INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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european social fund in the czech republic
EUROPEAN UNION
MINISTRY OF EDUCATION, YOUTH AND SPORTS
OP Education for Competitiveness
INVESTMENTS IN EDUCATION DEVELOPMENT

Data Exploration

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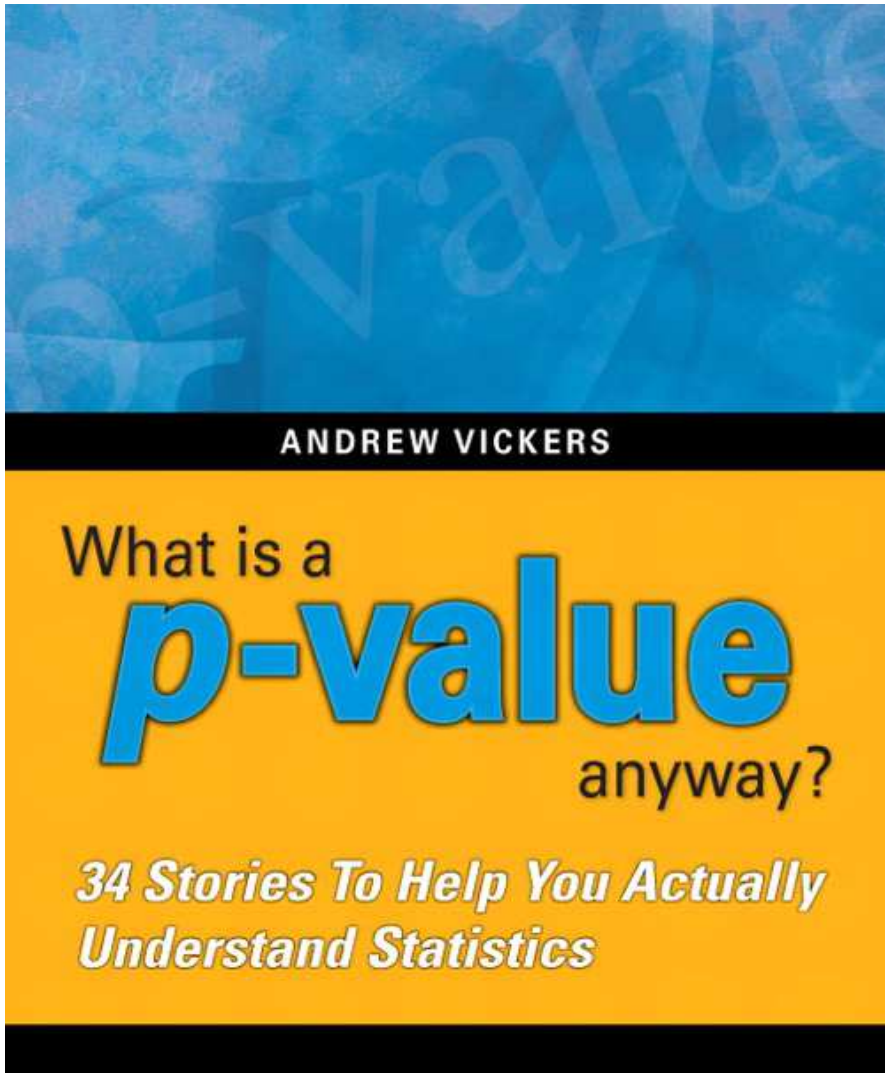
Credits


ANDREW VICKERS
What is a
p-value
anyway?
34 Stories To Help You Actually
Understand Statistics

Statistics

- Estimation vs inference
- Estimation: how big or small something is.
- Inference: making conclusions. Usually with a statistical test or hypothesis.

Data type

- Categorical (e.g. “fertilized” vs “control”)
- Real numbers
  - Continuous (1.34, 147.3…)
  - Discrete (1, 30)

- If real numbers: data restricted? (e.g. positive)

Models

- Dependent variable: the one you want to explain: Y.
- Independent variable: explanatory: X.

- Explain Y: central tendency and measure of dispersion

Central tendency:
About Means and Medians

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About Means and Medians

- Mean (arithmetic mean):

$$\overline{x} = \frac{x_1 + x_2 + \ldots + x_n}{n}$$

- Median: middle value

Central tendency:
About Means and Medians

$85,000
$50,000
$45,000
$40,000
$35,000
$30,000
$30,000

- Yearly salaries
- **Mean**: $45,000
- Median: $40,000

Central tendency:
About Means and Medians

$1,000,000,000
$85,000
$50,000
$45,000
$40,000
$35,000
$30,000
$30,000

Bill Gates: Outlier

- Yearly salaries
- Mean: $125,039,375
- **Median**: $42,500

Central tendency:
About Means and Medians

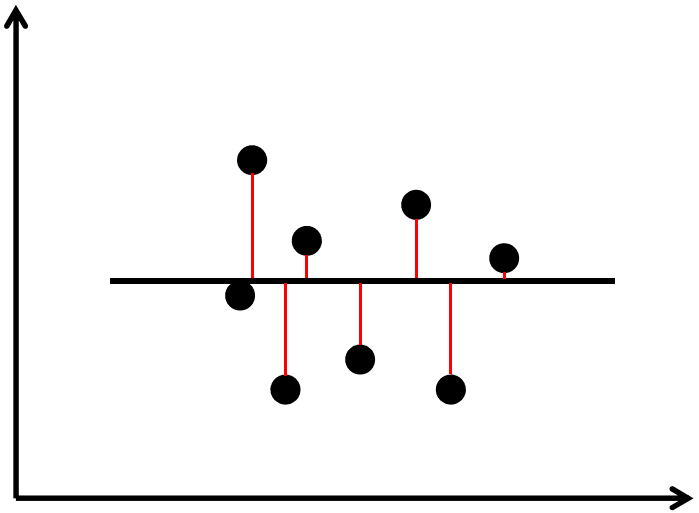
$250,000
$85,000
$50,000
$45,000
$40,000
$35,000
$30,000
$30,000

- Cost of surgery
- **Mean**: $70,625
- Median: $42,500

Measures of dispersion: Standard deviation and interquartile range

- Variance:

$$V = \frac{1}{n} \sum_{i=1}^{p} n_i (x_i - \bar{x})^2$$



- Standard deviation:

$$SD = \sqrt{V}$$

- Interquartile range: IQR=Q3-Q1
  - Breakdown point of 25%
  - Middle of IQR: median

Measures of dispersion: Standard deviation and interquartile range

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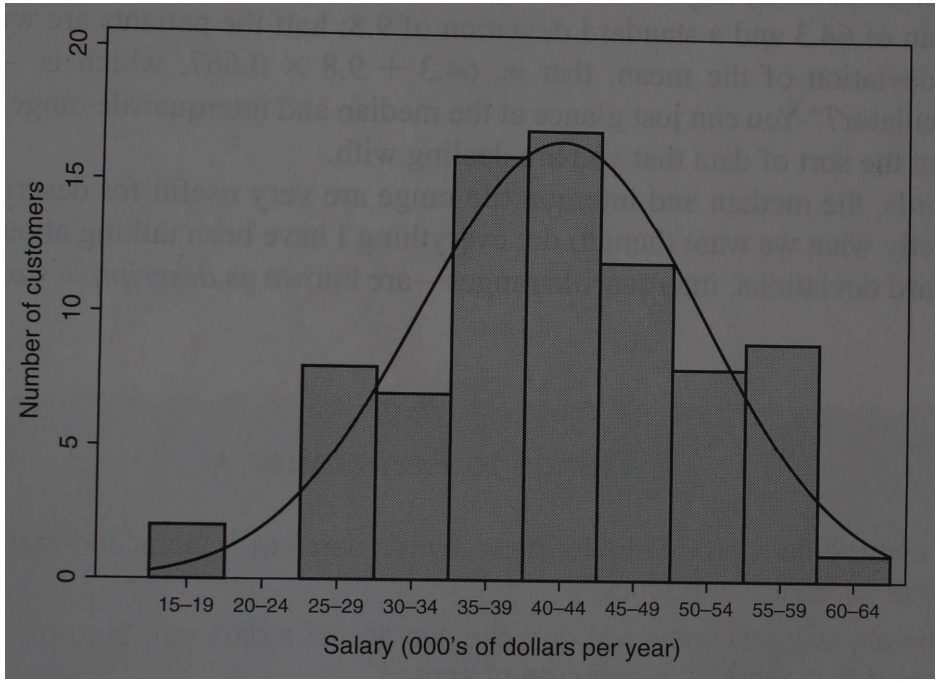
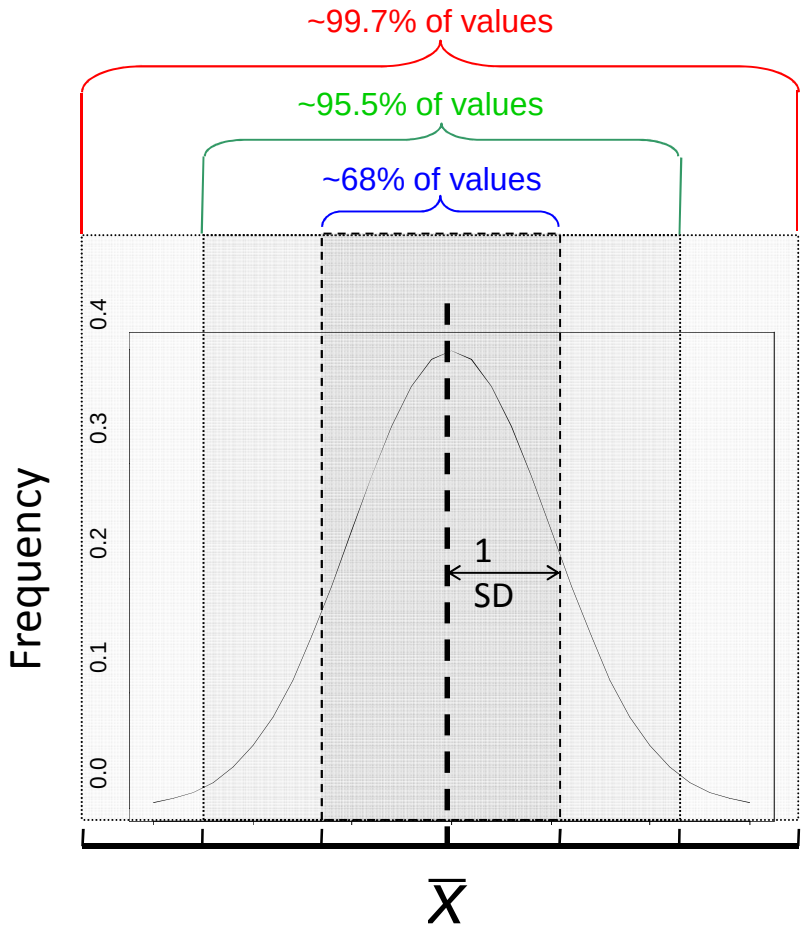


- Without Bill Gates:
  - Approx. Normal
  - Mean: $42,360
  - SD: $9,616
  - 5% of the salaries below $23,128 or above $61,592

Normal distribution

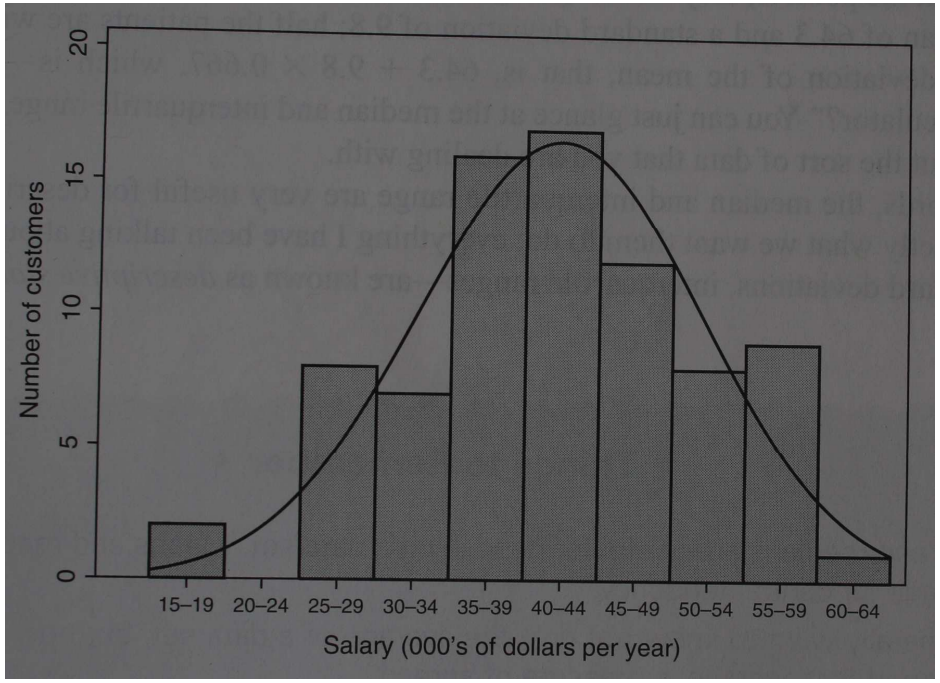
- Sum of lot of random events
- Bell shaped
- Symmetrical
- Mean = median
- 95% of values within ± 2 SD



$$f(x) = \frac{1}{\sigma\sqrt{2\Pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

μ : Mean σ : SD

Measures of dispersion: Standard deviation and interquartile range



- With Bill Gates:
  - Skewed
  - Mean: $12 million
  - SD: $100 million
  - Can't have a salary of negative $88 million
  - Median: $41,900
  - IQR: $36,000 to $49,300

Correlations

- Measures the strength of association between two continuous variables.
- -1 < correlation between X and Y < 1
- If > 0, positive correlation. Y increases when X increases.
- If < 0, negative correlation. Y decreases when X increases.
- The further away from 0, the stronger the correlation.
- Doesn’t say anything about causality!

Data exploration in R

- c(), list(), data.frame(), matrix()
- read.table(, h=TRUE)
- [], subset()
- ==, %in%
- mean(), range(), dim()
- rep(), seq()
- function(){}

Data exploration in R: Data type

```
> str(dataset)
```

gives the data type of each variable and its values

```
> levels(dataset$categorical.variable)
```

returns the values of a factor

```
> range(dataset$numeric.variable)
```

returns of vector of length 2: min and max

```
> min(dataset$numeric.variable)
> max(dataset$numeric.variable)
```

Data exploration in R: Central Tendency

```
> mean(dataset$numeric.variable)
> mean(dataset$numeric.variable, na.rm=T)
      # na.rm=TRUE: removes NAs
> median(dataset$numeric.variable)


> is.na(dataset$numeric.variable)
      # returns a vector of TRUE and FALSE of the same length
```

Data exploration in R: Measures of dispersion

```
> var(dataset$numeric.variable)
    # variance
> sd(dataset$numeric.variable)
    # standard deviation
> quantile(dataset$numeric.variable)
    # returns min, Q1, median, Q3, and max
```

Data exploration in R: Summary

```
> summary(dataset)
> summary(dataset$variable)
```

returns min, max, quantiles, mean and median

Data exploration in R: Correlation

```
> cor(x,y)
```

returns only the value of the correlation between X and Y.

- X and Y must be two vectors of same length!

```
> cor.test(x,y)
```

returns some information about the significance of the correlation as well. More about that later.

Exercise: Forest

- Fake data.
- 105 forest plots with different number of tree species.
- Productivity estimated as tons of Carbons produced per hectare and per year.
- Forest plots can be divided into 3 categories: “only conifer species”, “only deciduous”, and “mixed conifers and deciduous”.