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Analysis of the current state of courses in Applied statistics at the University of Niš

There is great diversity of courses in the area of Applied statistics and related areas at the University of Niš. The purpose of this text is to identify these courses in different study programs at the University, as a basis for creating future joint study program in Applied statistics with several modules. We also analyze the current state of the teaching staff in this area at the University, and we analyze the need for statistical software.

Analysis of courses

1. Faculty of Science and Mathematcis

Different departments and study programs at the Faculty offer a lot of courses in areas of mathematical and applied statistics, probability, and other related areas.

Department of Mathematics and Informatics has two bachelor degree programs (*Mathematics* and *Informatics*), three master degree programs (*Mathematics*, *Applied mathematics* and *Informatics*), and two PhD degree programs (*Mathematics* and *Informatics*).

Both bachelor degree programs offer courses *Introduction to probability* and *Mathematical statistics*, and the program in *Mathematics* also offers elective courses *Financial mathematics* and *Finance*, as prerequisites for future studies on the module *Mathematics in finance* of the master degree program in *Applied mathematics*.

The master degree program in *Mathematics*, and both modules of the master degree program in *Applied mathematics* (*Mathematics in finance* and *Mathematics in physics*), offer courses *Probability theory* and *Stochastic processes*, and the module *Mathematics in finance* offer a lot of other courses concerning applications of probability and statistics in finance, and related courses: *Multivariate analysis*, *Financial mathematics*, *Actuarial mathematics*, *Time series in economics*, *Financial modeling 1* and *2*, *Risk theory*, *Modern financial manage-*

ment, *Statistical software in economy*, *Decision-making theory*, *Sampling theory and design of experiments*, and *Operations research*.

The PhD program in *Mathematics* also provides elective courses in the area of applications of probability and statistics in finance: *Probability theory*, *Selected topics in statistics*, *Stochastic processes*, *Martingale theory*, *Mathematical statistics*, *Design and analysis of experiments*, *Stochastic differential equations*, *Risk management*, *Time series analysis*, *Financial modeling*, *Stability theory for stochastic differential equations*, *Risk theory*, and *Time series with random coefficients*.

Department of Physics has two compulsory courses in the area of applied statisics: *Fundamentals of statistical physics* (at the bachelor level) and *Statistical physics* (at the master level), and the PhD course *Statistical physics of equilibrium systems*. At the **Department of Biology** there is the compulsory course *Probability and statistics in biology* at the bachelor level, and at the **Department of Geography** there are three courses at the bachelor level, the compulsory course *Statistics* and elective courses *Business mathematics* and *Business statistics*.

2. Faculty of Economics

The faculty offers the compulsory course *Statistics* at the bachelor level, elective courses *Statistical analysis in marketing* and *Decision-making theory* at the master level, the elective course *Quantitative methods in economics* at the PhD level, and many other related courses such as *Mathematics*, *Informatics*, *Operations research* and *Financial and actuarial mathematics* (at the bachelor level), and *Mathematical methods in economics* (at the PhD level).

3. Faculty of Medicine

The faculty offers compulsory courses *Medical statistics and informatics* at the integrated study programs *Medicine* and *Dentisty*, and *Statistics in pharmacy* at the integrated study program *Pharmacy*. Certain basic topics from probability and statistics are partly involved in the compulsory course *Mathematics* at the integrated study program *Pharmacy*.

All PhD degree programs (*Molecular medicine*, *Clinical medicine*, *Public health*, *Fundamental research in dentistry*, *Clinical and epidemiologic research in dentistry* and *Toxicology*) have the course *Medical statistics* as compulsory, and the program *Public health* has also the compulsory course *Applied statistical methods*.

4. Faculty of Sport and Physical Education

The faculty offers two PhD degree compulsory courses: *Quantitative methods* and *Statistical software*.

5. Faculty of Philosophy

The Faculty offers several courses in the area of *Applied statistics* at the bachelor level. The program *Psychology* offers compulsory courses *Statistics in psychology* and *Multivariate statistics*, the program *Pedagogy* offers compulsory courses *Statistics in pedagogy* and *Software for data analysis*, and the program *Sociology* offers the compulsory course *Introduction to data analysis*.

6. Faculty of Occupational Safety

The faculty has one study program at the bachelor level (Working and living environmental protection) and five programs at the master level (Environmental protection engineering, Occupational safety, Fire protection, Emergency management, Communal system management). At the bachelor level there is one compulsory course in the area of Applied statistics (*Data processing and analysis*), and three related compulsory courses (*Mathematics*, *Computer science*, *Systems and risk theory*). At the master level there is one course which can be classified in the area of Applied statistics (*Risk modelling and simulation*) and four related corses (*Decision-making theory*, *Fire modelling and simulation*, *System engineering*, *Project management*). Each master degree program contains at least three of these five courses.

7. Faculty of Mechanical Engineering

The bachelor degree program at this faculty offers two elective courses in area of *Applied statistics*: *Statistical process control* and *Methods of risk analysis*. At the master level there are courses such as *Neural and fuzzy modeling and control*, *Intelligent Control Systems* and *Operations research*, but not courses in area of *Applied statistics*.

The PhD degree program offers the course *Selected topics in higher mathematics*, where students can choose topics in *Probability and statistics*, as well as courses *Stochastical processes in mechanical systems* and *Stochastic control systems*, as well as some related courses, such as *Intelligent control systems*, *Modeling and optimization of processes*, etc.

8. Faculty of Electronic Engineering

The faculty offers bachelor degree elective courses *Probability and statistics* and *Statistical methods of quality control* at the module *Electronic components and microsystems*, and *Statistical theory of telecommunications* at the module *Telecommunications*. Topics concerning stochastic processes are included in several other courses at the module *Telecommunications*. *Fundamentals of probability and statistics* form a part of the course Mathematics 3 at the module *Computer Engineering*.

The PhD program offers the elective course *Statistical signal processing*.

9. Faculty of Civil Engineering

The faculty offers the PhD degree course *Probalility theory and statistics*, as the only course in the area of Applied statistics. The course *Mathematical modeling*, also at the PhD level, deals with issues of fuzzy logic, genetic algorithms and neural networks.

10. Faculty of Technology in Leskovac

The faculty offers only two courses that could belong to the area of *Applied statistics*: the compulsory master degree course *Mathematical analysis of experimental data*, and the elective PhD degree course *Analysis of experimental data*.

Analysis of the teaching staff

There is also great diversity of teaching staff in the area of Applied statistics and related areas. At present, the *Faculty of Science and Mathematics*, Department of Mathematics and Informatics, can provide 8-9 teachers in the areas of statistics, stochastic, and related areas, and that number will increase in the next few years. We can also count to 4-5 teachers from the *Faculty of Economics*, 2 from the *Faculty of Medicine*, 1 from the *Faculty of Occupational Safety*, and 1 from the *Faculty of Philosophy*.

Analysis of the need for statistical software

One of the most important decisions which has to be made on the occasion of introduction of some course in statistics, whether it is a basic or advanced one, such as multivariate analysis, planning and analysis of experiments, analysis of time series etc., is the choice of appropriate software. There is a large number of statistical software at disposal. They have many similarities, but they are different and sometimes these differences are not small, so the choice is not easy. We could get information which statistical software various participants of the Tempus project use and what is their experience with this software. The entire discussion was reduced to two proposals. Colleagues from the University of Vienna proposed usage of the free statistical software R, and the other colleagues proposed to use some commercial software, like SPSS, for example. We fully agree with the suggestion given by colleagues from the University of Vienna. Now, we will try to explain our position about this.

Both basic and advanced courses in statistics are organized at almost all faculties of the University of Nis, at almost all levels of studies: graduate, master and doctoral study. The

statistical software SPSS is mainly used at the majority of faculties, while the statistical software R is used at the Faculty of Science and Mathematics on all levels of study.

Choice of statistical software depends on the following elements:

1. For poor countries like ours is, the most important element is a price. The majority of statistical software has to be paid, and it can be of the crucial importance when we choose the statistical software. We are giving prices of some statistical packages:

SPSS: There are two versions of this software for students: the basic-GrandPack Base version and the advanced one-GrandPack version. Prices depend on the duration of the license. So, 6 months GrandPack Base version costs 46$, while the annual license costs 80$. As for the prices of advanced versions they are, respectively, 80$ (six months), 140$ (one year) and 200$ (four years). We can note that this software is not quite cheap.

Minitab: There are teachers and students version that cost 30$ for the six-month license and 50$ for the annual license.

Stata: Students versions depend on the duration of the license and on the size of the sample which can be worked with. So, let's say, six-month license, for the version with the small sample, costs 30$, while the annual license, for the version with a large sample, costs 235$.

R: This statistical software is free and its usage is not restricted by any license.

2. Another important element is the duration of the license. As we can see, the use of commercial software is limited by the license, which, depending on the software can last from six months until 4 years. Unlike them, the statistical software R has no time-limited license, and it can be used as desired.

3. Any statistical software develops and appears with the new version in time. The majority of commercial statistical software allows improving of the existing software at the new version which is not quite cheap. Unlike them, the statistical software R can be built for free.

4. All companies do not use the same commercial statistical software.

5. An important element is the users interface. The most of commercial, statistical software have the good users interface. The statistical software R is the command-type software (Figure 1) and because of that most people avoid to work with it.

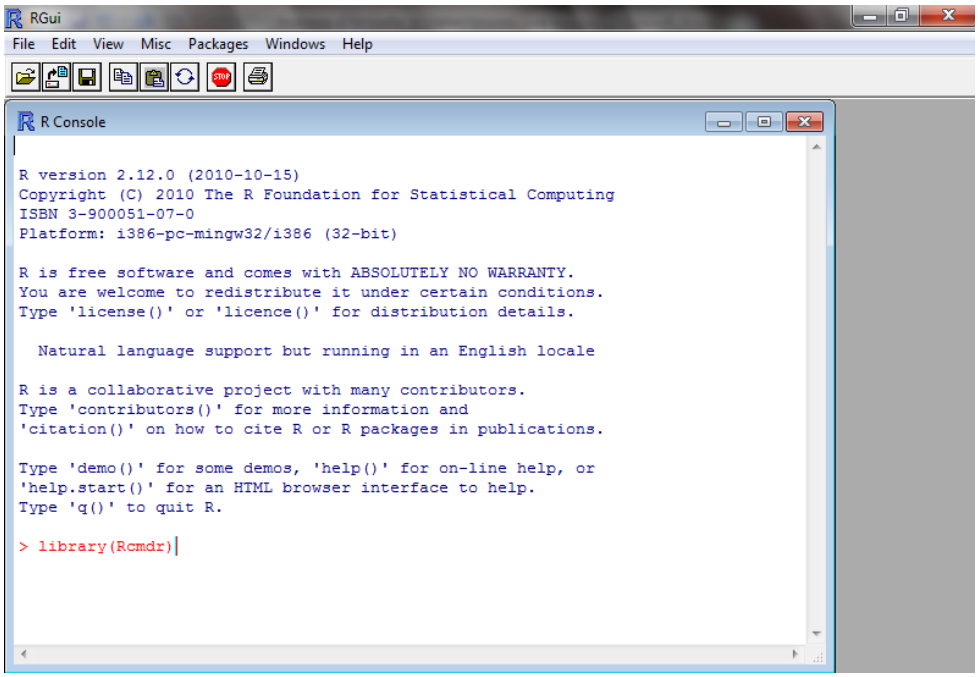

Figure 1. Users interface in R

However, the users are not sufficiently informed, and hence they are mistaken. Namely, inside the statistical software R can be run the package R Commander, which creates more than a solid users interface (Figure 2).

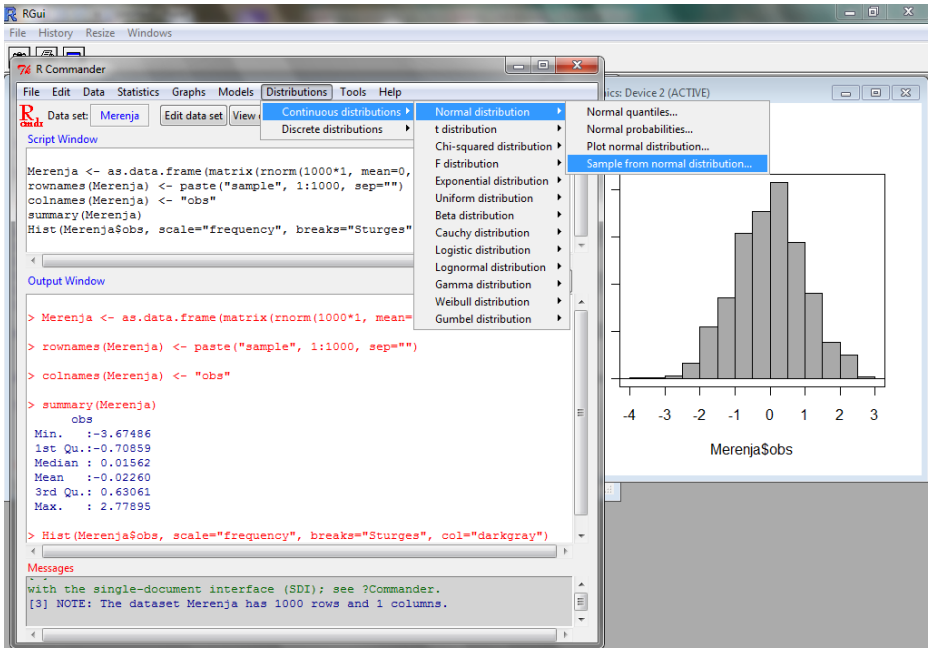

Figure 2. Graphics interface

It should also be emphasized that this statistical software has no limits for the size of the sample which will be worked with. Users have access to all features of statistical software

through the variety of packages which number is more than 1000, now. Statistical package R Commander can be simply improved.

From all this, we conclude that the statistical software R is the best for use, because it is free, has no time-limited license, has no restrictions for use, has great users interface and it is improving every day. This free statistical software is, otherwise, widely used in many rich, western universities in the world, what demonstrates its qualities in the teaching process.