

**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-2020-06-30

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	40	-	-	110	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:**

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.

**Prerequisites:**

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:  $\chi^2$ ,  $t$  in  $F$  porazdelitev; vzorčno povprečje in vzorčna varianca.
- Anketno vzorčenje: populacijski parametri, enostavno slučajno vzorčenje, ocenjevanje razmerja, stratificirano slučajno vzorčenje.
- Ocenjevanje parametrov in prilaganje verjetnostnih porazdelitev, metoda največjega verjetja.
- Testiranje hipotez in ocenjevanje prilaganja: 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 pravila 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:  $\chi^2$ ,  $t$  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.

<p>pravila, posteriorna analiza, Bayesovo sklepanje za normalno porazdelitev, Bayesova analiza za binomsko porazdelitev.</p> <ul style="list-style-type: none"> <li>• Teoretične in konceptualne perspektive kvantitativnega raziskovanja: cilji raziskave, etika v raziskovalnem procesu, razlike v primerjavi s kvalitativnim raziskovanjem.</li> <li>• Osnovni koraki kvantitativnega raziskovanja, veljavnost in zanesljivost merjenja, spremenljivke in merske lestvice.</li> <li>• Metode in tehnike zbiranja ter shranjevanja podatkov: različne oblike anketiranja, avtomatsko zajemanje podatkov.</li> </ul>	<ul style="list-style-type: none"> <li>• Theoretical and conceptual perspective of quantitative research: research goals, ethics in the research process, differences to qualitative research.</li> <li>• Basic steps of quantitative research, validity and reliability of measurement, variables and measuring scales.</li> <li>• Methods and techniques of collecting and storing the data: survey methods, automated data capture.</li> <li>• Selected topics from descriptive statistics: quantiles, central tendency, dispersion, graphical data representation</li> </ul>
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### Temeljni literatura in viri / Readings:

<ul style="list-style-type: none"> <li>• Rice, J.A. (2013). <i>Mathematical Statistics and Data Analysis, 3rs Revised Edition</i>. California: Cengage Learning.</li> <li>• DeGroot, M.H. in Schervish, M.J. (2018). <i>Probability and Statistics, 4<sup>th</sup> Edition</i>. Edingburgh Gate, Harlow, Essex: Pearson Education Limited.</li> <li>• Erman, N., Makarovič, M. Prosojnice iz predavanj in gradiva z vaj pri predmetu Izbrana poglavja iz verjetnosti in statistike. FIŠ, Moodle.</li> <li>• Pustavrh, S., Povh, J., Vidiček, M., Govorčin J. (2011). <i>Zbirka rešenih nalog iz statistike</i>. Ljubljana: Založba Vega.</li> <li>• Foddy, W. (2001). <i>Constructing Questions for Interviews and Questionnaires. Theory and Practice in Social Research</i>. Cambridge University Press.</li> </ul>
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### Cilji in kompetence:

<p><i>Učna enota prispeva k razvoju naslednjih splošnih in predmetno specifičnih kompetenc:</i></p> <p><i>Splošne kompetence:</i></p> <ul style="list-style-type: none"> <li>• sposobnost skrbeti za kakovost strokovnega dela skozi avtonomnost, samoiniciativnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje</li> <li>• sposobnost fleksibilne uporabe znanja v praksi</li> <li>• uporaba ustreznih metodoloških pristopov za izvajanje, koordiniranje in organiziranje raziskav</li> </ul> <p><i>Predmetno-specifične kompetence:</i></p> <ul style="list-style-type: none"> <li>• poznavanje osnovnih metod verjetnosti in njihove uporabe v statistiki</li> </ul>
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### Objectives and competences:

<p><i>The instructional unit contributes to the development of the following general and subject-specific competences:</i></p> <p><i>General competences:</i></p> <ul style="list-style-type: none"> <li>• the ability to manage quality of professional work through autonomy, initiative, as well as (self-)criticism, (self-)reflection and (self-)evaluation</li> <li>• the ability of flexible usage of knowledge in practice</li> <li>• utilization of adequate methodological approaches to conduct, coordination and organisation of research</li> </ul> <p><i>Subject-specific competences:</i></p>
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- 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:**

Znanje in razumevanje:

*Sposobnost študenta/šudentke 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

### **Intended learning outcomes:**

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:**

- *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

### **Learning and teaching methods:**

- *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:	Delež (v %) / Weight (in %)	Type:
<ul style="list-style-type: none"> <li>• pisni izpit</li> <li>• redno delo, vezano na vaje</li> </ul>	<p>80 %</p> <p>20 %</p>	<ul style="list-style-type: none"> <li>• written exam</li> <li>• regular work, linked to tutorials</li> </ul>

**Reference nosilca / Lecturer's references:**

- ERMAN, Nuša, GOLOB, Tea, JELOVAC, Dejan, RAKOVEC, Primož. The impact of internal dialogue on aggressive driving. *The social sciences*, ISSN 1993-6125. [Online ed.], 2020, vol. 15, iss. 3, str. 119-127.
- 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, MAKAROVIC, 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, MAKAROVIC, Matej, SUKLAN, Jana. National development generates national identities. *PloS one*, ISSN 1932-6203, 2016, vol. 11, no. 2, str. 0146584-1-0146584-14.
- MAKAROVIC, 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.
- MAKAROVIC, Matej, REK, Mateja. Power and Influence-Based Political Participation in European Democracies. *Sociológia*, ISSN 0049-1225, 2014, vol. 46, no. 6, str. 686-705.
- MAKAROVIC, 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.