

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Izbrana poglavja visoko zmogljivega računalništva
Course title: Selected topics in High Performance Computing

| Študijski program in stopnja Study programme and level | Študijska smer Study field | Letnik Academic year | Semester Semester |
|--|-------------------------------|-------------------------|----------------------|
| Informacijske znanosti, doktorski študijski program tretje stopnje | Računalniške znanosti | Drugi | Tretji ali četrti |
| Information Sciences, third cycle Doctoral Study Programme | Computer Sciences | Second | Third or fourth |

Vrsta predmeta / Course type

Izbirni / Elective

**Univerzitetna koda predmeta /
University course code:**

1-IZ-DR-RZ-IP-IPVZR-2024-04-24

| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | Klinične vaje work | Druge oblike študija | Samost. delo Individ. work | ECTS |
|------------------------|--------------------|------------------|--------------------------|----------------------------|-------------------------------------|------|
| 30 | - | - | - | - | 270 | 10 |

Nosilec predmeta / Lecturer: izr. prof. dr. Pavle Boškosi**Jeziki /****Languages:****Predavanja /****Lectures:****Vaje / Tutorial:**

Slovenski / Slovenian, Angleški / English

**Pogoji za vključitev v delo oz. za
opravljanje študijskih obveznosti:**Pogoj za vključitev v delo je vpis v 1. ali 2.
letnik študijskega programa.**Prerequisites:**The precondition for this course is enrolment
in the first or second year of the study
programme.**Vsebina:**Pri predmetu bodo predstavljena in
obdelana izbrana poglavja z naslednjih
področij:

- SLURM (Simple Linux Utility for Resource Management): arhitektura, konfiguracija, ukazi;
- Vsebnik (ang. docker) in kontejnerji: namestitve in uporaba;
- Programiranje večprocesorskih sistemov (OpenMP);
- Programiranje grafičnih procesnih enot (OpenCL / Cuda);

Content (Syllabus outline):At the course selected chapters from the
following areas will be presented and
analysed:

- SLURM (Simple Linux Utility for Resource Management): architecture, configuration, commands;
- Docker and containers: setup and usage;
- Multiprocessor programming (OpenMP);
- Programming of graphic processing units (OpenCL / Cuda);

- Visoko zmogljivo paralelno procesiranje na gručah, omrežjih in v oblakih;
- Hadoop (MapReduce, Spark, distribuirani datotečni sistem Hadoop, razvijanje hadoop aplikacije za analizo vele podatkov);
- Primeri uporabe HPC/paralelnega računalništva v znanosti in tehnologij.

- High-performance parallel computing with clusters and cloud networks;
- Hadoop (MapReduce, The Hadoop distributed file system, developing a Hadoop application for analyzing massive data);
- Some examples of usage of HPC/parallel computing in science and technology.

Temeljni literatura in viri / Readings:

- Deakin, T., & Mattson, G. (2023). *Programming Your GPU with OpenMP: Performance Portability for GPUs*. MIT Press.
- NVIDIA (2022). *CUDA C++ Programming Guide*. Design Guide. https://docs.nvidia.com/cuda/pdf/CUDA_C_Programming_Guide.pdf
- Slurm (2021). *Slurm tutorials*. <https://slurm.schedmd.com/tutorials.html>
- Wilt, N. (2018). *The CUDA Handbook: A Comprehensive Guide to GPU Programming*. Addison-Wesley.
- White, T. (2015). *Hadoop: The Definitive Guide*, Fourth Edition, O'Reilly Media, Inc.

Cilji in kompetence:

Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:

Splošne kompetence:

- Sposobnost identificiranja danega raziskovalnega problema, njegove analize, ovrednotenja ter oblikovanja možnih rešitev.
- Ustvarjanje novega znanja, ki pomeni relevanten prispevek k razvoju znanosti.
- Sposobnost obvladanja standardnih metod, postopkov in procesov raziskovalnega dela na znanstvenem področju študija.
- Prizadevanje za kakovost znanstveno-raziskovalnega dela skozi avtonomnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje.

Predmetno-specifične kompetence:

- Sposobnost za načrtovanje in konstruiranje rešitve konkretnih raziskovalnih problemov povezanih s področjem visoko zmogljivih računalnikov, paralelnega procesiranja, HADOOP, SLURM, Docker in kontejnerje, OpenMP, OpenCL-Cuda.

Objectives and competences:

The instructional unit contributes to the development of the following general and subject-specific competencies:

General competences:

- 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.
- Ability to master standard methods, procedures and processes of research work in the scientific field of study.
- Striving for quality in scientific research through autonomy, (self-)criticism, (self)reflexivity and (self-)evaluation.

Subject-specific competences:

- Ability to design and construct solutions for specific research problems and questions related to the fields of high-performance computing, parallel processing, and HADOOP, SLURM, Docker and containers, OpenMP, OpenCL/Cuda.

- Sposobnost uporabiti predmetna teoretična znanja v praksi ter z ustreznimi metodološkimi pristopi reševati probleme na predlaganih področjih.

- Ability to apply subject-specific theoretical knowledge in practice and use appropriate methodological approaches to solve problems in the proposed areas.

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent

- Osvoji napredna znanja s področij visoko zmogljivega računalništva, paralelnega procesiranja ter HADOOP.
- Zna konfigurirati SLURM, izrabiti paralelne sisteme.
- Zna konfigurirati kontejnerje in jih zagnati na HPC.
- Oceni primernosti teoretičnih metod za reševanje praktičnih problemov s področja visoko zmogljivega računalništva ter njihovih omejitev.
- Je sposoben analitičnega razmišljanja in analize ter reševanja kompleksnih praktičnih problemov na področju visoko zmogljivega računalništva.

Intended learning outcomes:

Knowledge and understanding:

Student

- gains advanced knowledge from the fields of high-performance computing, parallel processing, and HADOOP.
- Can configure SLURM, and optimally exploit parallel systems.
- Can prepare containers and deploy them on HPC.
- Evaluates the appropriateness of theoretical methods to solve practical problems in the field of high-performance computing and their limits.
- Is able of analytical thinking, and to analyse and solve complex practical problems in the field of high-performance computing.

Metode poučevanja in učenja:

- predavanja z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov);

Learning and teaching methods:

- lectures with active students participation (explanations, discussion, questions, examples, problem solving);

Načini ocenjevanja:

| | Delež (v %) / Weight (in %) |
|---|--------------------------------|
| <ul style="list-style-type: none"> • projektna raziskovalna naloga | 100 % |

Assessment:

- project research work

Reference nosilca / Lecturer's references:

- Boškosi, P., Perne, M., Rameša, M., & Mileva Boshkoska, B. (2021). Variational Bayes survival analysis for unemployment modelling. *Knowledge-based systems*, 229, 107335.
- Andonovikj, V., Boškosi, P., Džeroski, S., & Mileva Boshkoska, B. (2023). Survival analysis as semi-supervised multi-target regression for time-to-employment prediction using oblique predictive clustering trees. *Expert Systems With Applications*, 235, 121246.
- Boškosi, P., Perne, M., Redek, T., & Mileva Boshkoska, B. (2022). *Occupation similarity through bipartite graphs*. arXiv, Cornell University. <https://arxiv.org/abs/2202.11064>
- Brešar, M., & Boškosi, P. (2023). Directional coupling detection through cross-distance vectors. *Physical Review E*, 107, 4.