

Introduction to the Course

Quantitative Methods

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Introducing Ourselves



Figure 1: Scan this QR-code to obtain Dr. De Brouwer's business card and connect via LinkedIn

Quick introduction

Who are you?

What do you expect from this program?

What do you want from this program?

What should we focus on?

Practical Information

Availability of Slides and other materials

Course materials:

1. url: `http://www.de-brouwer.com`
2. select “Courses” and then your program
3. read materials there and download resources that you prefer (slides, handouts, or booklet)

Materials from “the Big R-Book” (De Brouwer, 2020):

1. videos and code:
`http://www.de-brouwer.com/publications/r-book/index.html`
2. code and slides: `http://www.de-brouwer.com/publications/r-book/18901229-for-teachers.html`

The Program Quantitative Methods

The Program Quantitative Methods

Objectives

Objectives of the program

know

the basics of statistics and data manipulation

know

at least one analytical tool (R)

understand

the importance of data in decision making

understand

uses and limits of various methods

apply

understand limits of models

apply

make informed decisions

apply

write a technical paper

apply

write a presentation and present it

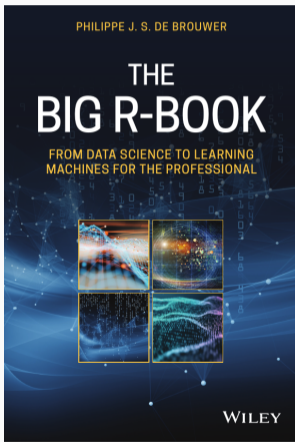
The Program Quantitative Methods

The content of the program

The content of the program

1. (optional) Getting started with R and its use
2. SQL Databases and importing data in R
3. Data wrangling (preparing data to build a model)
4. Building powerful models (linear regressions, generalised linear regression, non-linear regression, decision tree, random forest, SVN, neural network, etc.) and model validation
5. (optional) Introduction to companies and financial markets
6. Automating presentations, documents, etc.
7. (optional) Big Data
8. (optional) Code performance (speeding up R)
9. (extra/optional) Quantum Computers
10. (extra/optional) Crowdfunding and Fintech

De Brouwer, 2020



The Program Quantitative Methods

The grading of the program

Grading of the course

- 40% presence and collaboration in classroom (including in-class assignments)
- 60% selected assignment (details see Chapter *Assignments*, page 17)

The Program Quantitative Methods

Assignments

Definition (the assignment)

Students are expected to gather data, analyse it and report the results in

1. a paper (between 5 and 50 pages)
2. a presentation (life in the classroom – during last course)

The format of the presentation (during the last lesson) is a “10 minutes elevator pitch”
+ 10 minutes questions

The Grading of the assignment

- 50% for the idea, logic, coherence, and conclusions
- 25% for the written materials (paper and/or slides)
- 25% for the presentation itself (quality of slides if used + oratorical qualities)

The assignments are teamwork.

Ideas for the content of the Assignment

1. solve a problem by using data and rely on one or more of the methods studied (eg. regression, MCDA), etc.
2. use an existing project/document/essay and improve the decisions proposed by using data

Levels of Measurement

It is customary to refer to the theory of scales as having been developed by Stevens, 1946. In that paper he argues that all measurement is done by assuming a certain scale type. He distinguished four different types of scale: nominal, ordinal, interval, and ratio scales.

Levels of Measurement

Nominal Scale

Nominal Scale i

The nominal scale is the simplest form of classification: only labels (with no order). Examples include asset classes, first names, countries, days of the month, etc.

Scale Type	Nominal
Characterization	labels (e.g. asset classes, stock exchanges)
Permissible Statistics	mode (not median or average), chi-square
Permissible Scale Transformation	equality
Structure	unordered set

Table 1: Characterization of the Nominal Scale of Measurement.

It is not possible to use statistics such as average or median. We can measure which label occurs the most (modus of mode).

Note that it is possible to use numbers as labels, but that this is very misleading. When using an nominal scale, none of the traditional metrics (such as averages) can be used.

Levels of Measurement

Ordinal Scale

This scale type assumes a certain order. An example is a set of labels such as very safe, moderate, risky, very risky. Bond rating such as AAA, BB+, etc. also are ordinal scales: they indicate a certain order, but there is no way to determine if the distance between, say, AAA and AA- is similar to the distance between BBB and BB-. It may make sense to talk about a median, but it does not make any sense to calculate an average (as is sometimes done in the industry and even in regulations)

Scale Type	Ordinal Scale
Characterization	ranked labels (e.g. ratings for bonds from rating agencies)
Permissible Statistics	median, percentile
Permissible Scale Transformation	order
Structure	(strictly) ordered set

Table 2: Characterization of the Ordinal Scale of Measurement.

Ordinal labels can be replaced by others if the strict order is conserved (by a strict increasing or decreasing function). For example AAA, AA-, and BBB+ can be replaced

by 1, 2 and, 3 or even by -501, -500, and 500,000. The information content is the same, the average will have no meaningful interpretation.

Levels of Measurement

Interval Scale

Interval Scale i

This scale can be used for many quantifiable variables: temperature (in degrees Celsius). In this case, the difference between 1 and 2 degrees is the same as the difference between 100 and 101 degrees, and the average has a meaningful interpretation. Note that the zero point has only an arbitrary meaning, just like using a number for an ordinal scale: it can be used as a name, but it is only a name.

Scale Type	Interval Scale
Characterization	difference between labels is meaningful (e.g. the Celsius scale for temperature)
Permissible Statistics	mean, standard deviation, correlation, regression, analysis of variance
Permissible Scale Transformation	affine
Structure	affine line

Table 3: Characterization of the Interval Scale of Measurement.

Rescaling is possible and remains meaningful. For example, a conversion from Celsius to Fahrenheit is possible via the following formula, $T_f = \frac{9}{5}T_c + 32$, with T_c the temperature in Celsius and T_f the temperature in Fahrenheit.

An affine transformation is a linear transformation of the form $\mathbf{y} = \mathbf{A}\mathbf{x} + \mathbf{b}$. In Euclidean space an affine transformation will preserve collinearity (so that lines that lie on a line remain on a line) and ratios of distances along a line (for distinct collinear points p_1, p_2, p_3 , the ratio $\|p_2 - p_1\|/\|p_3 - p_2\|$ is preserved).

In general, an affine transformation is composed of linear transformations (rotation, scaling and/or shear) and a translation (or “shift”). An affine transformation is an

internal operation and several linear transformations can be combined into one transformation.

Levels of Measurement

Ratio Scale

Using the Kelvin scale for temperature allows us to use a ratio scale: here not only the distances between the degrees but also the zero point is meaningful. Among the many examples are profit, loss, value, price, etc. Also a coherent risk measure is a ratio scale, because of the property translational invariance implies the existence of a true zero point.



Scale Type	Ratio Scale
Characterization	a true zero point exists (e.g. VAR, VaR, ES)
Permissible Statistics	geometric mean, harmonic mean, coefficient of variation, logarithms, etc.
Permissible Scale Transformation	multiplication
Structure	field

Table 4: Characterization of the Ratio Scale of Measurement.

Levels of Measurement

References

References

-  De Brouwer, Philippe J. S. (2020). **The Big R-Book: From Data Science to Learning Machines and Big Data**. New York: John Wiley & Sons, Ltd. ISBN: 978-1-119-63272-6.
-  Stevens, Stanley Smith (1946). **'On the theory of scales of measurement'**. In: *Science* 103.2684, pp. 677–680.

Nomenclature

MCDA Multi Criteria Decision Analysis