UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Izbrana poglavja iz verjetnosti in statistike
Course title:	Selected topics in probability and statistics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Podatkovne znanosti, magistrski študijski program druge stopnje	-	Prvi	Prvi
The second cycle masters study programme Data Sciences	-	First	First

Vrsta predmeta / Course type	Obvezni / Obligatory
Univerzitetna koda predmeta / University course code:	2-PZ-MAG-IPVS-2024-01-31

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	35	-	-	115	6

Nosilec predmeta / Lecturer:	prof. dr. Matej Makarovič, doc. dr. Nuša Erman

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski, angleški / Slovene, English
	Vaje / Tutorial:	Slovenski, angleški / Slovene, English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Specifičnih pogojev za vključitev v delo ni. Priporočeno je poznavanje osnovnih matematičnih pojmov. Pogoj za pristop k pisnemu izpitu so pravočasno oddane in pozitivno ocenjene obveznosti vaj.	There are no specific requirements for this subject. Knowledge of basic mathematical notions is recommended. Prerequisite for attending the written exam is timely submitted and positively assessed work from tutorial.

Vsebina: **Content (Syllabus outline):**

- Verjetnost: uvod, prostor vzorcev, mere verjetnosti, računanje verjetnosti, pogojna verjetnost, neodvisnost.
- Slučajne spremenljivke:
  - diskretne slučajne spremenljivke: Bernoullijeve slučajne spremenljivke, binomska porazdelitev, geometrična in negativna binomska porazdelitev, hipergeometrijska porazdelitev, Poissonova porazdelitev;
  - zvezne slučajne spremenljivke: eksponentna gostota, Gamma gostota, normalna porazdelitev.
- Večrazsežne porazdelitve za diskretne, zvezne in neodvisne slučajne spremenljivke, pogojne porazdelitve.
- Pričakovane vrednosti: pričakovana vrednost slučajne spremenljivke, varianca in standardni odklon, kovarianca in korelacija.
- Limitni izreki: zakon velikih števil, konvergenca v porazdelitvi in centralni limitni izrek.
- Porazdelitve, izpeljane iz normalne porazdelitve: χ^2, *t* in *F* porazdelitev; vzorčno povprečne in vzorčna varianca.
- Anketno vzorčenje: populacijski parametri, enostavno slučajno vzorčenje, ocenjevanje razmerja, stratificirano slučajno vzorčenje.
- Ocenjevanje parametrov in prileganje verjetnostnih porazdelitev, metoda največjega verjetja.
- Testiranje hipotez in ocenjevanje prileganja: Neyman-Pearsonova paradigma, optimalni testi, dualnost intervalov zaupanja in testov hipotez, verjetnostni grafikoni, testiranje normalne porazdelitve.
- Povzemanje (opisovanje) podatkov: empirična kumulativna porazdelitvena funkcija, diagrami kvantilov, histogrami, krivulje gostot, histogrami s številkami (stem-and-Leaf plots), mere centralne tendence (aritmetična sredina, mediana, modificirana aritmetična sredina), mere variabilnosti, grafikoni kvantilov (boxplots).
- Teorija odločanja in Bayesovo sklepanje: Bayesova plavila in minimaks

- Probability: introduction, sample space, probability measures, computing probabilities, conditional probability, independence.
- Random variables:
  - discrete random variables: Bernoulli random variables, the binomial distribution, the geometric and negative binomial distributions, the hypergeometric distribution, the Poisson distribution;
  - continuous random variables: the exponential density, the Gamma density, the normal distribution.
- Joint distributions for discrete, continuous and independent random variables, conditional distributions.
- Expected values: the expected value of a random variable, variance and standard deviation, covariance and correlation.
- Limit theorems: the law of large numbers, convergence in distribution and central limit theorem.
- Distributions derived from the normal distribution: χ^2, *t* and *F* distributions; the sample mean and the sample variance.
- Survey sampling: population parameters, simple random sampling, estimation of ratio, stratified random sampling.
- Estimation of parameters and fitting the probability distributions, the method of maximum likelihood.
- Testing hypotheses and assessing goodness of fit: Neyman-Pearson paradigm, optimal tests, the duality of confidence intervals and hypothesis tests, probability plots, tests for normality.
- Summarizing data: empirical cumulative distribution function, quantile-quantile plots, histograms, density curves, stem-and-leaf plots, measures of location (the arithmetic mean, the median, the trimmed mean), measures of dispersion, boxplots.
- Decision theory and Bayesian inference: Bayes rules and Minimax rules, posterior analysis, Bayesian inference for the normal distribution, Bayesian analysis for the binomial distribution.

pravila, posteriorna analiza, Bayesovo sklepanje za normalno porazdelitev, Bayesova analiza za binomsko porazdelitev. • Teoretične in konceptualne perspektive kvantitativnega raziskovanja: cilji raziskave, etika v raziskovalnem procesu, razlike v primerjavi s kvalitativnim raziskovanjem. • Osnovni koraki kvantitativnega raziskovanja, veljavnost in zanesljivost merjenja, spremenljivke in merske lestvice. • Metode in tehnike zbiranja ter shranjevanja podatkov: različne oblike anketiranja, avtomatsko zajemanje podatkov.	• Theoretical and conceptual perspective of quantitative research: research goals, ethics in the research process, differences to qualitative research. • Basic steps of quantitative research, validity and reliability of measurement, variables and measuring scales. • Methods and techniques of collecting and storing the data: survey methods, automated data capture. • Selected topics from descriptive statistics: quantiles, central tendency, dispersion, graphical data representation

Temeljni literatura in viri / Readings:

- Rice, J.A. (2013). *Mathematical Statistics and Data Analysis, 3rs Revised Edition*. California: Cengage Learning.
- DeGroot, M.H. in Schervish, M.J. (2018). *Probability and Statistics, 4th Edition*. Edingburgh Gate, Harlow, Essex: Pearson Education Limited.
- Erman, N., Makarovič, M. Prosojnice iz predavanj in gradiva z vaj pri predmetu Izbrana poglavja iz verjetnosti in statistike. FIŠ, Moodle.
- Pustavrh, S., Povh, J., Vidiček, M., Govorčin J. (2011). *Zbirka rešenih nalog iz statistike*. Ljubljana: Založba Vega.
- Foddy, W. (2001). *Constructing Questions for Interviews and Questionnaires. Theory and Practice in Social Research*. Cambridge University Press.

Cilji in kompetence:	**Objectives and competences:**
Učna enota prispeva k razvoju naslednjih splošnih in predmetno specifičnih kompetenc: *Splošne kompetence:* • sposobnost skrbeti za kakovost strokovnega dela skozi avtonomnost, samoiniciativnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje • sposobnost fleksibilne uporabe znanja v praksi • uporaba ustreznih metodoloških pristopov za izvajanje, koordiniranje in organiziranje raziskav *Predmetno-specifične kompetence:* • poznavanje osnovnih metod verjetnosti in njihove uporabe v statistiki	*The instructional unit contributes to the development of the following general and subject-specific competences:* *General competences:* • the ability to manage quality of professional work through autonomy, initiative, as well as (self-)criticism, (self-)reflection and (self-)evaluation • the ability of flexible usage of knowledge in practice • utilization of adequate methodological approaches to conduct, coordination and organisation of research *Subject-specific competences:*

• sposobnost izvedbe kvantitativne raziskave in analize podatkov z uporabo ustreznih statističnih metod in modelov s pomočjo primerne programske opreme • sposobnost logičnega sklepanja, ocenjevanja verjetnosti in tveganja, natančnosti izražanja, pisanja in razmišljanja	• familiarity with the basic methods of probability and their application in statistics • ability to perform quantitative research and data analysis using appropriate statistical methods and models and suitable software • ability to make logical conclusions, to estimate probability and risk, the ability to express oneself, write and think in an accurate manner

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: *Sposobnost študenta/študentke bo:* • poznal in razumel bo temelje kvantitativnega raziskovanja. • razumel verjetnostni račun, verjetnostne porazdelitve in centralni limitni izrek • zavzemal stališče do ključnih etičnih vprašanj v raziskovalnem procesu in kritično vrednotiti konkreten primer • znal izbrati in uporabiti izbrane metode in tehnike kvantitativnega raziskovanja • sposoben uporabe osnovne programske opreme za kvantitativno analizo • sposoben pripraviti in izvesti načrt kvantitativne raziskave: raziskovalno vprašanje, hipoteze, načrt zbiranja in obdelave podatkov, zbiranje in obdelava podatkov, diskusija o rezultatih • sposoben refleksije in kritičnega vrednotenja primernosti določene raziskovalne metode za analizo konkretnega problema	Knowledge and understanding: The ability of the student will be able: • to realize and understand the basics of quantitative research; • understand probability, probability distributions and central limit theorem • to take a position on key ethical issues in the research process and to be critical in evaluating concrete examples; • select and apply methods and techniques of quantitative research; • to use of basic software for quantitative analysis; • to prepare and implement a quantitative research plan: research questions, hypotheses, data collection and processing plan, collection and processing of data, discussion about the results; • reflection and critical evaluation of the appropriateness of certain research methods for the analysis of concrete problems

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov) • *vaje*, kjer študentje na enostavnih primerih ponovijo temeljne koncepte in metode, predstavljene na predavanjih ter se seznanijo s programskimi orodji za zbiranje in analiziranje podatkov	• *lectures* with active students' participation (explanations, discussion, questions, examples, problem solving); • *tutorials* (students will recall, reinforce, and shed light on the concepts and methods taught on lectures and familiarize with the software tools for data collection and analysis).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način: • pisni izpit • redno delo, vezano na vaje	 80 % 20 %	Type: • written exam • regular work, linked to tutorials

Reference nosilca / Lecturer's references:

- ERMAN, Nuša, ROJKO, Katarina, LESJAK, Dušan. Traditional and new ICT spending and its impact on economy. Journal of computer information systems. 2022, vol. 62, iss. 2, str. 384-396
- ROJKO, Katarina, ERMAN, Nuša. The Impact of the Covid-19 Pandemic on Higher Education Students' Perceptions of Educational Applications and Platforms. International Journal of Cognitive Research in Science, Engineering and Education. 2023, vol. 11, no. 2, str. 267-279
- ROJKO, Katarina, LESJAK, Dušan, ERMAN, Nuša. The COVID-19 Pandemic Crisis : impact on ICT spending. Journal of computer information systems. 2022, vol. , iss. , str. 1-16
- ROJKO, Katarina, ERMAN, Nuša, JELOVAC, Dejan. Impacts of the transformation to industry 4.0 in the manufacturing sector : the case of the U.S. Organizacija: revija za management, informatiko in kadre. Noc. 2020, vol. 53, no. 4, str. 287-305
- ERMAN, Nuša, TODOROVSKI, Ljupčo. The effects of measurement error in case of scientific network analysis. Scientometrics, aug. 2015, vol. 104, iss. 2, str. 453-473.
- GOLOB, Tea, MAKAROVIČ, Matej. Student mobility and transnational social ties as factors of reflexivity. Social sciences, ISSN 2076-0760, 2018, vol. 7, no. 3, str. 1-18
- GOLOB, Tea, MAKAROVIČ, Matej, SUKLAN, Jana. National development generates national identities. PloS one, ISSN 1932-6203, 2016, vol. 11, no. 2, str. 0146584-1-0146584-14.
- MAKAROVIČ, Matej, TOMŠIČ, Matevž. Democrats, authoritarians and nostalgics : Slovenian attitudes toward democracy. Innovative issues and approaches in social sciences, ISSN 1855-0541, Sep. 2015, vol. 8, no. 3, str. 8-30.
- MAKAROVIČ, Matej, REK, Mateja. Power and Influence-Based Political Participation in European Democracies. Sociológia, ISSN 0049-1225, 2014, vol. 46, no. 6, str. 686-705.
- MAKAROVIČ, Matej, GOLOB, Tea. Increasing fluidity of identifications in the context of individualisation : identification with the European Union. International social science journal, ISSN 1468-2451, sep.-dec. 2013, vol .64, issue 213-214, str. 291-303.

Opomba: Večina navedenih objav je tematsko socioloških, a vključujejo uporabo statističnih metod in sicer:

- Analiza poti
- Analiza glavnih komponent in hierarhična regresijska analiza
- Faktorska analiza
- Hierarhično razvrščanje v skupine (klaster analiza)
- Hierarhična regresijska analiza.