Excercise 3 Increasing Well-Being with Data Analytics

TECHNISCHE UNIVERSITÄT DARMSTADT

Summer Term 2023

ise. Information Systems and Electronic Services

Agenda

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Data Analytics and Regression Analysis

Ordinary Least Squares (OLS)

Hypothesis Testing: The t-test

What is Data Analytics?

- “a careful and complete analysis of data using a model, usually performed by a computer; information resulting from this analysis”.[1]
- Within data analytics (inferential), statistics are utilized to draw conclusions from a population sample in order to identify potential causal relationships between the independent and the dependent variables.[2]
- Data Science and Data Analytics can be considered applied branches of statistics.[3]

1 Oxford Dictionary
2 Judd, Charles and, McCleland, Gary (1989). Data Analysis. Harcourt Brace Jovanovich. ISBN 0-15-516765-0.
3 Donoho, D. (2017). 50 years of data science. *Journal of Computational and Graphical Statistics*, *26*(4), 745-766.

Regression Analysis

Comprehensive methodology to analyze quantitative data (usually including at least one numerical variable):

“set of statistical processes for estimating the **relationships** between a **dependent variable** and one or more **independent variables.**”

The most widely applied methodology to perform (inferential) statistical analyses

Typical data sources:

Survey, (Field) Experiment, Observational Data

Source: https://en.wikipedia.org/wiki/Regression_analysis

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Data Analytics and Regression Analysis

Ordinary Least Squares (OLS)

Hypothesis Testing: The t-test

Fundamental Regression Model: ordinary least squares (OLS)

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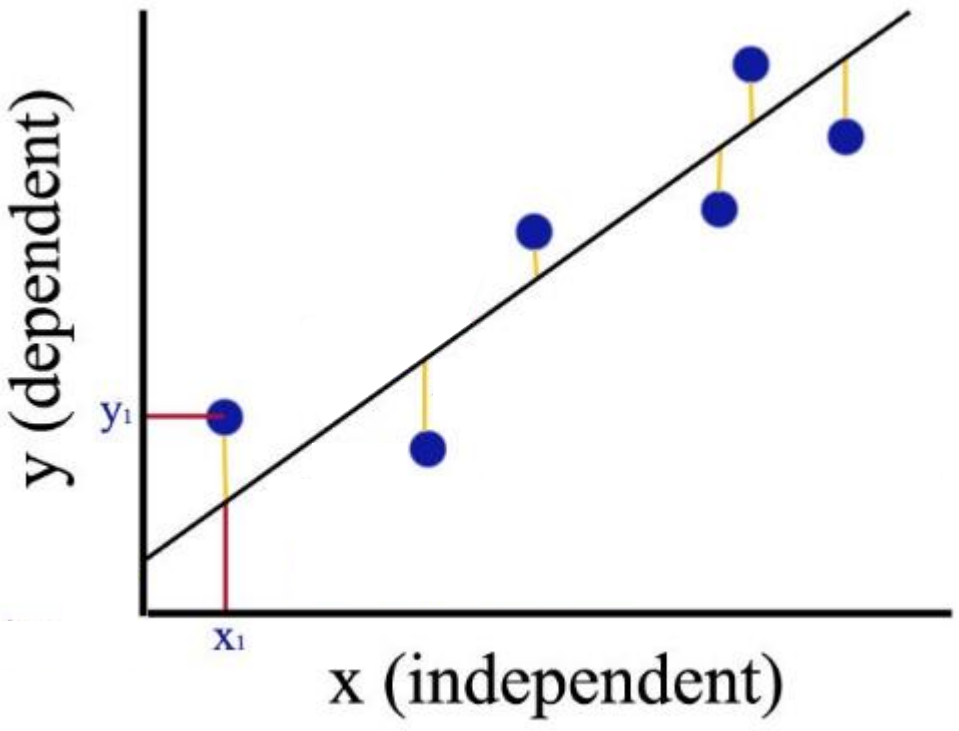
OLS: a method for estimating the unknown parameters in a linear regression model



Sources:
https://medium.com/analytics-vidhya/ordinary-least-square-ols-method-for-linear-regression-ef8ca10aadfc;
https://en.wikipedia.org/wiki/Ordinary_least_squares

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Fundamental Regression Model: ordinary least squares (OLS)

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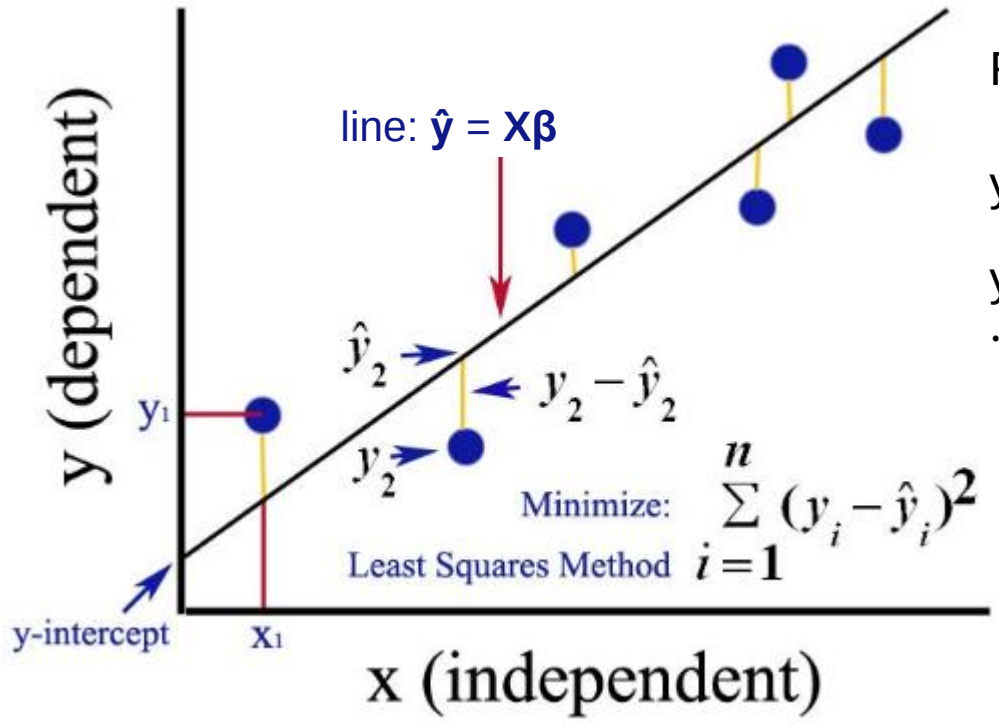
OLS: a method for estimating the unknown parameters in a linear regression model



Regression Equation:

$$y = b_0 + \beta_1 * x + \varepsilon$$

$$y = \beta_0 + \beta_1 * x_1 + \beta_2 * x_2 + \cdots + \beta_k * x_k + \varepsilon$$

Sources:
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- Data Analytics and Regression Analysis
- Ordinary Least Squares (OLS)
- **Hypothesis Testing: The t-test**

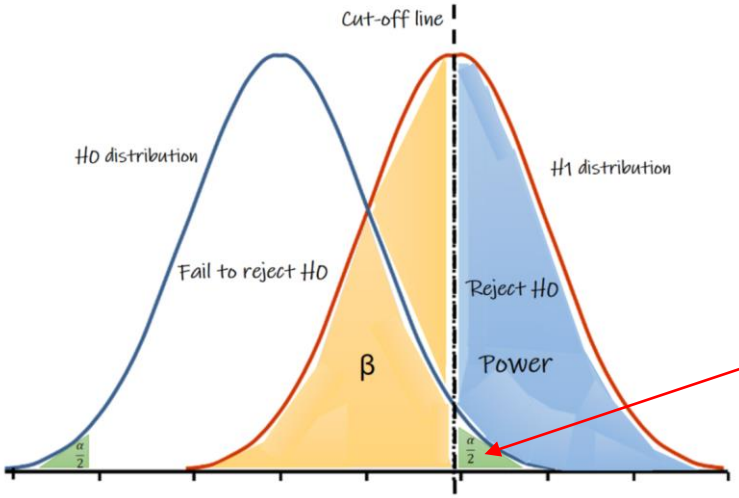
Hypothesis Testing: The t-test

To test if we have a significant independent variable, we can use hypothesis testing, such as a t-test.

To understand hypothesis testing, we have to think of two variables:

H0: Null hypothesis — the default **no-difference hypothesis** we are trying to reject.

H1: Alternative hypothesis — the difference hypothesis.



α (type 1 error)

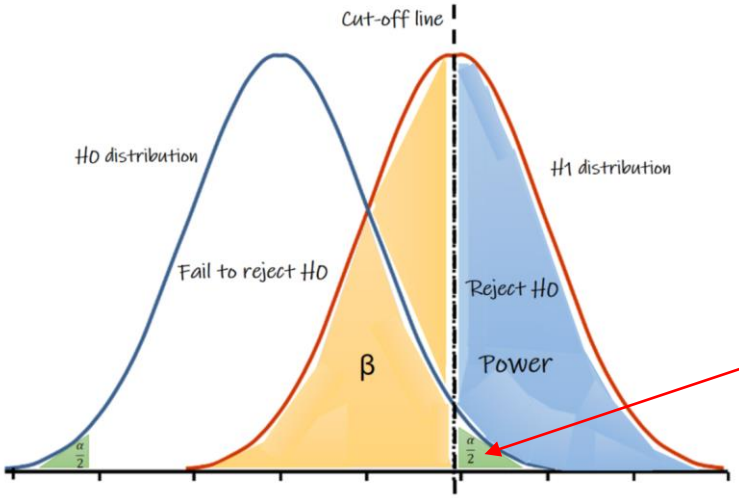
Source: https://medium.com/evidentebm/the-value-of-the-p-value-9460797a92d6

Hypothesis Testing: The t-test

The β estimators are derived from randomly distributed data; therefore, parameter values of OLS regressions can be tested.

To test if an independent variable of regression has a significant relationship with our dependent variable, we set our hypothesis as follows:

H0: Null hypothesis $\beta = 0$ | H1: Alternative hypothesis $\beta \neq 0$



α (type 1 error)

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Regression: P-Value

As a result of the t-test, we receive a p-value.

The p-value and a self-defined cut-off of α (usually 0.05) indicate if the value of β is statistically significant.

If p-value<α (e.g., p-value=0.02), we reject the null hypothesis and say there is a statistically relevant difference, but if p-value≥α (e.g., p-value=0.50), we cannot reject the null hypothesis and there is no statistically relevant difference.

The p-value indicates the probability of the result occurring by chance.

Source:
https://medium.com/evidentebm/the-value-of-the-p-value-9460797a92d6

OLS-Regression output in R

```
Call:
lm(formula = WORK_LIFE_BALANCE_SCORE ~ FRUITS_VEGGIES + BMI_RANGE +
    TODO_COMPLETED + DAILY_STEPS + SUFFICIENT_INCOME + TIME_FOR_PASSION +
    WEEKLY_MEDITATION + AGE + GENDER + YEAR, data = KA_sub)

Residuals:
    Min      1Q  Median      3Q     Max
-68.492 -15.703   1.191  15.920  42.681

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)       540.0369     7.5066  71.941  < 2e-16 ***
FRUITS_VEGGIES      6.1293     0.8817   6.952 1.57e-11 ***
BMI_RANGE         -12.4581     2.4538  -5.077 6.00e-07 ***
TODO_COMPLETED      4.5360     0.4677   9.699  < 2e-16 ***
DAILY_STEPS         3.0800     0.4316   7.136 4.87e-12 ***
SUFFICIENT_INCOME  30.5668     2.6603  11.490  < 2e-16 ***
TIME_FOR_PASSION    6.2116     0.4522  13.735  < 2e-16 ***
WEEKLY_MEDITATION   2.3515     0.4020   5.849 1.06e-08 ***
AGE36 to 50        -2.0451     2.7990  -0.731   0.4654
AGE51 or more      -2.3778     3.4146  -0.696   0.4866
AGELess than 20     8.9271     3.6152   2.469   0.0140 *
GENDERMale         -4.2973     2.3816  -1.804   0.0720 .
YEAR2016           -7.9251     3.9975  -1.983   0.0481 *
YEAR2017           -3.0408     4.0172  -0.757   0.4495
YEAR2018           -4.7586     4.5987  -1.035   0.3014
YEAR2019           -7.5908     4.7900  -1.585   0.1139
YEAR2020           -8.2080     4.0206  -2.041   0.0419 *
YEAR2021            4.9846     8.5954   0.580   0.5623
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 22.23 on 382 degrees of freedom
Multiple R-squared:  0.7783,    Adjusted R-squared:  0.7684
F-statistic: 78.89 on 17 and 382 DF,  p-value: < 2.2e-16
```

regression model

parameter estimates

p-values

Thank You!

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