COURSE DESCRIPTION CARD - SYLLABUS

Course name

Artificial Intelligence in Biomedical Informatics

Course

Field of study	Year/Semester
Artificial intelligence	2/3
Area of study (specialization)	Profile of study
	general academic
Level of study	Course offered in
Second-cycle studies	English
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	15	0
Tutorials	Projects/seminars	
0	0	

Number of credit points

2

Lecturers

Responsible for the course/lecturer:

Szymon Wilk, D.Sc., Ph.D.

email: szymon.wilk@put.poznan.pl

tel. +48 61 665 2930

Wydział Informatyki i Telekomunikacji

ul. Piotrowo 2, 60-965 Poznań

Responsible for the course/lecturer:

Maciej Antczak, D.Sc., Ph.D.

email: maciej.antczak@put.poznan.pl

tel. +48 61 665 3056

Wydział Informatyki i Telekomunikacji

ul. Piotrowo 2, 60-965 Poznań

Prerequisites

The student starting this module should have basic knowledge and skills in statistics, data science, and artificial intelligence (AI) with particular emphasis on machine learning, deep learning, and artificial neural networks. Basic knowledge of bioinformatics or biology is welcome although not required.

The student should be able to develop (using existing libraries and environments, mainly in Python) simple modules that allow for performing computational and simulation experiments.

Moreover, the student should demonstrate attitudes such as honesty, perseverance, creativity, and respect for other people. Finally, they should have the ability to obtain information from the indicated sources, often in English.

Course objective

1. Acquainting the students with the methods of AI, which are used in solving a number of problems originating from the field of biomedical informatics, requiring specialized analysis of biological and medical data, representation of the discovered knowledge in the form of complex models, and explanation of the operation of these models.

2. Acquainting the students with exemplary systems and programming tools implementing selected AI techniques usedin biomedical informatics.

3. Developing the students' ability to design and conduct computational and simulation experiments for problems in the field of biomedical informatics.

4. Developing the students' ability to independently search and retrieve information related to the application of AI techniques in biomedical informatics.

Course-related learning outcomes

Knowledge

As a result of the conducted course, the student:

1. Has advanced and in-depth knowledge of intelligent information systems applied in biomedical informatics, theoretical foundations of their construction and methods, tools and programming environments used to implement them.

2. Has knowledge about development trends and the most important cutting edge achievements in biomedical informatics and AI

3. Knows advanced methods, techniques and tools applied to solve complex engineering tasks and conduct research in the field of biomedical informatics and AI.

Skills

As a result of the conducted course, the student:

1. Is able to plan and carry out computational and simulation experiments, interpret the obtained results and draw conclusions and formulate and verify hypotheses related to engineering and research problems in the field of biomedical informatics and AI.

2. Can - when formulating and solving engineering tasks - integrate knowledge from different areas of computer science and AI (and if necessary also knowledge from other scientific disciplines, e.g., medicine or biology).

3. Is able - using among others conceptually new methods - to solve complex IT tasks in the field of biomedical informatics and AI, including untypical tasks and tasks containing a research component.

Social competences

As a result of the conducted course, the student:

1. Understands that in the field of biomedical informatics and AI the knowledge and skills quickly become obsolete.

2. Understands the importance of using the latest knowledge in the field of biomedical informatics in solving research and practical problems.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
The knowledge and skills acquired during the course (considering both the lecture and the laboratories) are verified by means of a 45-minute test, carried out during the last lecture, which students solve it on their own. The test includes approximately 10 questions (open and closed, differently marked). Passing threshold: 50% of points.

The skills acquired during the laboratories are verified based on partial grades obtained from the mini-projects carried out during the class. In order to pass the laboratories, it is necessary to complete each of the mini-projects, and the final grade is the average of the attained grades.

Programme content

The lecture program covers the following topics

1. In the field of bioinformatics:

- application of machine learning techniques (selected classical methods and approaches using deep learning) for integration and comprehensive analysis of diverse biological data,

- review and analysis of artificial intelligence techniques for solving selected problems in the field of structural bioinformatics with particular emphasis on modeling and quality assessment of spatial structures of biological molecules, discovery and classification of molecular interactions crucial for the design of new generation drugs.

2. In the field of medical informatics

- The application of machine learning techniques that allow the analysis of multimodal data (images, texts, time series), including approaches using different variants of data fusion,

- application of distributed machine learning techniques (including federated learning) ensuring confidentiality at the level of data and the obtained decision models,

- the use of techniques to clarify the structure of the extracted models and justify suggestions for particular decision-making problems,

- application of domain knowledge in symbolic form (e.g., ontologies, graphs) and related inference methods, and integration of techniques using expert knowledge and knowledge discovered from data.

Laboratory exercises are conducted in the form of two-hour classes held in a computer laboratory. During the laboratory classes, students complete individually or in groups of two, four mini-projects related to biomedical informatics. The projects are practical in nature and involve the implementation of computational modules for solving the indicated problems and conducting the necessary experiments (e.g., training decision-making models, verifying their operation). Students have one to two weeks to complete each project, depending on its complexity. Progress is checked on an ongoing basis during class, and the completion of each project ends with the preparation of a short report and its presentation to the group. The list of proposed projects is updated before the beginning of the semester according to the current state of biomedical informatics development.

Teaching methods

1. Lecture: slide show presentation illustrated with additional examples presented on the board if needed.

2. Laboratory classes: practical exercises at the computer carried out according to a specific scenario, implementation of relatively simple programs and performing computational experiments, discussion of applied solutions, and case studies.

Bibliography

Basic

1. S. Mitra, S. Datta, T. Perkins, G. Michailidis, "Introduction to Machine Learning and Bioinformatics".

2. P. Baldi, S. Brunak, "Bioinformatics: The Machine Learning Approach".

3. V. Buffalo,"Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools".

4. E.H. Shortliffe, J.J. Cimino, M.F. Chiang (red.): Biomedical Informatics: Computer applications in Health Care and Biomedicine. Springer, 2021.

Additional

1. A. D. Baxevanis, G. D. Bader, D. S. Wishart, "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins".

2. P. Compeau, P. Pevzner, "Bioinformatics Algorithms".

3. A. Hozlinger (red.): Machine Learning for Health Informatics. State-of-the-Art. and Future Challenges, Springer, 2016.

4. B. Nordlinger, C. Villani, D. Rus: Healthcare and Artificial Intelligence. Springer, 2020.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	20	1,0

[1] delete or add other activities as appropriate