FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY
SUBJECT CARD

Name of subject in Polish: TEORIA ESTYMACJI
Name of subject in English: Estimation theory
Main field of study (if applicable): APPLIED MATHEMATICS
Specialization (if applicable): COMPUTATIONAL MATHEMATICS
Profile: **academic / practical***
Level and form of studies: ~~**1st/**~~ **2nd* level, full-time /** ~~**part-time***~~
Kind of subject: ~~**obligatory /**~~ **optional /** ~~**university-wide***~~
Subject code
Group of courses **YES /** ~~**NO***~~

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		60		
Form of crediting	crediting with grade				
For group of courses mark (X) final course	X				
Number of ECTS points	3		2		
including number of ECTS points for practical classes (P)	2		2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5		1,5		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student knows how to use statistical packages
2. Student has a basic knowledge of mathematical statistics.
3. Student has a basic knowledge of mathematical analysis and functional analysis
4. Student has basic programming skills.

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SUBJECT OBJECTIVES

C1 Learning of statistical criteria for assessing the quality of statistical estimation
C2 Learning basic parametric estimation methods and their properties.
C3 Learning basic non-parametric estimation methods and their properties.
C4 Ability to program advanced statistical methods.
C5 Ability to carry out simulation studies.
C6 Ability to evaluate properties of statistical methods based on simulation studies.
C7 Mastering of English vocabulary in the field of estimation methods .
C8 Report writing skills in English.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the basic parametric estimation methods.
PEU_W02 knows the basic non-parametric estimation methods.
PEU_W03 knows the basic criteria for assessing the quality of the estimation.
PEU_W04 knows the theoretical basis of statistical simulation.
PEU_W05 knows English in the extent necessary for the creation of simulation reports.
PEU_W06 knows Programming Languages enable to carry out the simulation study.

relating to skills:

PEU_U01 able to apply advanced statistical methods to analyze real data.
PEU_U02 can use programming languages to program the high-order complex statistical methods and simulation tests and to carry out simulation studies.
PEU_U03 able to assess the properties of statistical methods based on simulation studies.
PEU_U04 can develop a report in English summarizing the results of simulation studies.

relating to social competences:

PEU_K01 can benefit from the scientific literature in English, including reaching the source materials and review them.
PEU_K02 understands the need for systematic work to improve knowledge

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Basic concepts of estimation theory: bias, variance, mean square error matrix of Fisher information, efficiency, asymptotic normality	2
Lec 2	Theoretical basis of simulation methods and replication	2
Lec 3	Bias and variance estimation - bootstrap, Jacknife, the delta method	2
Lec 4	Construction of confidence intervals - classic and boostrap intervals	2
Lec 5	Nonparametric density estimation - histogram and its properties	2
Lec 6	Nonparametric density estimation - kernel estimator and its properties	2
Lec 7	Selection of bandwidth in the kernel estimator	2
Lec 8	Modifications of kernel estimator - variable bandwidth, higher-order kernels	2
Lec 9	Estimation of density through orthogonal expansions	2
Lec 10	Estimation of density - local likelihood function and maximum likelihood method with smoothing	2
Lec 11	Nonparametric regression function estimation - estimation of kernel	2
Lec 12	Selection of the bandwidth and modification of the kernel estimator of regression function.	2
Lec 13	Hazard function estimation - parametric and non-parametric methods.	2

Lec 14	Empirical Bayesian methods - Stein estimator	2
Lec 15	Test	2
	Total hours	**30**

Laboratory		**Number of hours**
Lab 1	Parametric estimation - method of maximum likelihood. Bias, variance, mean square error - estimation using computer simulations.	4
Lab 2	Estimation of bias, variance and construction of confidence intervals using the method of substitution and replication methods (bootstrap, jackknife). Estimating the quality of estimators based on simulation studies.	4
Lab 3	Estimating the several parameters - asymptotic covariance matrix, the covariance matrix estimation using the method of substitution and replication methods. Estimating the quality of estimators based on simulation studies.	4
Lab 4	Nonparametric estimation of density - the histogram, method of the nearest neighbor, kernel estimator, orthogonal expansions. Smoothing parameter selection. Quality rating based on simulation studies.	6
Lab 5	Nonparametric estimation of the regression function. Estimators: kernel, local polynomial, the nearest neighbor, the smooth spline functions. Construction of confidence intervals and bands using the bootstrap method. Smoothing parameter selection. Quality rating based on simulation studies.	6
Lab 6	Estimation of survival function and hazard function with parametric and nonparametric methods. Construction of confidence intervals through approximation with the normal distribution and the bootstrap method. Quality rating based on simulation studies.	4
Lab 7	Empirical Bayesian methods. Quality assessment using simulation studies.	4
	Total hours	**30**

TEACHING TOOLS USED
1. Lecture problem - computer presentation and traditional method 2. Laboratory - self development of programs for simulation, reports from analyses 3. Consultations 4. Student's self work – preparation for the laboratory

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	All subject effects of the course	Reports and activity during the laboratory.
F2	PEU_W01	Test

	PEU_W02 PEU_W03 PEU_W04 PEU_W05	
P=0,75*F1+0,25*F2		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] L. Devroye, A Course in Density Estimation [2] B. Efron, R. Tibshirani, Introduction to the Bootstrap [3] B. Silverman, Density Estimation for Statistics and Data Analysis. [4] W. Härdle, Smoothing Techniques with implementation in S [5] A.W.Bowman and A. Azzalini, Applied Smoothing Techniques for Data Analysis, The kernel approach with S-Plus Illustrations [6] P.J. Green and B.W.Silverman, Nonparametric regression and Generalized Linear Models
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
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