AJAJAJ or AI? Artificial Intelligence in cardiovascular medicine

1. IMPRINT

Academic Year	2025/2026
Department	Faculty of Medicine
Field of study	Medicine
Main scientific discipline	Medical sciences
Study Profile	General academic
Level of studies	Uniform MSc
Form of studies	Full time studies
Type of module / course	Non-compulsory (optional)
Form of verification of learning outcomes	Completion
Educational Unit / Educational Units	Department of Medical Informatics and Telemedicine 00-581 Warsaw, 14/16 Litewska St., room 317, III floor phone (+48) 22 116 92 44, (+48) 22 116 92 43 http://zimit.wum.edu.pl/ e-mail: zimt@wum.edu.pl
Head of Educational Unit / Heads of Educational Units	**Dr hab. n. med. Andrzej Cacko**
Course coordinator	**Lek. Jakub Rokicki** e-mail: jakub.rokicki@wum.edu.pl
Person responsible for syllabus	**Lek. Jakub Rokicki** e-mail: jakub.rokicki@wum.edu.pl
Teachers	**Lek. Jakub Rokicki** e-mail: jakub.rokicki@wum.edu.pl

2. BASIC INFORMATION

Year and semester of studies	III-V year, summer and winter semester	**Number of ECTS credits**	2.00

FORMS OF CLASSES	**Number of hours**	**ECTS credits calculation**
Contacting hours with academic teacher		
Lecture (L)		
Seminar (S)	30 (e-learning)	1.20
Classes (C)		
e-learning (e-L)		
Practical classes (PC)		
Work placement (WP)		
Unassisted student's work		
Preparation for classes and completions	20	0.80

3. COURSE OBJECTIVES

O1	Build a foundational understanding of AI concepts and methods
O2	Apply and critically evaluate AI in cardiovascular contexts
O3	Integrate ethical, clinical, and translational perspectives on AI

4. STANDARDS OF LEARNING – DETAILED DESCRIPTION OF EFFECTS OF LEARNING

Code and number of the effect of learning in accordance with standards of learning	**Effects in the field of:** *(in accordance with appendix to the Regulation of Minister of Science and Higher education from 26th of July 2019)*
Knowledge – Graduate* knows and understands:	
B.W26.	basic information about technology and biostatistical methods used in medicine, including medical databases, spreadsheets and basics of computer graphics;
B.W27	basic statistical analysis methods used in experimental and clinical research
B.W28	applications of the contemporary telemedicine as a tool supporting a medical doctor's work

B.W29.	rules and methods of conducting scientific research, observational and experimental, as well as in vitro studies leading to development of Medicine
Skills– Graduate* is able to:	
B.U10.	Using databases, including web-based, and search for information needed with use of available tools

** In appendix to the Regulation of Minister of Science and Higher education from 26th of July 2019 „graduate", not student is mentioned.*

5. ADDITIONAL EFFECTS OF LEARNING *(non-compulsory)*

Number of effect of learning	Effects in the fields of:
Knowledge – Graduate knows and understands:	
K1	the fundamental concepts of artificial intelligence, machine learning, and deep learning, including their relevance to cardiovascular medicine
K2	the main applications of AI in cardiology (imaging, ECG analysis, wearables, heart failure management) and their clinical potential
K3	the limitations, risks, and ethical issues of implementing AI in healthcare, such as bias, explainability, and patient safety.
Skills– Graduate is able to:	
S1	search, interpret, and synthesize information from medical databases and scientific literature to assess AI innovations in cardiology
S2	critically evaluate AI-based prediction models and research studies using methodological frameworks (e.g., PROBAST, TRIPOD)
S3	propose practical ways of integrating AI solutions into clinical workflows while considering real-world constraints
Social Competencies – Graduate is ready for:	
SC1	adopting a reflective and responsible approach to using AI in medicine, prioritizing patient welfare and trust.
SC2	collaborating with interdisciplinary teams (clinicians, data scientists, engineers) to implement AI-driven solutions in cardiology.
SC3	engaging in continuous learning to keep pace with emerging AI technologies and their evolving role in medical practice.

6. CLASSES

Form of class	Class contents	Effects of Learning
Seminar	**Introduction to AI, ML, and DL: What Every Doctor Needs to Know** Demystifying the terminology: AI vs. ML vs. DL. Overview of supervised, unsupervised, and reinforcement learning. The paradigm shift of Foundation Models.	B.W26
	How Machines Learn: Data, Features, and Model Training Understanding data types (numerical, categorical). The concept of features and feature engineering. Introduction to model training, validation, and testing. The problems of overfitting and underfitting	B.W27

	Deep Learning and Neural Networks: The Power of Depth From the Perceptron to Multi-Layer Perceptrons (MLPs). How deep neural networks (DNNs) automatically learn features. Introduction to Convolutional Neural Networks (CNNs) for images and Transformers for language	B.W26
	AI for Cardiovascular Imaging: Seeing the Unseeable AI applications in echocardiography (view classification, quality assessment), cardiac CT/MRI (segmentation, calcium scoring), and coronary OCT. Introduction to the Segment Anything Model (SAM) and its potential.	B.W26
	The AI-Enhanced Electrocardiogram (ECG) Moving beyond rule-based analysis. Using DL to detect low ejection fraction, hypertrophic cardiomyopathy, and atrial fibrillation from a simple ECG. Pitfalls: adversarial attacks and lack of explainability	B.W27
	Statistical Shape Modelling: The Geometry of Heart Disease How Principal Component Analysis (PCA) is used to create statistical models of heart anatomy. Tracking disease trajectories (e.g., hypertensive heart disease, HCM) and predicting outcomes (e.g., CRT response).	B.W27
	AI in Heart Failure: Diagnosis, Phenotyping, and Management Using AI for early detection of HFpEF/HFrEF from ECGs and EHRs. Phenomapping patients into subgroups with different prognoses and treatment responses. AI for optimizing guideline-directed medical therapy (GDMT).	B.W29
	Wearables and Sensors: Cardiology in the Real World Overview of sensor types (ECG, PPG, accelerometer). The transition from consumer gadgets to regulated medical devices. Use cases: AF screening, heart failure decompensation monitoring	B.W28
	Discriminative vs. Generative AI: Diagnosis vs. Creation Discriminative models (e.g., for classification) vs. Generative models (e.g., for creating synthetic data). How generative AI can solve data scarcity and privacy issues but risks memorization and bias	B.W26
	How to Critically Appraise an AI-Based Prediction Model Introduction to the PROBAST+AI and TRIPOD+AI frameworks. Key questions: Is AI needed? Is the data representative? Was overfitting avoided? Is the model fair and open?	B.W29
	The Challenge of Foundation Models and Multimodal AI The promise and perils of large models like GPT-4V. Their emergent abilities and current limitations in understanding space, time, and clinical context. The concept of "hallucination".	B.W26
	Evaluating AI in Practice: From Bench to Bedside Why many AI models never leave the lab. The importance of human-centered design, clinical workflow integration, and real-world validation (RCTs). The story of IBM Watson.	B.W28
	Ethics, Trust, and Responsibility in Medical AI Algorithmic bias and fairness (e.g., performance disparities across ethnicities). Explainability vs. accuracy. The EU guidelines for Trustworthy AI. Accountability and regulatory oversight.	B.W29
	The Future Doctor: Augmented, Not Replaced Exploring the doctor-patient relationship in the age of AI. AI for administrative tasks, informed consent, and patient communication. The future of AI in clinical trials (endpoint adjudication, digital biomarkers).	B.W28

	Course Wrap-Up and Final Project Presentations Synthesis of key course themes. Student presentations of their final projects.	B.U10

7. LITERATURE

Obligatory

1. Presentation and materials provided during the classes
2. Nicolas Duchateau, Andrew P. King AI and Big Data in Cardiology. A practical guide. Springer Cham 2023

Supplementary

P. Presbitero, M. Chiarito, A. G. Levra The First Steps of Artificial Intelligence in Cardiology: Will We Still Need Cardiologists?

8. VERIFYING THE EFFECT OF LEARNING

Code of the course effect of learning	Ways of verifying the effect of learning	Completion criterion
B.W26, B.W27, B.W28, B.W29, B.U10; K1, K2, K3	Watching seminars with subsequent solving tasks and tests provided during the classes	*80% points*
B.W26, B.W27, B.W28, B.W29, B.U10, S1, S2, S3	Asessments of tasks and tests provided during the course	Providing responses on time
SC1, SC2, SC3	Individual marking of the participants	Attendance

9. ADDITIONAL INFORMATION

1. Classes are held as e-classes (use of distance learning techniques).
2. materials are published on the platform www.e-learning.wum.edu.pl. I kindly ask each student to check before class if they can log on to the WUM Platform. In case of problems, please contact the person responsible for the course: Jakub Rokicki (jakub.rokicki@wum.edu.pl).
3. After this date, the student will have access to the course: "AJAJAJ or AI. Artifical intelligence in cardiovascular medicine 2025/2026". After accessing the course, the student is required to read the detailed information in the course. Watching all seminars is mandatory to proceed to tests.
4 The course should be started within 4 weeks of the opening of the course. Completion of the last assignments in the course should take place no later than the end date of the course, i.e. 25.01.2026.
5. closing date of the course: 25.01.2026.
6. continuous contact with the tutor via e-mail is possible during the course: Jakub Rokicki (jakub.rokicki@wum.edu.pl).
7. At the Department there is a Students' Club MedIT which associates students willing to improve their knowledge about medical informatics, artificial intelligence and using advanced omputer methods in Medicine. Shall you be interested in it please contact the tutor: Jakub Rokicki, Jakub.rokicki@wum.edu.pl

ATTENTION

The final 10 minutes of the last class of the block/semester/year should be allotted for students to fill out the Survey of Evaluation of Classes and Academic Teachers