

**TEACHING MATHEMATICAL STATISTICS
AT STATE UNIVERSITIES
OF THE REPUBLIC OF SERBIA**

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Abstract

Statistic thinking and talking is one of the important manners of contemporary communication. Statistical inference is included in almost all social and natural sciences. It will not be an exaggeration if we say even in all of them. In spite of variety of data that are the subject of statistical inference and teaching statistics within various faculties that are not devoted to mathematics itself, the fundamental method of the inference in statistics is mathematical.

This paper introduces how or how much the statistics is studied on the faculties of mathematics in the Republic of Serbia.

Key Words : mathematical statistics, teaching statistics, faculty of mathematics

1 Introduction

When people hear the word "statistics," they think of either sports-related numbers or the college class they took and passed. While statistics can be thought about in these terms, there is more to the relationship between you and statistics than you probably imagine.

It is well known that the statistics is an art as well as a science. Science refers to a systematized body of knowledge. In this we study cause and effect relationship and try to make generalizations. Statistics can also be called the science of scientific methods. About science and statistics it is even said that "science without statistics bear no fruit, statistics without science has no root."

Some informal definitions of statistics, provided by various well-known statisticians, are [1]

- The science of learning from (or making sense out of) data.
- The theory and methods of extracting information from observational data for solving real-world problems.
- The science of uncertainty.

- The quintessential interdisciplinary science.
- The art of telling a story with data.

An informed and educated person is one who recognizes, respects, values, and accepts a world of diverse cultures.

Knowledge aids in decision support, problem solving, and ultimately an enhanced appreciation for the affairs of the world. The steps from curiosity and questioning to a systematic process of inquiry should form the foundation for a lifetime pursuit of knowledge. Formal education should reinforce this process through a rich variety of learning experiences. One of them is learning statistics which improves personal quantitative analysis, and analytic processing.

Most educational systems are segregated in which disciplines are not well connected. In Serbia, some elements of statistics are involved even in the elementary school mathematics. But, in the secondary schools curricula vary. So, in the most of gymnasium modula, it is taught as a part of the fourth class mathematics course. In that case, the teacher is a mathematician. The situation is different with secondary schools which have separate courses in mathematics and in statistics. Some of teachers are mathematicians and some are economists. It means that the situation is the same as the worldwide. On the faculties, teaching of statistics is entrusted to many different professors, even without any mathematical education on the faculty level. Meanwhile, if we focuss on some famous statisticians, Sir David Cox [2], for instance, who made many pioneering and important contributions to numerous areas of statistics and applied probability over the years, he is a mathematician. He studied mathematics and he was Head of the Department of Mathematics at Imperial College London for a period, but he was also the President for several statistical societies over the years including the Royal Statistical Society, the Bernoulli Society and the International Statistical Institute. It was assumed up to the first half of the previous century that anybody who was doing reasonably well at mathematics could pick up statistics in a week or so! There had been very little teaching of statistics at universities before the Second World War. Afterwards, it all started to expand.

Industry, physics, chemistry, biology and so on, have and solve their own problems. However, some of these problems are mathematical, but the great majority had a statistical component to them.

As we said, there had been very little teaching of statistics at universities before the Second World War. It has evolved over the years and was first primarily a postgraduate subject, taken after reading mathematics if someone wished to be a scientific statistician, rather than an economic statistician. In that case, someone took at least a diploma, or a one-year master or two year magister study or a doctorate. Then statistics came into mathematics degrees, partly to make them more appealing to a wider audience and that has changed, so nowadays, most statisticians start fairly intensively in an undergraduate course, which has some advantages and some disadvantages.

The gap between theory and applications of statistics is significant. Sir David Cox thinks that the theory has almost disappeared [3]. Almost everyone works on applications. The issue is whether this has gone a bit too far. Maybe mathematics surrounding can provide better development of the theory itself.

The purpose of this paper is to collect courses in present curricula at the faculties of mathematics in Serbia in order to investigate teaching and learning statistics as a mathematical method. The paper is organized as follows. Section 2 lists faculties or departments of mathematics in the state universities in Serbia together with courses concerning statistics that are taught there. Section 3 contains some concluding remarks.

2 The Courses Concerning Statistics in Curricula at Faculties of Mathematics in Serbia

Here we present the actual list of courses concerning statistics on three levels of studying, i.e. on three levels of academic studies: Bachelor of Science, Master of Science, and PhD degree. It is important to say also, that the new accreditation procedure is going on and in the near future it might not be so. But, one will be able to have the grand picture how much statistics is taught under the auspices of mathematics at the state universities in Serbia. However, some faculties of mathematics have separate department for informatics or computer sciences and department for mathematics and some of them have the Department of Mathematics and Informatics, i.e. mathematics and informatics are together. So, we listed the courses of statistics on informatics also.

As the elementary probability theory is now the natural introduction to the theory of statistics, we particularized the course in probability whenever it exists in curricula of Bachelor and Master degree.

The following abbreviations are used below:

- ECTS – European Credit Transfer System
- MC – Mandatory Course
- OC – Optional Course
- IY – First Year of studying
- IIY – Second Year of studying
- IIIY – Third Year of studying
- IVY – Fourth Year of studying
- WS – Winter Semester
- SS – Summer Semester
- $a + b$:
 - a – Number of lecture classes per week
 - b – Number of recitation classes per week
- $a + b + c$:
 - a – Number of lecture classes per week

- b – Number of recitation classes per week
- c – Other types of classes per week

**University of Novi Sad, Faculty of Science,
Department of Mathematics and Informatics [4]**

- Bachelor, **three years**, 180 ECTS:
 1. M_1 : Mathematics (Undergraduate academic studies – Mathematics)
Probability, IIIY, SS, 3 + 2, 7 ECTS, MC
 2. M_2 : Applied Mathematics (Undergraduate academic studies – Applied Mathematics)
Probability, IY, SS, 3 + 3, 7 ECTS, MC
Statistics, IIIY, SS, 3 + 3, 7 ECTS, MC
 3. I : Informatics (Undergraduate academic studies – Informatics)
No course in statistics.
- Bachelor, **four years**, 240 ECTS:
 1. M_o : Bachelor Professor of Mathematics (Undergraduate academic studies – Bachelor Professor of Mathematics)
Probability, IIIY, SS, 3 + 3, 7 ECTS, MC
Statistics, IVY, WS, 2 + 3, 6 ECTS, MC
 2. I : Informatics (Undergraduate academic studies – Informatics)
Probability, –, WS, 2 + 2, 5 ECTS, OC
- Master study, **two years**, 120 ECTS:
 1. MA: Mathematics (Graduate academic studies – Mathematics)
Statistics, IY, WS, 2 + 3, 6 ECTS, MC
Statistic Modeling, IY, SS, 2 + 2, 5 ECTS, OC
 2. MB: Applied Mathematics (Graduate academic studies – Applied Mathematics)
Time series, IY, WS, 2 + 2, 5 ECTS, OC
Statistic Modeling, 2 + 2, 5 ECTS, OC
 3. IA: Informatics (Graduate academic studies – Informatics)
Probability, IY, WS, 2 + 2, 5 ECTS, MC
Statistics, IY, WS, 2 + 3, 6 ECTS, MC
 4. IB: Information Technologies (Graduate academic studies – Information Technologies)
Probability, IY, WS, 2 + 2, 5 ECTS, OC, only Module Software Engineering
Statistics, IY, WS, 2 + 3, 6 ECTS, OC, only Module Information Systems

- PhD, **three years**, 180 ECTS:
 1. MD: Mathematics (Doctorial academic studies – Mathematics)
No course in statistics.
 2. ID: Informatics (Doctorial academic studies – Informatics)
No course in statistics.

**University of Belgrade, Faculty of Mathematics, Department of
Mathematics and Department of Informatics [5]**

- Bachelor, **four years**, 240 ECTS: Bachelor of Mathematics

Module 1ML *Two courses teaching:* Bachelor Professor of Mathematics and Computer Science (Undergraduate academic studies)
Probability and Statistics A, IVY, WS, 2 + 2, 5 ECTS, MC
Probability and Statistics B, IVY, SS, 2 + 2, 5 ECTS, MC

Module 1MM Theory of Mathematics and Applications (Undergraduate academic studies)
Probability and Statistics A, IVY, WS, 2 + 2, 5 ECTS, MC
Probability and Statistics B, IVY, SS, 2 + 2, 5 ECTS, MC

Module 1MR Computer Science and Informatics (Undergraduate academic studies)
Probability and Statistics A, IIIY, WS, 2 + 2, 5 ECTS, MC
Probability and Statistics B, IIIY, SS, 2 + 2, 5 ECTS, MC

Module 1MP Applied Mathematics (Undergraduate academic studies)
Probability and Statistics A, IVY, WS, 2 + 2, 5 ECTS, MC
Probability and Statistics B, IVY, SS, 2 + 2, 5 ECTS, MC

Module 1MS Statistics, Actuarial and Financial Mathematics (Undergraduate academic studies)
Probability and Statistics A, IY, WS, 2 + 2, 5 ECTS, MC
Probability and Statistics B, IY, SS, 2 + 2, 5 ECTS, MC
Probability Theory, IIIY, WS, 4 + 4, 10 ECTS, MC
Statistical Software 1, IIIY, WS, 0 + 2 + 0, 3 ECTS, MC
Statistical Software 2, IIIY, SS, 0 + 2 + 0, 3 ECTS, MC
Mathematical Statistics, IIIY, SS, 4 + 4 + 0, 10 ECTS, MC
Sampling Theory, IIIY, SS, 2 + 2, 5 ECTS, OC
Statistical Software 3, IVY, WS, 0 + 2 + 1, 4 ECTS, MC
Statistical Software 4, IVY, SS, 0 + 2 + 1, 4 ECTS, MC
Time Series and their Application in Finance, IVY, SS, 3 + 2 + 0, 6 ECTS, MC
Analysis of Variance, IVY, WS, 2 + 2 + 0, 5 ECTS, OC

Linear Statistical Models, IVY, WS, 2 + 2 + 0, 5 ECTS, OC

Stochastic Models in Operational Research, IVY, SS, 3 + 2 + 0, 6 ECTS, OC

Queuing Theory, IVY, SS, 3 + 2 + 0, 6 ECTS, OC

Module 1MA Astronomy (Undergraduate academic studies)

Probability and Statistics A, IY, WS, 2 + 2, 5 ECTS, MC

Probability and Statistics B, IY, SS, 2 + 2, 5 ECTS, MC

- Master study, **one year**, 60 ECTS: Master of Mathematics

Module 2ML *Two courses teaching:* Professor of Mathematics and Computer Science (Graduate academic studies)

No course in statistics.

Module 2MM Theory of Mathematics and Applications (Graduate academic studies)

No course in statistics.

Module 2MR Computer Science and Informatics (Graduate academic studies)

No course in statistics.

Module 2MP Applied Mathematics (Graduate academic studies)

No course in statistics.

Module 2MS Statistics, Actuarial and Financial Mathematics (Graduate academic studies)

Selected Topics in Mathematical Statistics, IY, 3 + 2 + 2, 8 ECTS, OC

- PhD, **three years**, 180 ECTS: Doctor of Mathematical Science

- Mathematics (Doctoral academic studies)

Mathematical Statistics, IY or IY, 4 + 6, 9 ECTS, OC

Time Series Analysis, IY or IY, 4 + 6, 9 ECTS, OC

Hypothesis Testing, IY or IY, 4 + 6, 9 ECTS, OC

Linear Statistical Models, IY or IY, 4 + 6, 9 ECTS, OC

Special Course – Probability and Statistics, IY or IY, 4 + 6, 9 ECTS, OC

University of Niš, Faculty of Sciences and Mathematics, Department of Mathematics and Department of Computer Science [6]

- Bachelor, **three years**, 180 ECTS:

1. Mathematics (Undergraduate academic studies)

Introduction to Probability, IY, SS, 3 + 3, 8 ECTS, MC

Mathematical Statistics, IY, WS, 2 + 2, 7 ECTS, MC

2. Informatics (Undergraduate academic studies)
 - Introduction to Probability**, IY, SS, 3 + 3, 8 ECTS, MC
 - Mathematical Statistics**, IIIY, WS, 2 + 2, 7 ECTS, OC
- Master study, **two years**, 120 ECTS:
 1. Mathematics (Graduate academic studies)
 - Probability Theory**, IY, WS, 3 + 2, 7.5 ECTS, MC
 - No course in statistics.
 2. Applied Mathematics (Graduate academic studies)
 - (i) Module Mathematics in Finance
 - Multivariate analysis**, IY, WS, 3 + 2, 7.5 ECTS, MC
 - Time Series in Economy**, IY, SS, 3 + 2, 7.5 ECTS, MC
 - Statistical Packages in Economy**, IY, SS, 3 + 2, 7.5 ECTS, OC
 - Decision theory**, IY, WS, 3 + 2, 7.5 ECTS, OC
 - Sampling Theory and Design of Experiments**, IY, SS, 3 + 2, 6 ECTS, OC
 - (ii) Module Mathematics in Physics
 - No course in statistics.
 3. Informatics (Graduate academic studies)
 - Decision theory**, IY, WS, 3 + 2, 7 ECTS, OC
- PhD, **three years**, 180 ECTS:
 1. Mathematics (Doctorial academic studies)
 - Selected Topics in Statistics**, IY, WS, 4 + 0, 12 ECTS, OC
 - Mathematical Statistics**, IY, SS, 4 + 0, 12 ECTS, OC
 - Design and Analysis of Experiments**, IY, SS, 4 + 0, 12 ECTS, OC
 - Time Series Analysis**, IY, WS, 4 + 0, 12 ECTS, OC
 - Time Series with Random Coefficients**, IY, SS, 4 + 0, 12 ECTS, OC
 2. Informatics (Doctorial academic studies)
 - Selected Topics in Statistics**, IY, WS, 4 + 0, 12 ECTS, OC

University of Kragujevac, Faculty of Science, Institute for Mathematics and Informatics [7]

- Bachelor, **four years**, 240 ECTS:
 1. Bachelor of Theoretical Mathematics (Undergraduate academic studies)
 - Probability**, IVY, WS, 3 + 3, 7 ECTS, MC
 - Statistics**, IVY, SS, 3 + 2 + 1, 7 ECTS, MC
 2. Bachelor Professor of Mathematics (Undergraduate academic studies)
 - Probability**, IVY, WS, 3 + 3, 7 ECTS, MC
 - Statistics**, IVY, SS, 3 + 2 + 1, 7 ECTS, MC

3. Bachelor of Informatics (Undergraduate academic studies)
No course in statistics.
 4. Bachelor Professor of informatics (Undergraduate academic studies)
No course in statistics.
- Master study, **one year**, 60 ECTS:
 1. Theoretical Mathematics (Graduate academic studies)
No course in statistics.
 2. Professor of Mathematics (Graduate academic studies)
No course in statistics.
 3. Master of Informatics (Graduate academic studies)
Probability and Statistics, IY, WS, 2 + 2, 5 ECTS, OC
 - PhD, **three years**, 180 ECTS:
 1. Doctor in Mathematics (Doctorial academic studies)
No course in statistics.
 2. Doctor in Informatics (Doctorial academic studies)
No course in statistics.

University of Priština in Kosovska Mitrovica, Faculty of Natural Sciences, Department of Mathematics and Department of Informatics [8]

- Bachelor, **four years**, 240 ECTS:
 1. Mathematics (Undergraduate academic studies)
Introduction to Probability Theory, IY, SS, 2 + 2, 6 ECTS, MC
Mathematical Statistics, IVY, WS, 2 + 3, 6 ECTS, MC
 2. Informatics (Undergraduate academic studies)
Probability and Statistics, IY, WS, 3 + 3, 7 ECTS, MC
- Master study, **one year**, 60 ECTS:
 1. Mathematics (Graduate academic studies)
Selected Topics in Probability and Statistics, IY, WS, 3 + 3, 8 ECTS, OC

State University of Novi Pazar, Department of Mathematic Sciences [9]

- Bachelor, **four years**, 240 ECTS:
 1. Mathematics (Undergraduate academic studies – Mathematics)
Probability, IIIY, SS, 2 + 2, 6 ECTS, MC
Statistics, IVY, WS, 2 + 2 + 1, 6 ECTS, MC

2. *Two courses teaching* – Mathematics and Physics (Undergraduate academic studies)
 - Probability and Statistics**, IIIY, WS, 3 + 2, 6 ECTS, MC
 - Statistical Physics** IVY, WS, 2 + 2 + 1, 6 ECTS, MC
 3. *Two courses teaching* – Informatics and Mathematics (Undergraduate academic studies)
 - Probability and Statistics**, IIIY, SS, 3 + 2, 6 ECTS, MC
 4. *Two courses teaching* – Informatics and Physics (Undergraduate academic studies)
 - Statistical Physics** IVY, WS, 2 + 2 + 1, 6 ECTS, MC
- Master study, **one year**, 60 ECTS:
 1. Mathematics (Graduate academic studies)
 - No course in statistics.
 2. *Two courses teaching* – Mathematics and Physics (Graduate academic studies)
 - No course in statistics.
 3. *Two courses teaching* – Informatics and Mathematics (Graduate academic studies)
 - No course in statistics.
 4. *Two courses teaching* – Informatics and Physics (Graduate academic studies)
 - No course in statistics.
 - PhD, **three years**, 180 ECTS:
 - Mathematics (Doctorial academic studies – Mathematics)
 - No course in statistics.

3 Conclusion

Whoever, a statistician or someone else, but the faculties of mathematics have to be encouraged to develop cooperative projects and curricular activities related to other courses of study. All educational pursuits should lead to ensuring students are properly prepared to compete in a world job market, regardless of academic (university) or vocational pursuit.

The statistics is, no doubt, knowledge that will ultimately lead to an understanding, respect, and appreciation for the diverse cultural and physical world in which we live.

The United Nations General Assembly endorsed the Fundamental Principles of Official Statistics this year, also. On 29 January 2014, the General Assembly endorsed the draft resolution A/68/L.36 entitled Fundamental Principles of Official Statistics. Endorsement by the United Nations General Assembly marks the first time the Fundamental Principles have received such high recognition at the global political level. So, this means that the most universal, global political body has now endorsed its principles, which guide the production and dissemination of all official statistics in the globe. This is the historic moment for the global statistical system. Nowadays becomes important more than in the past to focus on

improving the public's understanding of statistics in every-day life. Yet, there are not that many statisticians who are trained to the level needed!

There is a gap, as we said before, between the theory of statistics and its applications. But, the challenge is preferably for an academic statistician, to be involved in several fields of application in a non-trivial sense and combine the stimulus and the contribution that this application will suggest. So, in our opinion, it is very important to develop statistics as a theoretical discipline at the faculties of mathematics as it is fundamentally a mathematical method. Meanwhile, however, as it can be seen from the above analysis, the only two state faculties of mathematics in Serbia that offer doctoral studies, that is where one can get PhD degree in Mathematical Statistics are Faculty of Mathematics, University of Belgrade and Faculty of Sciences and Mathematics, University of Niš.

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