Course title:	Statistical Inference for Astronomers
Lecturer:	dr hab. Radosław Poleski (rpoleski@astrouw.edu.pl; phone: 22-55-305-07 ext.108; consultations can be scheduled via email)
Field, type and level of studies	Astronomy; all years of PhD
Leading Institute	Astronomical Observatory, University of Warsaw
Number of ECTS points:	
Course character:	Lecture (in-person)
Language	English
Criteria to complete the course	Active participation (in-person; laptop for coding is required) and homework assignments for missed lectures.
Number of hours	30
Short description (Skrócony opis przedmiotu)	The goal of the course is to prepare participants for conducting statistical inference using modern tools. The main focus will be on the Markov chain Monte-Carlo and similar methods.

Description (Pełny opis przedmiotu)	Prerequisites: • probability theory, • programming and data visualization – python is suggested but other languages are allowed. The main topics of the course: • sampling from 1-D distributions, • Monte-Carlo integration, • importance sampling, • Markov chain Monte-Carlo, • nested sampling, • hierarchical Bayesian inference. Topics will be adjusted based on the participants interests. Participants are required to bring their laptops to each lecture and actively write code.
Bibliography (Literatura)	1. Hogg, Myers, and Bovy 2010 „Inferring the Eccentricity Distribution", ApJ 725, 2166 2. Foreman-Mackey, Hogg, and Morton 2014 „Exoplanet Population Inference and the Abundance of Earth Analogs from Noisy, Incomplete Catalogs", ApJ 795, 64 3. Sharma 2017 „Markov Chain Monte Carlo Methods for Bayesian Data Analysis in Astronomy", ARA&A 55, 213 4. Ivezić et al. 2019 „Statistics, Data Mining, and Machine Learning in Astronomy: A Practical Python Guide for the Analysis of Survey Data", Princeton University Press 5. Speagle 2019 „A Conceptual Introduction to Markov Chain Monte Carlo Methods", arXiv:1909.12313 6. Aigrain and Foreman-Mackey 2023 „Gaussian Process Regression for Astronomical Time Series", ARA&A 61, 329 7. Wall and Jenkins 2014 "Practical Statistics for

	Astronomers", Cambridge University Press 8. Feroz and Hobson 2008 "Multimodal nested sampling: an efficient and robust alternative to Markov Chain Monte Carlo methods for astronomical data analyses", MNRAS 384, 449
Learning outcomes (Efekty uczenia się)	A student should have a deep knowledge and understanding of the methodology used in the field and be able to solve problems illustrating discussed topics (WG_01, WG_02, WG_03). **Knowledge - P8S_WG:** Upon successful completion of the course, the student will demonstrate advanced knowledge and understanding of: • Theoretical foundations and practical implications of Monte-Carlo integration. • Principles, mathematics, and assumptions underpinning Markov Chain Monte Carlo, nested sampling, and hierarchical Bayesian models. • State-of-the-art literature and research developments in Bayesian statistics, including conceptual challenges and areas of active methodological research. **Practical Skills – P8S_UW, P8S_UO:** Upon successful completion of the course, the student will be able to: • Independently design and implement Monte Carlo and MCMC algorithms to perform efficient statistical inference. • Develop and critically evaluate hierarchical Bayesian models. **Social Skills – P8S_KK, P8S_KR:** Upon successful completion of the course, the student will be ready to: • Critically reflect on the ethical, theoretical and practical implications of statistical modelling choices, including responsibility for transparent and reproducible analysis. • Communicate complex statistical concepts, results and their limitations effectively to both specialist and non-specialist audiences. • Work autonomously and collaboratively in research or professional teams to integrate advanced inference

	methods into interdisciplinary projects. • Engage in independent study and continuous professional development, synthesising new research findings with existing knowledge to drive innovation in statistical practice.
Assessment methods and assessment criteria (Metody i kryteria oceniania)	Oral exam, active participation in lectures, and at least 85% attendance.