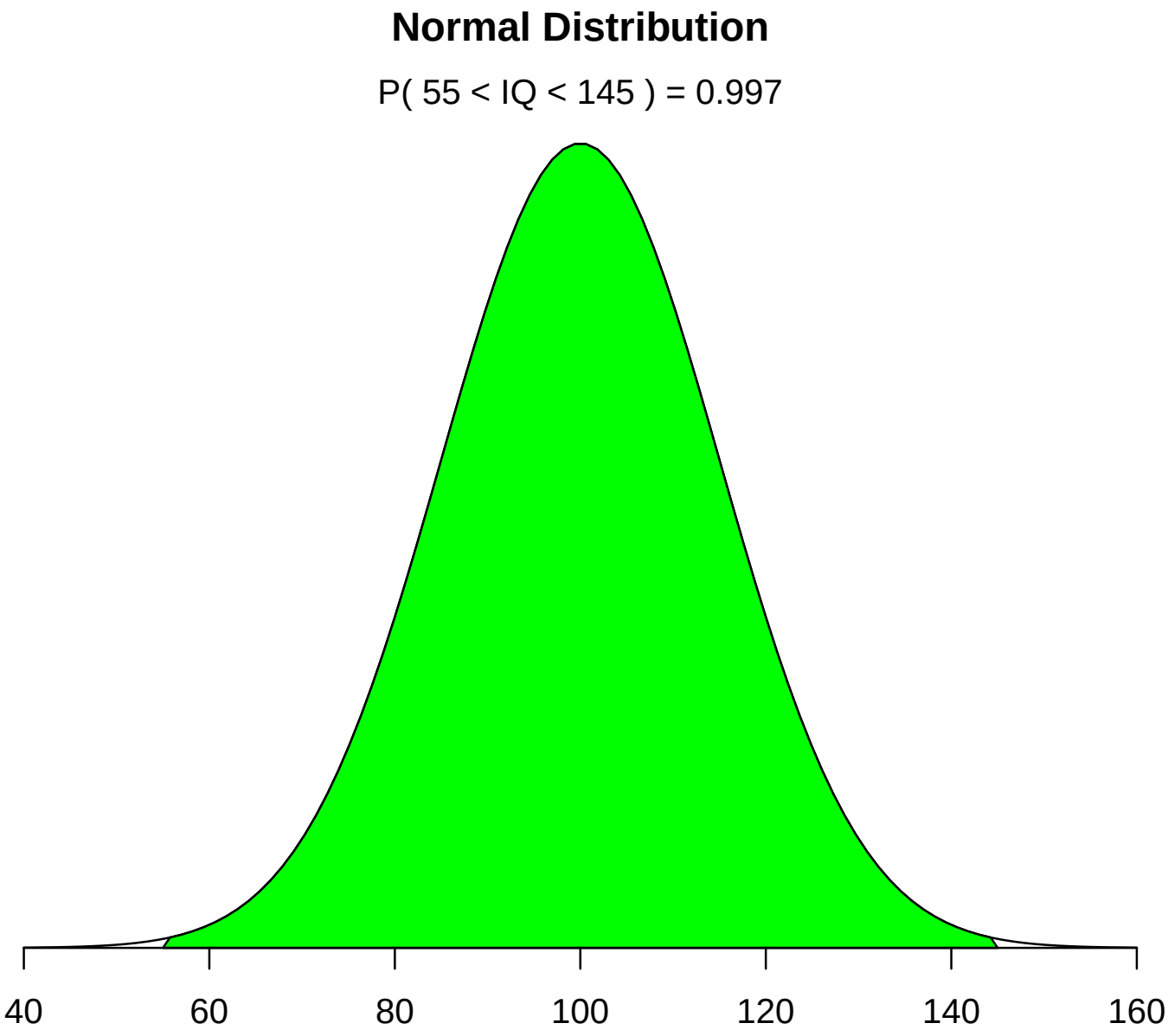
IQ - 1 Standard Deviation



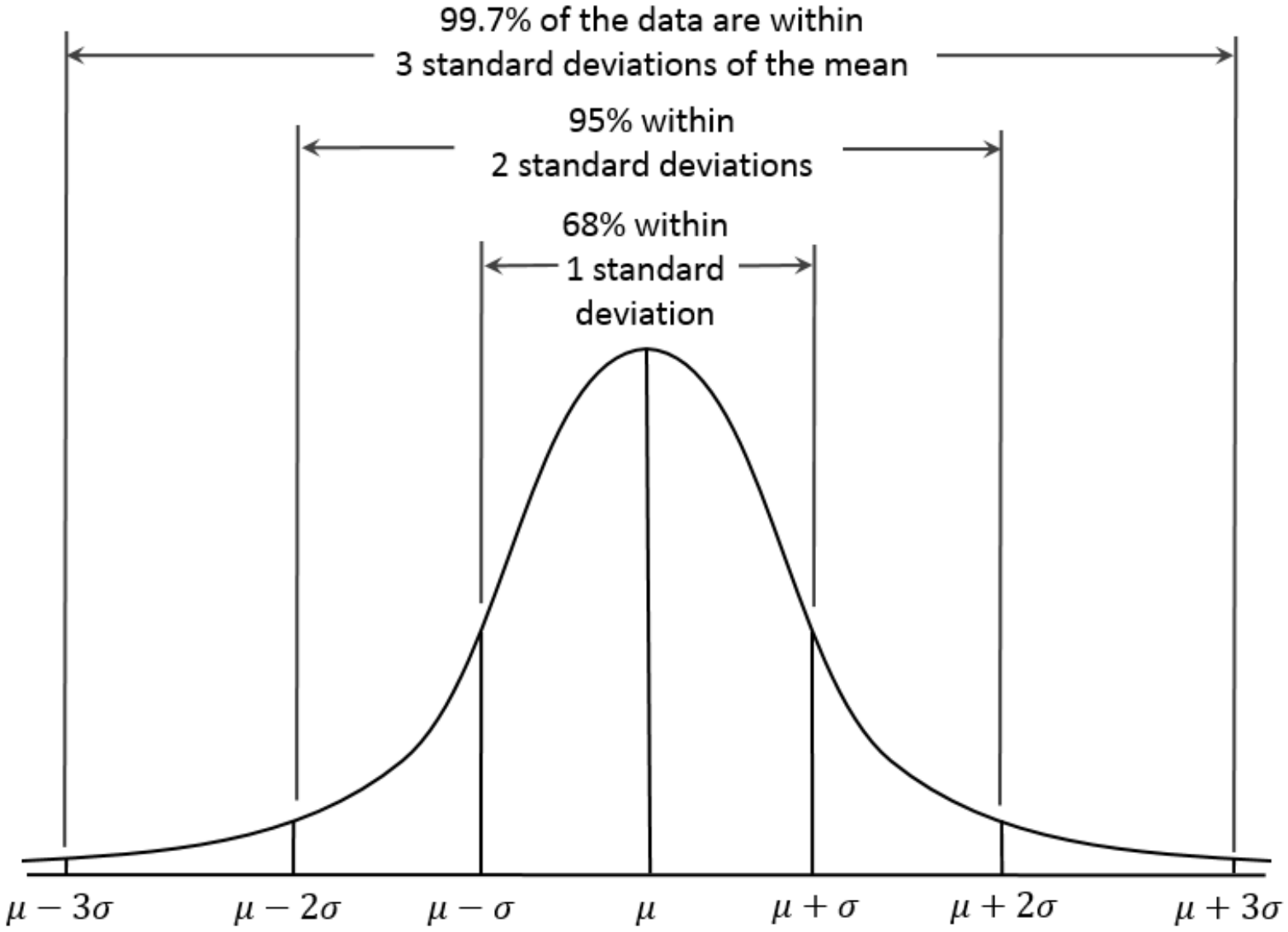
IQ - 2 Standard Deviation



IQ - 3 Standard Deviation



Characteristics of the Normal distribution



Z-distribution

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

SAT

The SAT is an aptitude test that high school students 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 devation of 110 and is normally distributed.

- What are the scores on the test that corresponds to 3, 2, 1, 0, -1, -2, -3 standard deviations?

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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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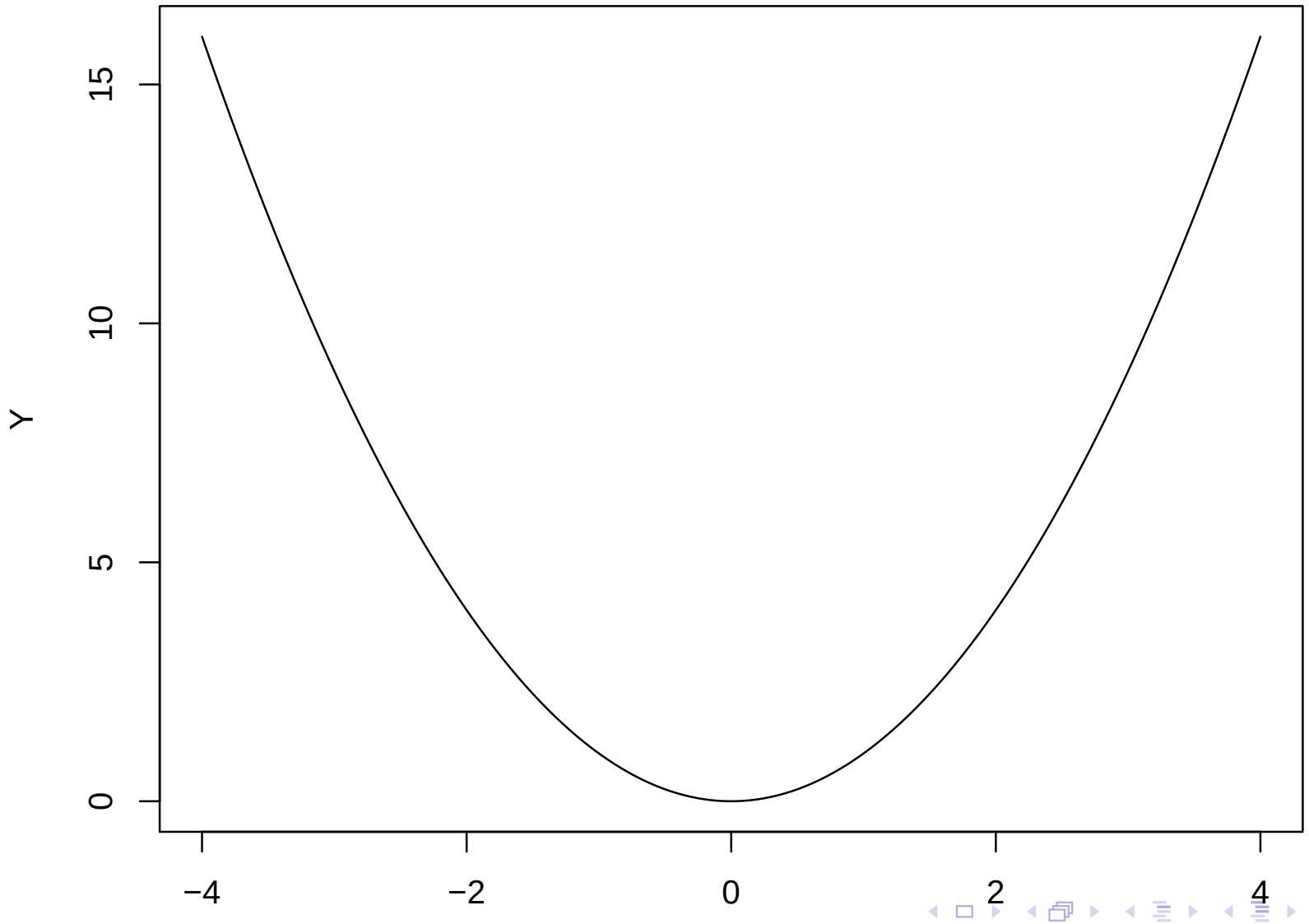
  - If you were in the 3rd stanine, what would your z-score be?
  - How many people would be below you?
  - What percent of the people are between the 3rd and the 6th stanines?
- Various linear and non-linear transformations are done to create scores and scores may be normalized.

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)
```

R correlation applet

1. Open RStudio
2. Open correlation_applet.R
3. Click the "Source" button

Spearman's rho

- Non-parametric measure of association
- Appropriate when at least one of your variables is ordinal variables
- Don't use Pearson's correlation with ordinal variables!

Simple Linear Regression

- If are you interested in predicting height given someone's weight, what would you do?

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Simple Linear Regression

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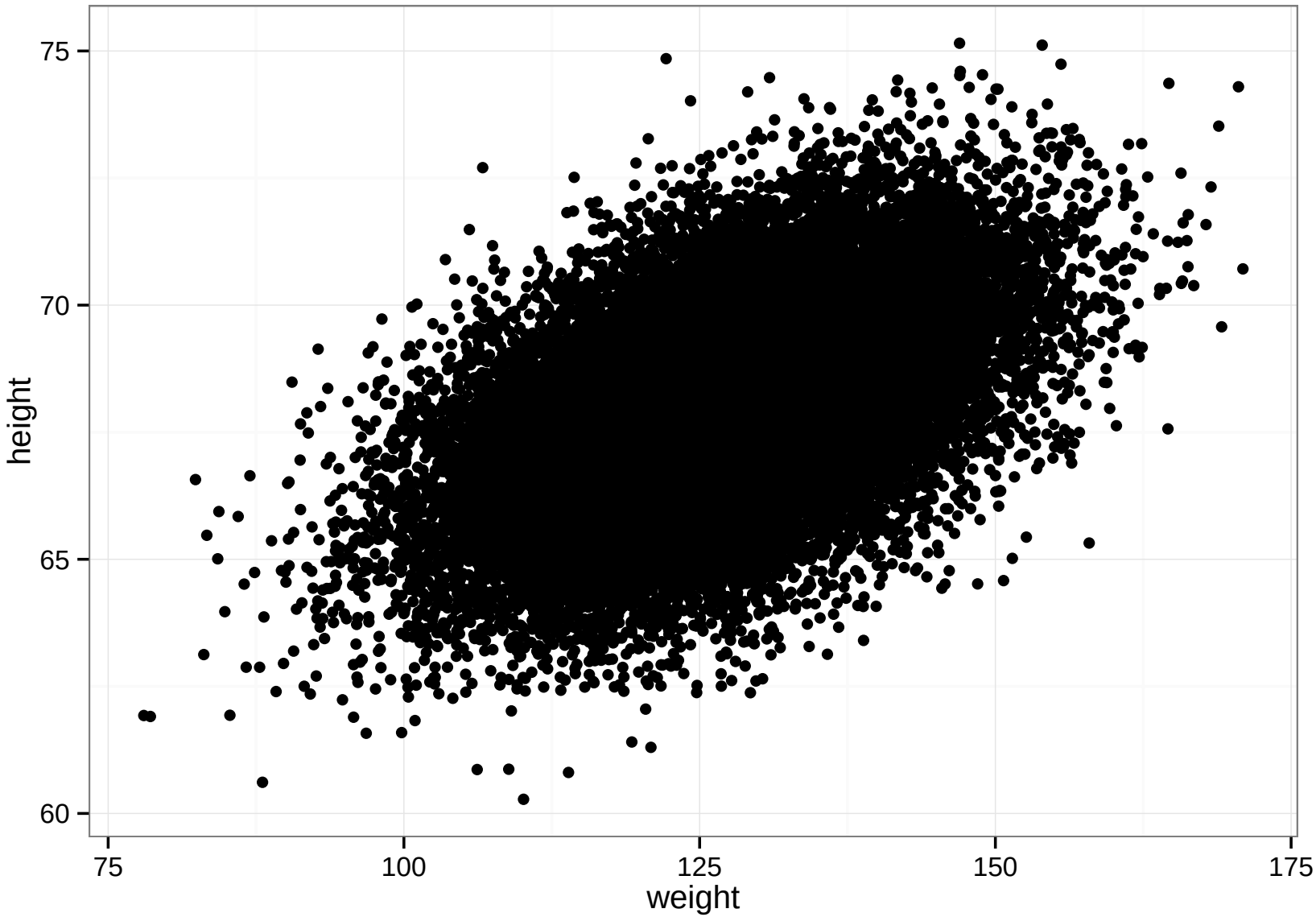
- We could consider a regression model.
- $Y_i = \beta_0 + \beta_1 * X_i$
- How could we assess if this is appropriate?

1993 Growth Survey of 25,000 Hong Kongese children

source: http://wiki.stat.ucla.edu/socr/index.php/SOCR_Data_Dinov_020108_HeightsWeights



Model Summary

Parameter	Estimate	SE	t-value	p-value
β_0	57.57	0.11	506.01	¡ .001
β_1	0.08	0.001	91.98	¡ .001

How does this relate to correlation?

Slope and the correlation

- There is a relationship between the estimated slope and the correlation between two variables in a simple linear regression.

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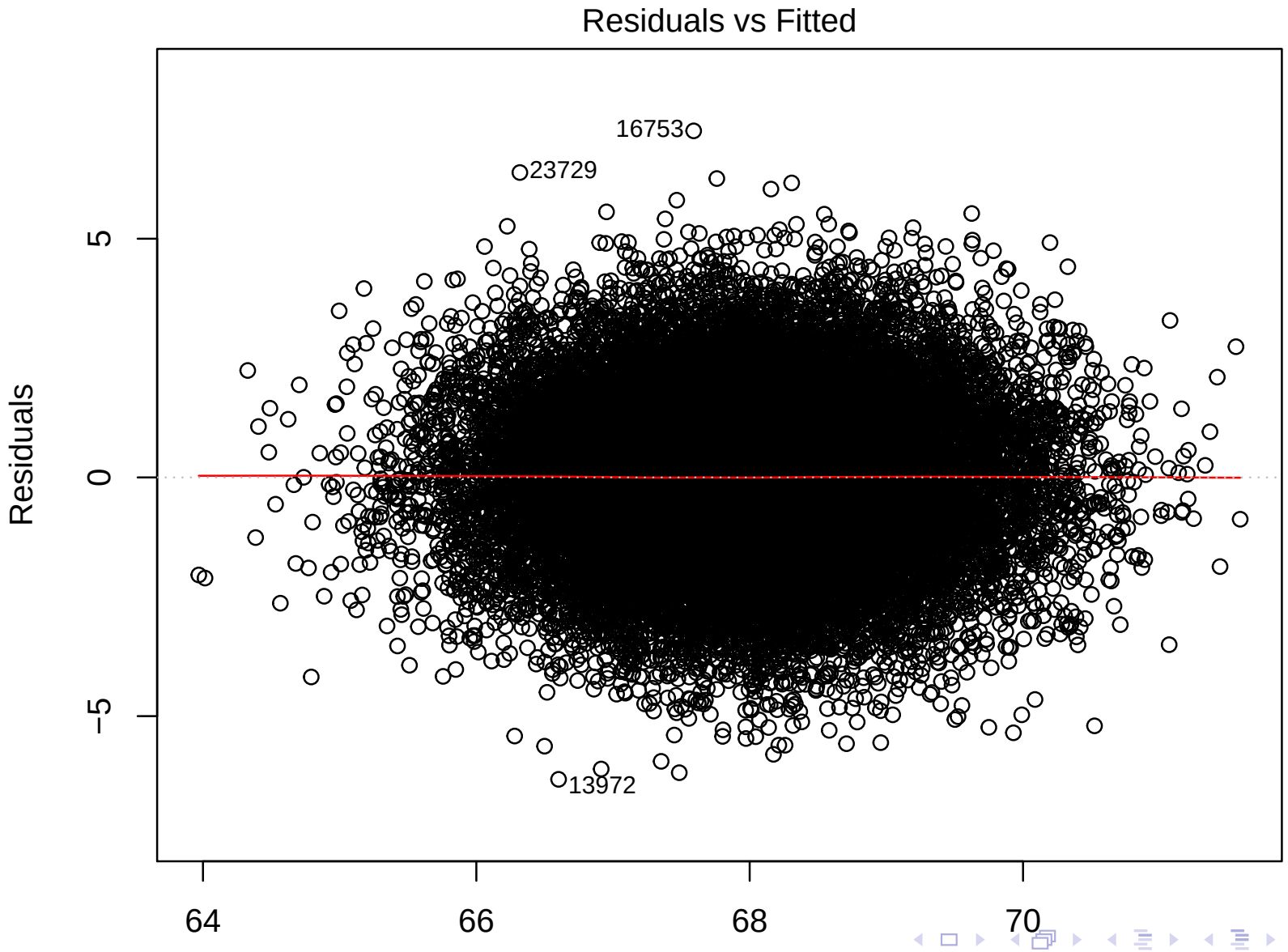
- $r = \beta_1 \frac{sd_x}{sd_y}$
- If $\beta_1 = 0.08$, the standard deviation of weight and height are 11.6608976 and 1.9016788, respectively, what is r?
- 0.5028585

Always look at the residuals



Brief history of testing

- 2200 BCE, Chinese believed to use testing for determining who would get governmental jobs
- Greek and Romans categorized individuals based on personality type ("blood" or "phlegm")
- Francis Galton's classification based on "natural gift" (i.e. eugenics)
  - Contributed to development of questionnaries, rating scales, and self-report inventories
- Wilhelm Wundt's laboratory and his focus on "standardization"
  - James Cattell's mental tests
  - Charles Spearman - reliability and factor analysis

Testing in the 20th century

- 1905, Binet and Simon publish a test measuring intelligence in mental retarded school children in Paris
- 1939, Wechsler publishes a test to measure intelligence in adults (would become WAIS)
- Group intelligence test administered by the US military during WWI and WWII
- WWI personality tests used to screen recruits

Necessary test assumptions

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- Psychological traits and states can be measured
- Behavior on tests predicts non-test behavior
- Measurement error is part of the process
- Test can be fair
- Test can benefit society

What makes a good test?

Norm-Referenced and Standardization

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- Understanding the normative sample is very important, why?

Sampling

- Simple random sample
- Stratified random sample
- Cluster random sample
- Purposive sample
- Convenience sample

Different Norms

- Percentiles
- Developmental Norms
  - Age Norms
    - A 6 year old performs at the level of a 10 year old
    - This is on this material only though!
  - Grade Norms
    - School year typically 10 months in the US
    - A 4th grader is performing at the level of a 5th grader in third month
    - This is on this material only though!
- National Norms, nationally representative
  - Anchor norms enable two tests to be compared
  - In USA, students could take SAT or ACT for admission to college

Fixed Reference and Criterion-Related

- Fixed reference group scores are used as the basis for calculation of future administrations of the test
- Raw scores are scaled relative to the performance of the fixed reference group
  - Answering 50 items correctly one year and 50 on the following year doesn't mean you'll have the same score
- SAT does this through using anchor items and equating
- Criterion-referenced, evaluate a score with reference to a set criteria or standard NOT other test takers
- What is the fairest way to score grades in a class room?