| UČNI NAČRT PREDMETA / COURSE SYLLABUS | |
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| **Predmet:** | Analiza časovnih vrst |
| **Course title:** | Time series analysis |

| **Študijski program in stopnja**<br>**Study programme and level** | **Študijska smer**<br>**Study field** | **Letnik**<br>**Academic year** | **Semester**<br>**Semester** |
|---|---|---|---|
| Informacijske znanosti, doktorski študijski program tretje stopnje | Matematika kompleksnih omrežij | Drugi | Tretji ali četrti |
| Information Sciences, third cycle Doctoral Study Programme | Mathematics of complex networks | Second | Third or fourth |

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| **Vrsta predmeta / Course type** | Izbirni/Elective |
| **Univerzitetna koda predmeta / University course code:** | 1-IZ-DR-MKO-IP-AČV-2024-04-24 |

| **Predavanja**<br>**Lectures** | **Seminar**<br>**Seminar** | **Vaje**<br>**Tutorial** | **Klinične vaje**<br>**work** | **Druge oblike študija** | **Samost. delo**<br>**Individ. work** | **ECTS** |
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| 20 | 10 | / | / | / | 270 | 10 |

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| **Nosilec predmeta / Lecturer:** | doc. dr. Bernard Ženko |

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| **Jeziki / Languages:** | **Predavanja / Lectures:** | Slovenski / Slovenian, Angleški / English |
| | **Vaje / Tutorial:** | |

| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | **Prerequisites:** |
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| / | / |

| **Vsebina:** | **Content (Syllabus outline):** |
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| - Koncept časovnih vrst in njihova analiza. Relevantnost za kompleksna omrežja, podatkovne znanosti in računalništvo.<br>- Vizualizacija časovnih vrst, razsevni diagrami. Vzorci v časovnih vrstah.<br>- Časovne skale in sezonska odvisnost v podatkih.<br>- Korelacije in avtokorelacije.<br>- Regresijski modeli časovnih vrst. Metoda najmanjših kvadratov.<br>- ARIMA modeli. Stacionarnost in nestacionarnost.<br>- Avtoregresijski modeli. Modeli drsečega povprečja.<br>- Napovedovanje časovnih vrst. | - Concept of time series and their analysis. Relevance to complex networks, data science and computer sciences.<br>- Time series vizualisation, scatter-plots. Patterns in time series.<br>- Time scales and seasonality in data.<br>- Correlations and auto-correlations.<br>- Time series regression models. Least squares method.<br>- ARIMA models. Stationarity and non-stationarity.<br>- Autoregressive models. Moving average models.<br>- Forecasting time series. |

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| - Dinamični regresijski modeli. Stohastični in deterministični trendi.<br>- Napovedovanje časovnih vrst z metodami strojnega učenja, nevronskimi mrežami.<br>- Nekaj praktičnih izzivov pri napovedovanju časovnih vrst. | - Dynamic regression models. Stochastic and deterministic trends.<br>- Predicting time series with machine learning methods, neural networks.<br>- Some practical issues in time series forecasting . |

**Temeljni literatura in viri / Readings:**

- Hyndman, R. J., & Athanasopoulos, G. (2021). *Forecasting: principles and practice*, 3rd edition, OTexts: Melbourne, Australia. https://otexts.com/fpp3/
- Nielsen A. (2019). *Practical Time Series Analysis: Prediction with Statistics and Machine Learning.* O'Reilly.

| **Cilji in kompetence:** | **Objectives and competences:** |
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| *Učna enota prispeva k razvoju naslednjih splošnih kompetenc:*<br><br>● Sposobnost identificiranja danega raziskovalnega problema, njegove analize, ovrednotenja ter oblikovanja možnih rešitev. Ustvarjanje novega znanja, ki pomeni relevanten prispevek k razvoju znanosti.<br>● Sposobnost obvladanja standardnih metod, postopkov in procesov raziskovalnega dela na znanstvenem področju študija.<br>● Razvoj veščin in spretnosti v uporabi znanja na raziskovalnem področju doktorske disertacije.<br><br>*predmetno-specifičnih kompetenc:*<br><br>● Sposobnost oblikovanja in implementacije izvirnih rešitev danih znanstvenih problemov.<br>● Sposobnost formuliranja ustreznih raziskovalnih vprašanj povezanih s časovnimi vrstami, pridobljenimi iz realnega sistema.<br>● Spretnost v preučevanju časovnih vrst z različnimi računskimi metodami. | *Learning unit contributes to development of the following general competencies:*<br><br>● Ability to identify a given research problem, analyse it, evaluate it and formulate possible solutions.Ability to create new knowledge, which represents a contribution to science.<br>● Ability to master standard methods, procedures and processes of research work in the scientific field of study.<br>● Development of skills and abilities in usage of knowledge in the scientific field of doctoral dissertation.<br><br>and subject-specific competencies:<br><br>● Ability to design and implement original solutions of given scientific problems<br>● Ability to formulate appropriate research questions when faced with time series obtained from a real system<br>● Skills in examining time-series data via a diverse range of computational methods. |

| **Predvideni študijski rezultati:** | **Intended learning outcomes:** |
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| Znanje in razumevanje:<br><br>*Študent/študentka:* | Knowledge and understanding:<br><br>*The student:* |

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| ● analizira delovanje metod in algoritmov za napovedovanje časovnih vrst na realnih primerih,<br>● je sposoben samostojno uporabiti tehnike za napovedovanje časovnih vrst na problemih v znanosti in tehnologiji,<br>● je sposoben kritično ovrednotiti konkretne rezulate pridobljene z analizo časovnih vrst. | ● analyses the methods and algorithms for predicting real-world time series examples,<br>● is able to use time series forecasting techniques on problems in science and technology,<br>● is able to critically evaluate specific results of time series analysis. |

| **Metode poučevanja in učenja:** | **Learning and teaching methods:** |
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| ● *Predavanja* z aktivno udeležbo študentov (razlaga, diskusija).<br>● *Seminarji in projekti,* kjer študenti ponovijo in preizkusijo svoje razumevanje skozi reševanje specifičnih problemov. | ● *Lectures* with active participation of students (explanations, discussions).<br>● *Seminars and projects* where students test the acquired knowledge and skills by solving specific problems. |

| **Načini ocenjevanja:** | Delež (v %) / Weight (in %) | **Assessment:** |
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| Način (pisni izpit, ustno izpraševanje, naloge, projekt):<br><br>● Projektna raziskovalna naloga specifično dodeljena vsakemu študentu | 100 | Type (examination, oral, coursework, project):<br><br>● Project research assignment customized for each student |

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


- Žnidaršič, M., Osojnik, A., Rupnik, P., & Ženko, B. (2021). Improving effectiveness of a coaching system through preference learning. *The 14th ACM International Conference on PErvasive Technologies related to Assistive Environments 2021*. New York: ACM.
- Kunić, Z., Ženko, B., & Mileva Boshkoska, B. (2021). FOCUSED-short-term wind speed forecast correction algorithm based on successive nwp forecasts for use in traffic control decision support systems. *Sensors, 21*(10).
- Grau Leguia, M., Levnajević, Z., Todorovski, L., & Ženko, B. (2019). Reconstructing dynamical networks via feature ranking. *Chaos, 1(29*).
- Simidjievski, N., Tanevski, J., Ženko, B., Levnajić, Z., Todorovski, L., & Džeroski, S. (2018). Decoupling approximation robustly reconstructs directed dynamical networks. *New journal of physics, 1*(20).
- Tušar, T., Gantar, K., Koblar, V., Ženko, B., & Filipič, B. (2017). A study of overfitting in optimization of a manufacturing quality control procedure. *Applied soft computing, 1*(59).