COURSE DESCRIPTION CARD - SYLLABUS

Course name
Artificial Intelligence in Bioinformatics [S2Bioinf2>SIB]

Course

Field of study
Bioinformatics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Maciej Piernik
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Lecturers

Prerequisites

Students enrolling in the course should have basic knowledge and skills in programming and bioinformatics data processing. They should also be aware of the need to continuously expand their competencies and be ready to collaborate with other team members, in particular people from other fields.

Course objective

1. Gaining knowledge about the applications of artificial intelligence in bioinformatics. 2. Deepening knowledge and skills in programming and bioinformatics data processing. 3. Acquiring knowledge and skills in designing, training, evaluating, implementing, using, and explaining machine learning models in bioinformatics for problems such as drug response prediction, diagnostics, gene expression prediction, gene perturbation effects prediction, and protein structure prediction. 4. Developing social competencies related to teamwork, including team work organization, particularly leadership and communication in group problem-solving processes.

Course-related learning outcomes

Knowledge:
Students know and understand:

- Advanced concepts from selected sciences useful for modeling biological processes
- Methods, techniques, and tools used in solving complex bioinformatics tasks, mainly of engineering nature

Skills:
Students can:
- Apply advanced computer science techniques and tools to solve biological problems and evaluate their usefulness
- Apply mathematical (including statistical) methods and specialized computer science techniques and tools to describe processes and analyze biological data

Social competences:
Students are ready to:
- Engage in lifelong learning, inspire and organize the learning process of others, including seeking expert opinions while critically evaluating collected content.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Continuous assessment:
a) lectures - based on questions asked during lectures
b) laboratory - based on monitoring progress of assigned tasks
Final assessment:
- Skills assessment based on tasks and projects completed during the semester
- Knowledge assessment based on test; at least 50% score required to pass

Programme content

Selected elements of deep learning:
- Autoencoders
- Convolutional neural networks
- Architectures dedicated to sequential data, e.g., RNN, transformer
Practical aspects of machine learning in bioinformatics:
- Large p, small n problem
- Model quality assessment
- Model explainability
Solving selected biological problems using artificial intelligence:
- Drug response prediction using patient data
- Patient diagnostics based on various data types
- Predicting gene expression and discovering relationships between genes based on different expression data (e.g., microarrays and scRNAseq)
- Protein structure prediction
Some topics are intended for students' independent work.

Course topics

- Data analysis and machine learning in diagnostics
- Introduction to deep learning
- Drug response prediction
- Artificial intelligence in genomics
- Discovering relationships between genes using expression data
- Explainability of bioinformatics artificial intelligence models

Teaching methods

Lecture: presentation, discussing examples on the board, live demonstrations, live exercises
Laboratory: completing assignments and tutorials, group work, live demonstrations

Bibliography

Basic:

- https://work.caltech.edu/telecourse
- Deep Learning with Python, F Chollet
- Python Machine Learning, 3rd Edition S Raschka, V Mirjalili Packt Publishing Ltd.

Additional:
- Deep Learning, Goodfellow, Ian, et al. MIT Press, 2016.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00