Statistics

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StudCee

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Disclaimer

What I DON'T know

- Some stuff about R
- Stuff that depends on the teacher
- Some complicated stuff

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- Some complicated stuff

What I DO know

- A lot of stuff about statistics

Tips

- With "?" you can get information about functions and datasets

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- Make flowcharts of methods for data analysis to see how they relate to each other

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- Make flowcharts of methods for data analysis to see how they relate to each other
- Or check out some useful links (studcee.svcover.nl!)

Exploratory Data Analysis: Which method should I use?

We want to look at the distribution(s). Are we looking at one or two variables at a time?

- **One** variable. Data numerical or categorical?

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  - numerical data. Use: *histogram*, *boxplot*, *stem-and-leaf plot* (not usually).

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- **One** variable. Data numerical or categorical?
  - numerical data. Use: *histogram*, *boxplot*, *stem-and-leaf plot* (not usually).
  - categorical data. Use: *barplot*, *pie chart* (not preferred).

Exploratory Data Analysis: Which method should I use?

From data set 'survey'

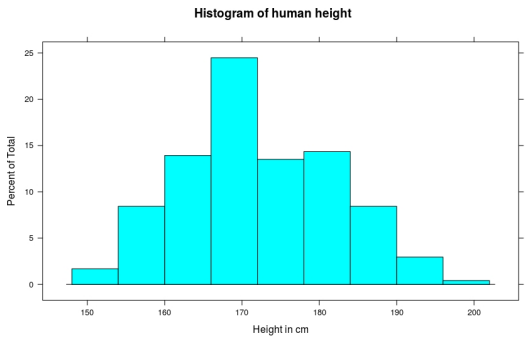

Figure: Histogram of human height

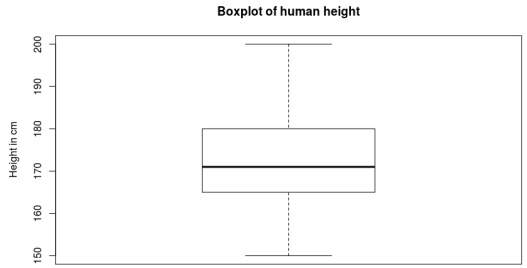

Figure: Boxplot of human height

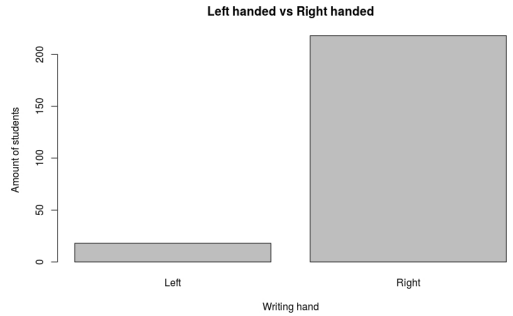

Figure: Barplot of writing hand

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  - both categorical. Use: *multiple barplots*.

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  - one numerical, one categorical. Use: *multiple boxplots*.
  - both numerical. Use: *scatterplot*. In this case, we're looking at a relationship, not at distributions.

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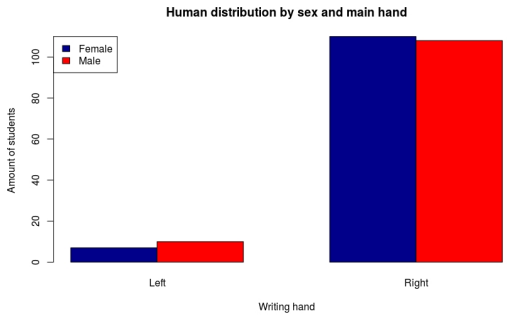

Figure: Barplot of main writing hand vs sex

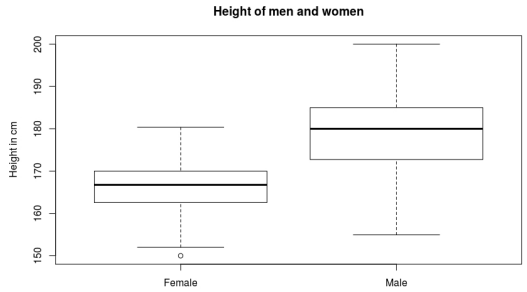

Figure: Boxplot of height of men and women

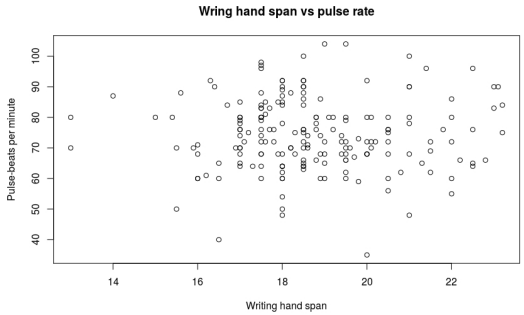

Figure: Scatterplot of writing hand span vs pulse rate

Formal Data Analysis: Which method should I use?

This depends on both the kind of data you're working with and the kind of research question you pose.
Kinds of data: numerical, binary, (non-binary) categorical.
Kinds of questions:

1. Is population 1's parameter equal to X?

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4. Are variables A and B independent?
5. Questions about relationships / predictions

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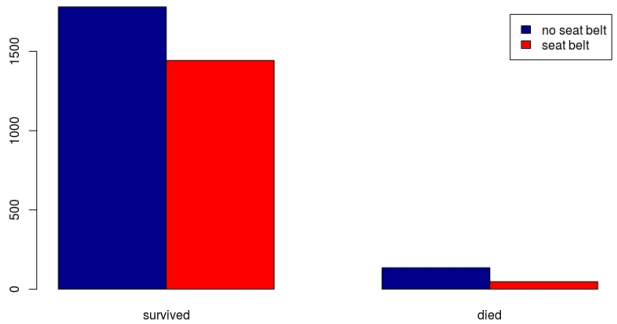

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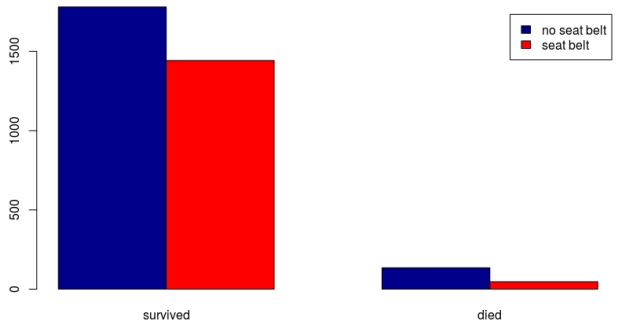

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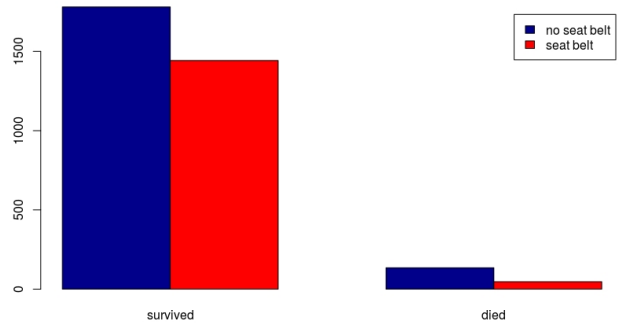

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- Example taken from:
  `http://www.dummies.com/programming/r/how-to-test-data-proportions-with-r/`

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  `http://www.stat.columbia.edu/~martin/W2024/R2.pdf`

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  - **Question:** Is there a difference between the results of the two companies?
  - p-value = 0.1836

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- (Q2, non-parametric) Do the data in polulation 1 and those in population 2 come from the same distribution? Use a *Wilcoxon Signed-Rank test* if the data are paired; else, use a *Wilcoxon Rank-Sum test*

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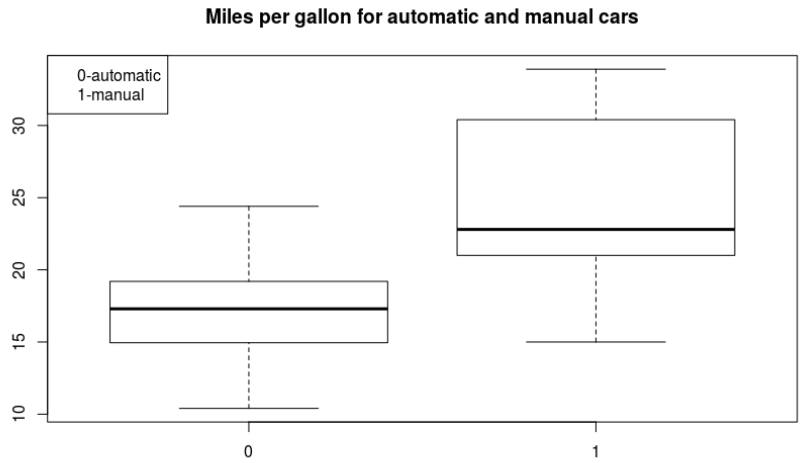

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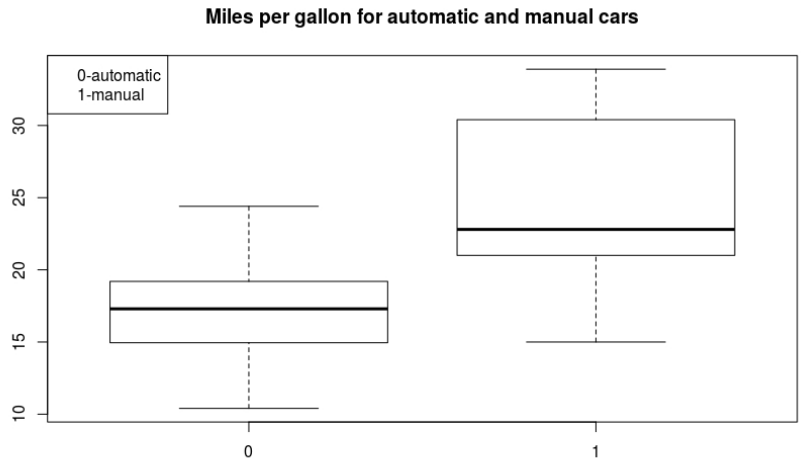

- p-value = 0.001871

FDA for categorical data

- (Q3) Is the variable spread according to given probabilities? Use a *chi-squared test for given probabilities*

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  - **Ex:** Given the amount of murders per day in the week, decide if there is equal probability of murder happening in town.

Mon	Tue	Wed	Thur	Fri	Sat	Sun
53	42	51	45	36	37	45

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  - X-squared $= 13.319$, df $= 6$, p-value $= 0.03824$

FDA for categorical data

- (Q4) Are the variables independent? Use a *chi-square test for independence*

FDA for categorical data

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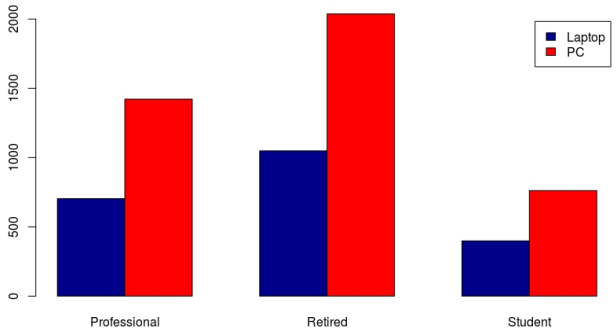
  - **Ex:** A researcher of a computer magazine collected data from customers on type of device they are using (Laptop or PC) and their working status (Student, Professional, Retired).

Chi-square test for independence

Assumption: Counts in the table are more than 5.
Suppose you have analytically explored the data and got the following results:



	Professional	Retired	Student
Laptop	704	1049	399
PC	1422	2037	762

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Chi-square test for independence

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- **Question:** Is the type of device dependents upon working status?
- X-squared = 0.66238, df = 2, p-value = 0.7181

Questions about relationships

Is there a linear relationship between A and B? Can we predict A from B? What is the best model to predict the response variable?

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- ANOVA is a generalization of the t-test
- t-test: difference between two groups? $\rightarrow$ ANOVA: difference between X groups?
- H_0: $\mu_1 = ... = \mu_X$. H_a: not H_0
- Find out where the difference lies with Tukey's Honestly Significant Difference test

Example One-Way Anova

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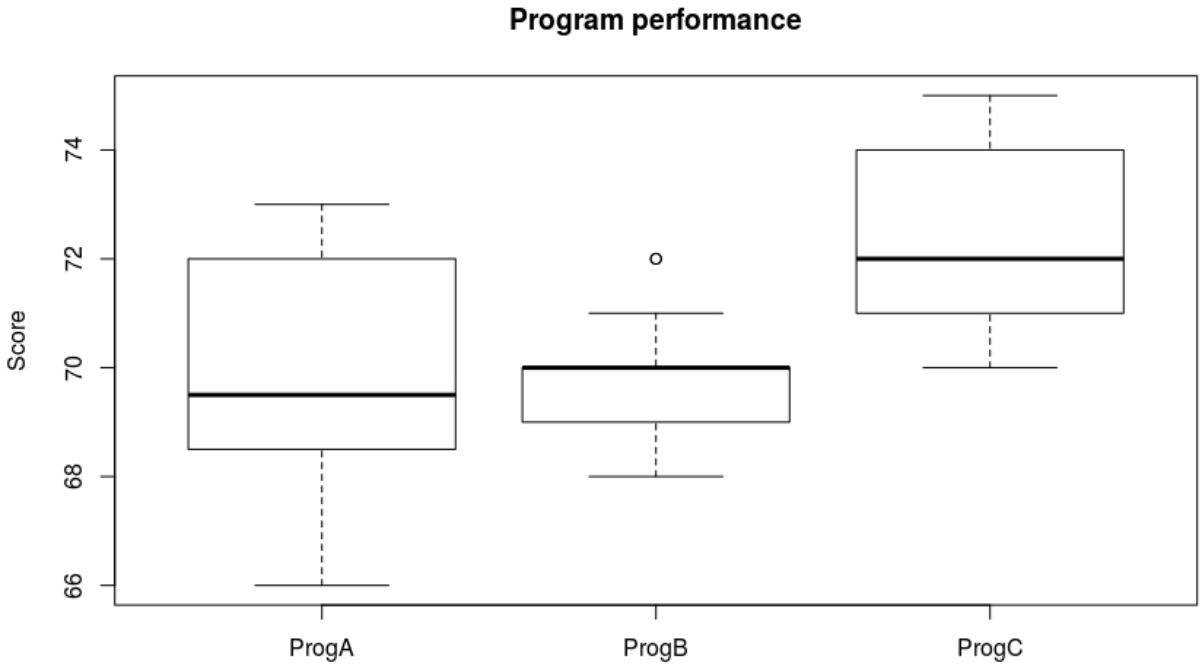

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	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Program	2	88.73	41.87	16.81	1.83e-06
Residuals	57	142.00	2.49		

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- Tukey's Honestly Significant Difference test results:

	diff	lwr	upr	p adj
ProgB-ProgA	-0.2	-1.401096	1.001096	0.9154357
ProgC-ProgA	2.4	1.198904	3.601096	0.0000339
ProgC-ProgB	2.6	1.398904	3.801096	0.0000080

ANOVA: In other words...

- ...We can pose the research question as such: "Does Y significantly differ by X?", where Y is numerical and X is categorical
- So: looks a lot like regression

Regression

- "Can we predict Y from X (and Z)?", where Y is numerical and:

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- X is categorical: +/- ANOVA
- X is numerical, Z is categorical: ANCOVA

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- "Can we predict Y from X (and Z)?", where Y is numerical and:
- X is numerical: Linear regression
- X is categorical: +/- ANOVA
- X is numerical, Z is categorical: ANCOVA
- X is transformed to X^2: Quadratic regression

- Special case if Y is binary: Logistic regression

Writing a report

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- What is our sample (size)?
- What are our variables? What type are they?
- How were the data collected?
- Research question: e.g. "Can we predict [y] from [x]?"

Exploratory analysis

Let's take a look at our data.

- What do our distributions look like?

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- What do our distributions look like?
- Do there seem to be relevant relationships between variables?

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Let's do relevant research.

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1. Choose relevant test based on (I) type of data, (II) research question and (III) whether the assumptions are justified.
2. Report relevant results. These include p-values, test statistics (R^2, t, ...) and possibly estimates (e.g. of β_0).

Conclusion

Let's draw a conclusion.

- Just draw a conclusion based on the hypotheses and the p-values. That's it. Let's ignore any problems.

Discussion

Let's discuss our research.

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- Those problems from the other slide...
- Are there problems with the initial research? Not enough data? Data not representative? Third variable problems? Etc. etc.
- Are there problems with your analysis? Any chance the assumptions don't hold? What are the possible impacts on the results? Etc. etc.

SPAM

We're still looking for members! Questions and applications: Send a mail to studcee@svcover.nl

$\sim$ *Tokei wa tanoshidesu!!!* $\sim$