What is Exploratory Data Analysis?*

Two phases of data analysis:

1. Exploratory Data Analysis (EDA)
    - descriptive statistics (mean, variance)
    - graphical (best visualization of data)
    - data driven
2. Confirmatory Data Analysis (CDA)
    - inferential statistics (CI, hypotheses)
    - theory (and hopefully EDA) driven

The strongest unifying theme underlying exploratory data analysis is expressed in "Look at the data and think about what you are doing."

*From: Hoaglin, Mosteller, and Tukey, *Understanding Robust and Exploratory Data Analysis*

Classical Techniques

Like:

- Estimates ($\bar{x}$, s)
- t-tests and t-based CIs

For classical (or "exact") techniques,

- emphasis on best possible estimate or test *when stringent assumptions apply*;
- resulting analysis may be garbage when assumptions are violated (sometimes even a little bit).

Effect of Recording Error

A sample of 10 observations from $N(10, 4)$:

```
> x <- round(10*rnorm(10)+4)
> x
 [1]   3  17 -12  10  -5 -13   0   8  14  10
> mean(x)
[1] 3.2
> sqrt(var(x))
[1] 10.50714
>
```

Oops! The number 14 was recorded as 41. ("Bad statistician! Very bad statistician!")

```
> y <- x; y[9]
[1] 14
> y[9] <- 41
> mean(y)
[1] 5.9
> sqrt(var(y))
[1] 15.75119
>
```

Robust and Resistant Methods

- aren't the best possible for given assumptions;
- are the "best" compromise for a wide range of situations;
- often are amazingly close to best possible in most situations.

Resistant to localized misbehaviour (small percentage of gross errors or deviations-from-usual);

Robust even when assumptions (like normality) are flat-out wrong for all the data.

Effect of Recording Error

Resistant location estimate (of μ):

```
> mean(x,trim=.1)  # good data
[1] 3.5
> mean(y,trim=.1)  # ‘‘bad’’ data
[1] 3.875
>
```

Resistant spread estimate (of σ):

```
> mad(x)  # good data
[1] 10.3782
> mad(y)  # ‘‘bad’’ data
[1] 11.8608
>
```

EDA and the Three “R”s

(gRaphics, Robustness, and Resistance)

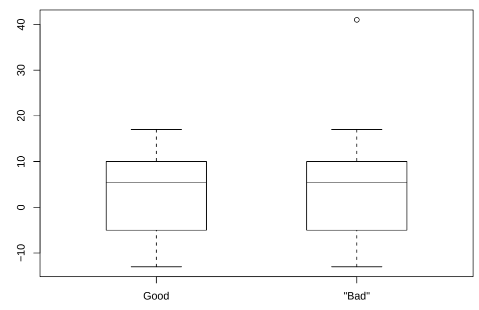
Because EDA deals with data in its rawest form:

- when little is known about it;
- when it hasn’t been “cleaned” up and may be filled with errors or weird behaviour.

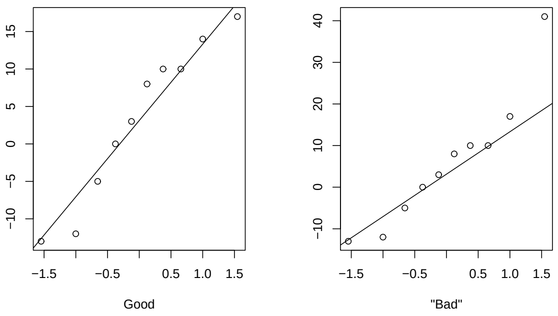
the emphasis is on:

- graphical methods (which quickly reveal many problems)
- robust and resistant methods (which work even if problems remain)

Boxplots



Q-Q Normal Plots



From the Textbook

Text: Venables and Ripley, *Modern Applied Statistics with S*, Fourth Edition.

Chapters 1–4 R (or S or S-PLUS) Language

Chapters 5–7 Core of the Course

- **5** Univariate Statistics
- **6** Linear Models
- **7** Generalized Linear Models

Other Topics One or Two of These:

- **8** Non-Linear and Smooth Regression
- **9** Tree-Based Methods
- **11** Exploratory Multivariate Analysis
- **12** Classification
- **13** Survival Analysis
- **14** Time Series
- **15** Spatial Statistics