Government of Russian Federation

Federal State Autonomous Educational Institution
of High Professional Education
National Research University «Higher School of Economics»

Faculty of Computer Science
School of Data Analysis and Artificial Intelligence

Syllabus for the course

«Data Analysis in Medicine»
for Master degree educational program "Data Sciences"
for 010402 «Applied Mathematics and Informatics»

Author:
Olga Yu. Rebrova, professor,
o.yu.rebrova@gmail.com

APPROVED BY

Approved on the meeting of the School of Data Analysis and Artificial Intelligence
Head of the School Sergei O. Kuznetsov

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Academic supervisor of the Master program «Data Science» in specialization 010402 «Applied Mathematics and Information Science» Sergei O. Kuznetsov

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«___» _____ 2017

Recommended by Academic Council of the Program «Applied Mathematics and Information Science»

«___» _____ 2017

Manager of the School of Data Analysis and Artificial Intelligence Larisa I. Antropova

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I. Introduction: Subject and background

Tutor and author

Olga Yu. Rebrova, Professor of National Research University Higher School of Economics, PhD

Summary

Data analysis in medicine is a growing field, where information sciences meet modern clinical applications. The main goal of this class in to introduce HSE students to the broad spectrum of medical data analysis problems and applications, and to provide the students with the skills necessary for conduction professional medical data analysis.

Prerequisites

Basic knowledge of statistics would be a must. Optional skills would include knowledge of SPSS or Statistica software.

Aims

- To develop knowledge of concepts underlying medical research
- To develop practical skills needed in modern data analysis
- To explain how data analysis can contribute to building better healthcare
- To give a hands-on experience with real-world medical data analysis
- To develop applied experience with medical software, programming, applications and processes

Background and outline

Medical data analysis a field that bridges math, computer science, and medicine. Yet – and unfortunately – medical data analysis is still not offered by most universities, and the lack of this training is becoming more and more apparent. Today's graduates have to be more prepared for solving the fundamental medical data analysis problems and for doing applied medical data

analysis.

This course is aimed at providing our students with knowledge, which could boost their careers in medical research. The course is based the most recent medical data analysis developments and international standards.

While the choice of medical data analysis, its problems and projects already defines the novelty of this class, we are trying to do our best to provide our students with the most up-to-date learning experience:

- Using the most current teaching software packages, the students can fully interact with the instructor and classmates, share desktops, share applications, take online tests and quizzes.
- The students work with real clinical data, solving real clinical problems. That is, unlike more conventional science classes, we prepare our students to solve real-world problems by working on these problems in the class.
- Independent, creative work is emphasized. Instead of "following the script" we accept the fact that several optimal solutions may be possible in most clinical projects, but only the very best will survive.
- Critical thinking is emphasized. The goal of each class project is to develop a solution that can be used in real life – with noisy data, imperfect practices, human errors, diverse equipment. We teach our students to take clinical data "as is", and to make most efficient use of what's available.
- The students get a great chance to learn math and information science in the most applied, "live" way. Although many of students are formally trained in math, they often lack the applied component, connecting any mathematical theory to the underlying reality. In essence, this class provides a perfect illustration to how math, information and data sciences can help real people in real life, via improved and more efficient healthcare. This also provides the students with a good motivational experience to use their training practically, and to excel in taking practical advantage of their formal knowledge.

This class topic is new to HSE and Russian universities in general – and this is precisely the void we are trying to fill. Modern healthcare needs medical data analysis more than anything else, and in return, the information science progress can be driven by the demanding healthcare applications. Medical data analysis programs start gaining their momentum in leading

universities abroad, which is another reason for HSE to cease the opportunity and to offer a competitive class in this field.

Teaching outcomes

The main outcome of this class is to train a student to support medical research. Universities and business crave for professionals with solid math/information background, but these individuals have to be trained to work with clinical problems. Our goal is to provide this training. Career-wise, we expect our students to be able to develop into skilled researchers. Finally, from the formal training point of view, we expect our students to become fluent in clinical data acquisition, processing and management, in the areas outlined in the schedule.

II. Schedule

	Topic	**Total hours**	**In class hours**		**Self-study**
			Lectures	**Labs**	
Module 3					
1.	Data analysis in medicine: introduction	7	2	2	3
2.	Health technologies assessment	7	2	2	3
3.	Evidence based medicine: hypotheses, designs, outcomes	7	2	2	3
4.	Systematic errors in clinical trials	7	2	2	3
5.	Design and planning of clinical trials of treatment and prevention technologies	7	2	2	3
6.	Data analysis in clinical trials of treatment and prevention technologies	10	2	2	6
7.	Design and planning of clinical trials of diagnostic and screening technologies	7	2	2	3
8.	Data analysis in clinical trials of diagnostic and screening technologies	7	2	2	3
9.	Reporting of data analysis in clinical trials	7	2	2	3
10.	Intermediate testing	6	0	4	2
	Subtotal	72	18	22	32
Module 4					
1.	Registers and databases of medical scientific information	7	2	2	3
2.	Search strategies in medical information sources	7	2	2	3
3.	Meta-analysis	8	2	2	4
4.	Indirect treatment comparisons	8	2	2	4

5.	Clinical economical analysis: data analysis	8	2	2	4
6.	Clinical economical analysis: modeling	8	2	2	4
7.	Decision support systems: statistical modeling	7	2	2	3
8.	Decision support systems: data mining	7	2	2	3
9.	Expert systems for medicine	7	2	2	3
10.	Multi-criteria decision analysis	7	2	2	3
11.	Final testing	6	0	4	2
	Subtotal	80	20	24	36
	Total	152	38	46	68

III. Assessment

The assessment includes 2 intermediate tasks and final exam.

Cumulative score = 0.5*Score for the 1st intermediate task + 0.5*Score for the 2nd intermediate task.

Final score = 0.6*Cumulative score + 0.4*Final exam score.

IV. Synopsis

The course is meant to cover the most principal areas of medical data analysis. It starts with the introductions into the field, its history, and its principal goals. We proceed with statistical support of planning and data analysis in clinical and epidemiological studies. International standards for these fields will be introduced. The class will cover the most critical topics of medical data analysis: data incompleteness and subjectivity, small samples, allocation of subjects into groups, choice of statistical tests, interpretation and representation of results, etc. After this point, the class will evolve into the secondary data analysis, such as meta-analysis and indirect treatment comparisons. Then applications of data mining, modeling and multi-criteria decision analysis methods in medical research and healthcare will be discussed.

V. Reading

- H. Motulsky. Essential Biostatistics. Oxford University Press; 2015.
- R. Fletcher, S.W. Fletcher. Clinical Epidemiology: The Essentials (Fifth Edition). Lippincot W. & W., 2012.
- D. Altman. Practical Statistics for Medical Research. 1st Edition. Chapman & Hall/CRC, 1990.
- O. Rebrova. Statistical analysis of medical data. Moscow, Media Sphera, 2006 (in Russian).