Quantitative Data Analysis – Exercises

(Week 07)

In these exercises, you will learn:

- to perform simple and multiple linear regression analyses.
- to perform regression analysis based on regression trees and random forests.

In the data analysis process model, these exercises cover part of the steps "Statistical data analysis and/or Modeling" and "Evaluation & Interpretation" (see figure 1). Results of the exercises must be uploaded as separate files (**no .zip files!**) by each student on Moodle. Details on how to submit the results can be found in the tasks below.

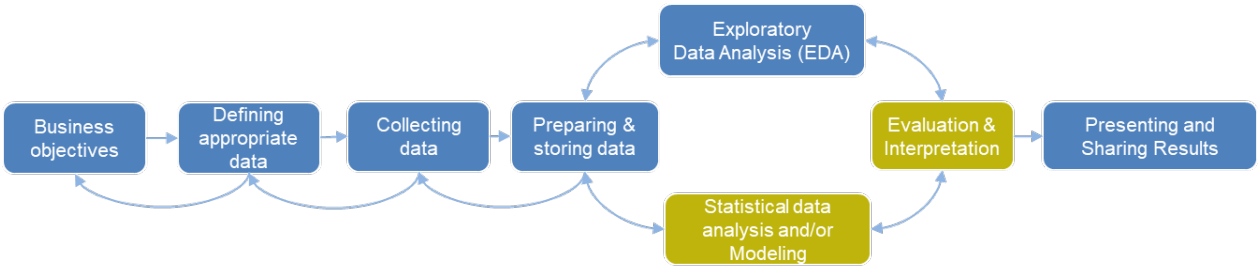


Figure 1: Data analysis process model (see slides of week 01)

Task 1

In this exercise, you will learn to perform simple and multiple linear regression analyses. The tasks are:

a) Run the Jupyter notebook 'linear_regression.ipynb' step by step and try to find out, what the Python code does.
b) Go to the section 'Simple linear regression …'. Create a new simple linear regression model with `price_per_m2` as target variable and `area` as the explanatory variable. Check the R-squared value of this new model. State whether the R-squared value is higher compared to the original model with `price` as target variable and `area` as the explanatory variable. Also check the histogram of model residuals. State whether the residuals are normally distributed or not.
c) Create a new simple linear regression model with `price_per_m2` as target variable and `rooms` as the explanatory variable. Check the R-squared value. State whether the R-squared value is higher compared to the original model with `price` as target variable and `area` as the explanatory variable? Also check the histogram of model residuals. State whether the residuals are normally distributed or not.
d) Go to the section 'Multiple linear regression …'. Include the variables `tax_income` and `dist_supermarket` as additional variables in the model. State whether the variables are statistically significant (at the 5% significance level). Note that this

can be figured out by looking at the part of the output-table shown below. If the value **P>|t|** is smaller than 0.05, than a variable is statistically significant (at the 5% significance level).

	coef	std err	t	P>|t|	[0.025	0.975]
const	458.4991	65.979	6.949	0.000	328.937	588.061
area	15.0355	0.639	23.543	0.000	13.781	16.290
pop_dens	0.2381	0.012	20.189	0.000	0.215	0.261

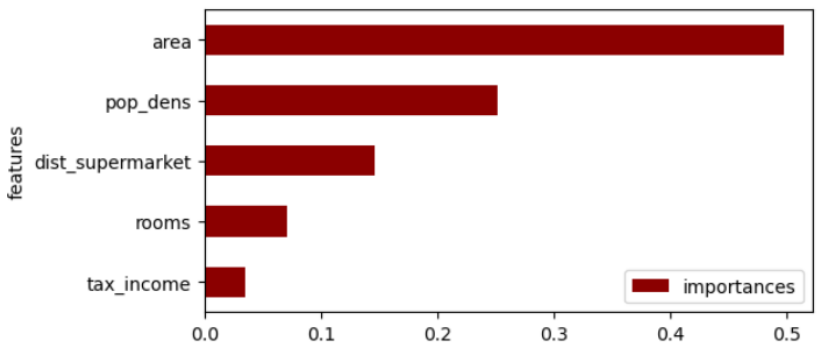
To be submitted on Moodle:

- The Jupyter notebook as html-file 'linear_regression.html' with the changes and short explanations according to b), c) and d).

Task 2

In this exercise, you will learn to perform regression analyses based on a regression tree and a random forest The tasks are:

a) Run the Jupyter notebook 'regression_trees_random_forest.ipynb' step by step and try to find out, what the Python code does.
b) Go to the section 'Fit the regression tree model'. Change the model parameter `max_depth=3` to `max_depth=5`. This will change the depth (complexity) of the tree. Compare the output (text and graphic) with the output of the original regression tree (in which `max_depth=3`). Do you see any differences? In the Jupyter notebook, explain why.
c) Go to the section 'Calculate coefficient of determination …'. Look at the coefficient of determination (R-squared). Now, go to the section 'Create train and test samples for the regression tree …'. Drop the two variables `area` and `rooms` from the train and test samples. Run the Jupyter notebook again. Does the R-squared value change? If so, explain why in the Jupyter notebook.
d) Go to the section 'Show feature importance' of the random forest and look at the barchart. Note that 'features' is another name for the 'explanatory variables' in a Machine Learning (ML) model. The barchart should look like this:



e) Go to the section 'Create train and test samples' and drop the variable `area`. Run the Jupyter notebook again.
f) Does the importance of features change? If yes, explain why in the Jupyter notebook.

To be submitted on Moodle:

- The Jupyter notebook as html-file 'regression_trees_random_forest.ipynb' with the changes and short explanations according to b), c), d), e) and f).