**Syllabus of an educational component of a degree programme**

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| Name of unit conducting a component | ***Doctoral School of Social Sciences*** |
| Name of an educational component | Advanced bayesian data analysis and causal inference |
| Language of education | English |
| Goals of education | This course covers some advanced topics in bayesian data analysis and some basic causal inference. Both the R programming environment and the Stan modeling language will be used extensively. The end-goal is that students will learn how to translate substantive hypotheses or questions into causal inference problems and – if it turns out that it is possible to do so - obtain answers to the related causal queries using bayesian inference. |
| Learning outcomes of an educational component | Knowledge:- causal inference basics (DAGs, structural causal model, d-separation, confounding and estimate bias, causal inference in linear and nonlinear models, elements of the do calculus)- hierarchical models (including metaanalysis models)- generalized linear models- nonlinear and nonparametric models- model checking- robust inference- causal inference in observational and experimental studies- dealing with censored data- mediation analysis- dealing with missing data- bayesian power analysis- bayesian computation (limitations of MCMC)- sensitivity analysisSkills:Ability to perform several types of advanced bayesian analyzes, ability to assess the identifiability of causal effects and obtain answers to causal queries using frequentist or bayesian inferenceSocial competences: Ability to collaborate when performing statistical analyzes and causal inference |
| Verification methods and assessment criteria of learning outcomes obtained by students | Homework assignments, online or offline tests, practical exams at the computer. |
| Type of an educational component (obligatory/optional) | obligatory |
| Year of study | 1st |
| Semester  | Summer |
| Name and surname of the coordinator of a component and/or person/s conducting a component  | Borysław Paulewicz |
| Name and surname of person/s conducting an examination or granting credit in the case when this sposóis other person than conducting a component  | Borysław Paulewicz |
| Manner of completion  | Workshop |
| Preliminary and additional requirements  | The “Elementary bayesian data analysis with elements of causal inference” course. |
| Type and number of hours of courses requiringdirect participation of academic staff and students, if in a given component such courses are included  | Contact hours – 45Homeworks - 45 hoursPreparation of a final assignment – 45 hours |
| Number of ECTS credits assigned to a component  | 5 |
| Balance of ECTS credits  | Contact hours – 45Homeworks - 45 hoursPreparation of a final assignment – 45 hours |
| Applied teaching methods | Lecture, exercises, group discussions, extensive use of computer |
| Form and conditions of passing a component, including conditions of allowing to take an examination, as well as form and conditions of passing each type of courses included in a given component | Conditions of allowing to take an examination:- at most 2 missed classes- passing all tests and doing all homework assignmentsFinal exam: performing a practical, causally motivated statistical analysis using R and Stan. |
| Content of an educational module (with division into forms of courses completion) | Causal inference basics:- DAGs and the structural causal model- d-separation- confounding- causal inference in observational and experimental studies- elements of the do calculusAdvanced Bayesian data analysis:- hierarchical models- generalized linear models- nonlinear and nonparametric models- model checking- robust inference- dealing with censored data- mediational analysis- dealing with missing data- bayesian power analysis- bayesian metaanalysis- bayesian computation (limitations of MCMC)- sensitivity analysis |
| List of basic as well as supplementary literature, knowledge of which is required in order to pass a given component  | The Book of Why Pearl, MacKenzieStatistical Rethinking 2nd ed. Richard McElreathCausal Inference in Statistics: A Primer Pearl, Glymour, JewellBayesian Data Analysis 3rd ed. Gelman et. al.\*Regression and Other Stories Gelman, Hill, & Vehtari\*Data Analysis Using Regression and Multilevel/Hierarchical Models Gelman & Hill\*Bayesian Cognitive Modeling Lee & Wagenmakers\*Doing Bayesian Data Analysis, Kruschke[\* is recommended, nonobligatory reading] |