

Course description

Informing students on course requirements

Program: PhD full-time training, elective course
Course: Modern Information Technology in Medicine
Course code: EODI-LIFEP-01
Academic year/Semester: 2025/26 2nd semester
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Type of course: lecture/ <u>seminar/practice</u> /laboratory
Weekly hours of the course: 2
Credit value of the course: 6
Type of examination: <u>final exam at the end of semester</u> , practice exam, other:.....
Preliminary requirements (preliminary academic performance or completed course required to fulfill the purposes and requirements of the course): none
Purpose of course: The primary aim of this course is to familiarize PhD students with the latest tools and applications of information technology in medicine. The course prepares students for the increasing demand for artificial intelligence (AI) in the health sciences. Through lectures and computer-based practical demonstrations, participants gain insight into the fundamental concepts of AI, its applications in life sciences, and its social and ethical implications. The course also aims to provide students in the life sciences with a broad foundation in medical image processing. In this context, it addresses 3D design, modeling, and printing in medical applications, utilizing the 3D printers available at the institute. During seminars, students are further introduced to cutting-edge information technology solutions, such as the medical use of virtual and augmented reality, and the applications of eHealth, mHealth, and telemedicine.
Outcome requirements of the course (specific academic results to be established by the course): Knowledge:

- The student has comprehensive knowledge of the applications of modern information technology in medicine and the life sciences;
- understands the basic principles, operational mechanisms, and typical applications of artificial intelligence, machine learning, and deep learning in medicine;
- knows the fundamentals of how large language models (LLMs) operate and their potential in supporting research processes and education;
- is aware of the ethical, social, and data security aspects of using artificial intelligence in healthcare;
- understands the theoretical foundations of medical image processing, including segmentation, registration, and methods for volume and distance measurement;
- knows the medical applications and technological limitations of 3D design, modeling, and printing;
- is familiar with the main components and use cases of virtual and augmented reality (VR/AR), as well as eHealth, mHealth, and telemedicine systems.

Competences:

- The student is able to interpret and apply simple machine learning models to process research data;
- use statistical tools and algorithms commonly applied in AI methodologies (e.g., regression, clustering, classification) in practice;
- independently use large language models (e.g., ChatGPT, Gemini, Copilot) to prepare research texts, support data analysis, or conduct literature reviews;
- perform basic measurements, segmentations, and modeling tasks using medical image processing software (e.g., 3D Slicer);
- create, edit, and export 3D models for medical applications and prepare them for 3D printing;
- interpret and critically analyze scientific publications related to AI applications in medicine;
- present and visualize the medical and research utility of information technology tools through presentations, posters, or digital demonstrations.

Attitudes:

- The student is open to the responsible and ethical use of new digital and AI-based technologies;
- strives to respect data security, patient rights, and scientific integrity when applying IT solutions;
- values the critical, evidence-based evaluation of technological innovations;
- demonstrates a collaborative attitude in multidisciplinary research teams (informatics, medicine, engineering).

Autonomy and responsibility:

- The student can independently select and apply IT and AI tools most suitable for their research goals;
- uses data processing, image analysis, and modeling software responsibly, taking ethical and data protection regulations into account;
- can independently plan and implement the methodological integration of AI, image processing, VR/AR, or 3D printing in their own research area;
- is capable of demonstrating, teaching, or adapting IT solutions for other researchers, clinicians, or students;
- independently evaluates the scientific and societal impact of technological tools in medicine.

Topics:

1. Supporting life science education through artificial intelligence (Prof. Ferenc Bari)
2. The potential of artificial intelligence in life sciences: social and ethical implications (Prof. Ferenc Peták)
3. Artificial intelligence, machine learning, and deep learning, basic concepts and simple demonstration examples in Excel (Dr. József Tolnai)
4. Using large language models to solve machine learning problems, practical demonstrations in Colab and TensorFlow (Dr. Gergely Fodor)
5. Overview and application of statistical tools used in AI methodologies (Dr. Ferenc Rárosi, Mónika Szűcs)
6. Applications of machine learning methods in drug development, from small molecules to proteins (Dr. Árpád Márki, Dr. Tamás Tarjányi)
7. Practical use of other AI tools supporting research, SCITE, Writefull, Research Rabbit, etc. (Dr. József Tolnai, Dr. Gergely Fodor)
8. Applications of artificial intelligence in medical image processing (Dr. Attila Nagy)
9. Introduction to 3D Slicer, learning basic functions, segmentation, and registration with examples; measuring volumes, distances, and angles; anatomical modeling (Dr. Attila Nagy)
10. Medical applications of 3D design and printing, practical demonstration (Dr. Gergely Fodor)
11. Applications of virtual and augmented reality in medicine (Dr. Gergely Fodor)
12. Introduction to eHealth, mHealth, and telemedicine, practical demonstrations (Dr. József Tolnai)
13. Consultation and evaluation session

Supporting methods to achieve learning outcomes:

Lectures and Practical Demonstrations

- The lectures aim to provide the theoretical background for the fundamental concepts of medical information technology, artificial intelligence, image processing, and 3D technologies.
- During interactive demonstrations, students become familiar with the operation of software tools (e.g., TensorFlow, Google Colab, 3D Slicer, Fusion 360, ChatGPT, ResearchRabbit).
- Theoretical knowledge is always linked to concrete medical or life sciences examples.
- Students practice the steps of AI modeling, image processing, segmentation, 3D design, and 3D printing using real research data.

Case Studies and Problem Solving

- Analysis of real or simulated medical research problems (e.g., image processing errors, AI bias, data privacy dilemmas, validation of diagnostic models).
- Group discussions and preparation of solution proposals with a multidisciplinary perspective.
- Students reflect on AI applications not only from a technological perspective but also from ethical and scientific viewpoints.

Independent Research and Literature Review

- Students independently search for and analyze the latest scientific publications on AI, VR, 3D printing, and telemedicine (e.g., Scopus, PubMed, Scite).

- Results of the literature review are presented in brief oral or written reports.
- The instructor provides reflective feedback on the quality of sources and the scientific reasoning.

Use of Digital Learning Environment

- Document sharing, collaborative editing, and assignment submission via Coospace and Office 365 platforms.
- eduID-based access to international research databases.
- Controlled and reflective use of online tools (AI chatbots, ChatGPT, ResearchRabbit, etc.).

Evaluation of the acquisition of expected learning outcomes:

Requirements:

Course requirements during the semester

- Active participation in lectures and seminars.
- Independent completion and timely submission of written assignments and the final written examination paper during the semester.

Examination requirements:

Assessment and grading

The performance during the semester is evaluated on a five-point scale (1–5) based on in-class activity, interim assignments, and the final submitted tasks.

- Maximum score achievable in the final examination: 100 points

Attendance and active participation in seminars are rewarded with additional bonus points.

Grades of the course are determined as follows:

- 0 - 49 points: Failed (1)
- 50 - 62 points: Passed (2)
- 63 - 73 points: Satisfactory (3)
- 74 - 84 points: Good (4)
- 85 - 100 points: Excellent (5)

Mandatory reading list:

- Comprehensive and up-to-date literature covering the entire scope of the course is not available.
- The specialized books relevant to individual subtopics generally exceed the depth required for this course, and their availability may vary over time.

Recommended reading list:

- Instructor-prepared teaching materials distributed during classes
- Instructor-developed e-learning materials