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# Teaching Artificial Intelligence to Medical Students

Gheorghe Ioan MIHALAS<sup>a,1</sup>, Casiana BORU<sup>a</sup> and Coralia COTORACI<sup>a</sup> <sup>a</sup>Vasile Goldiş Western University Arad, Romania ORCiD ID: Gheorghe Ioan Mihalas 0000-0002-6469-1651 ORCiD ID: Coralia Cotoraci 0000-0001-8830-0259

Abstract. Among the measures taken by UVVG to modernize the educational process is the pioneering undertaking regarding the introduction of a course on Artificial Intelligence in Medicine (AIM). Such an action has to face several challenges, at three levels, starting from its inclusion in the curricular vision of the university, its positioning in the didactic program as well as the content of the syllabus suitable for medical students. The first part presents the necessity and opportunity of introducing the course in the current context of the rapid growth of AIM applications. The second part refers to the concrete implementation of the first dedicated to the preparation of the syllabus starting from the premises that the field is growing very fast and we should provide the basic knowledge to assure an easy understanding and a smooth assimilation of further developments.

Keywords. Artificial intelligence, medical education, AIM syllabus

# 1. Introduction

The healthcare landscape is undergoing rapid transformation through technological advancements, and artificial intelligence (AI) stands as a pivotal driver in revolutionizing medical practice. Incorporating AI education into medical curricula is no longer just a novelty; it is a necessity. The urgency to introduce the AI course arises from the rapidly evolving medical landscape and the increased adoption of AI technologies across healthcare sectors. Delaying this course could result in a knowledge gap for our graduates, placing them at a disadvantage as they enter a workforce where AI integration is becoming commonplace. Offering this course now will ensure that our medical graduates will be prepared for the contemporary medical challenges. We believe that this course is not only timely but also a strategic step in alignment with our educational objectives.

# 2. AI Course Compliance with the University Strategic Development Plan

The Faculty of Medicine of the "Vasile Goldiş" Western University (UVVG) set its own mission and specific objectives for the biomedical education harmonized with the UVVG Strategic Development Plan. It develops autonomously, and responsibly undertaking the mission to integrate the new concept of border free medicine in the context of general

<sup>&</sup>lt;sup>1</sup> Corresponding Author: Gheorghe Ioan Mihalas; E-mail: mihalas@gmail.com.

strategy for integration in European structures. This concept includes the adoption of newest technological and scientific advances in all educational and research activities. As AI continues to develop, it is essential that medical students have a basic understanding of AI and its applications in medicine. The introduction of the AI course aligns with our university long-term strategic objectives. [1]

We are confident that this initiative will not only benefit our students but also contribute to the advancement of medical education in the country.

# 3. Challenges in the Practical Implementation of the AI Course in the Medical Studies Program

The introduction of a new course is always accompanied by a set of challenges related to its practical implementation [2]. They refer to various aspects: insertion of the course within the curriculum in correlation with other disciplines, preparing the infrastructure and additional materials and evaluation of students' expectations and needs [3].

As the proposed level was set as an introductory course, our analysis revealed a number of benefits to introducing an optional course on AI to first year medical students: prepare students for the future of medicine, encourage interdisciplinary thinking and attract top students, including those who are interested in a career in research.

A small-scale survey (2023, not published results) showed that medical students at preclinical level have just fragmentary information about AI and AI use in medicine, however expressing their wish to attend an introductory course on AI and its applications in medicine.

The infrastructure is already available as the university has well equipped computer laboratories and the necessary software is open source. The course and all informative materials are available on the informatics platform (Moodle) of the university.

Our first year's experience yielded a useful feedback for improving our course: improving communication and collaboration (creating educational programs and resources), promoting ethical use (ethical challenges of AI, developing ethical guidelines), mechanisms for oversight and accountability and observing new regulations (these regulations are designed to protect privacy and promote ethical use of AI [4]).

It is likely that these challenges related to AI medical applications will become more complex and difficult to address and it is important to understand them in order to ensure that AI will be properly used.

A set of recommendations on artificial intelligence in medical education and training, similar to those of IMIA on medical informatics education would be quite welcome.

#### 4. Building a Harmonized Syllabus on AIM

The fast advent of Artificial Intelligence (AI) and its applications in all domains, including medicine, found the educational system insufficiently prepared, generating confusion in understanding the real performance and limits of this "new tool", which brought both hopes and fear. The need of an urgent reaction is reflected by Martec's Law: "Technology changes exponentially, organizations change logarithmically". Indeed, even the AI research is older than half a century, it was only the last decade when educational systems included AI in their curricula [5]. Actually, several programs have been introduced for all healthcare professionals [6]. The present state in Romania at the

moment of preparation of this material includes some courses in technical universities and none yet for medical students.

# 4.1. Estimating actual needs, specific conditions and future perspectives

The decision to introduce such an educational program for medical students was taken after an analysis of the actual needs (which are general for all proposed educational programs in AI) and our specific conditions for implementation:

- Needs: as AI is very pervasive and our students will meet such applications; even educational activities became more and more related to the use of AI; hence on overview and basic knowledge would be quite welcome
- Specific conditions: an extensive review of the AI impact and major expected challenges of such an approach [7] revealed:
  - o AI is progressing so fast, that the applications presented during the studies will soon become obsolete, hence the program must include basic notions, to prepare the student to critically understand and assimilate the new products
  - o for most of our students the level of prerequisite knowledge in basic sciences (math, informatics) to provide a deep understanding of AI is generally low
  - o we might encounter difficulties to find appropriate staff

o insufficient educational tools for introductory levels or for medical domain etc. The most difficult tasks were:

- to find an appropriate level for the content sufficiently comprehensive, to cover the diversity of medical applications, but with limited use of the formal approach
- on the other hand, to provide basic knowledge as the only way to prepare the students in order to understand and assimilate all the new applications.
- A well balanced and harmonious content was the main goal and permanent target along all the time during the preparation of this course.

# 4.2. AI courses in other medical schools

It was also important to look for the experience of other universities which have already started a similar course. The available literature showed that, even the number of AI specific new courses is not yet very large, there is a clear increasing trend and we expect that soon these courses will be included in all curricula in medical schools.

In a review published in 2019, Paranjape [5] compared the syllabi from six American universities; the first observation is the high degree of diversity: two programs were only for residents, one of them being specialized for one domain (radiology), but the other addressed all medical students. The experience collected from the cited studies was synthesized as a very interesting set of recommendations per stage of medical education. Thus, the recommendation for the medical college admission test was to introduce questions on linear algebra (vectors, matrices), (differential and integral) calculus and probability theory, for the medical school core phase – working with medical data sets, data curation and AI fundamentals (reasoning, machine learning, natural language processing and neural networks) and for clinical phase – AI based clinical applications, clinical utility, ethics and law. It was also suggested to introduce questions on data science and AI in US Medical Licensing Examination.

As we can observe, the recommendations are quite ambitious, starting with math notions at the admission test, raising the level of AI fundamentals from introductory to

intermediate/advanced and introducing questions on data science at licensing examination UMLS. Even it looks like that the role of basic sciences (mathematics, physics, logics) was overestimated, several other studies paid a similar attention to the cognitive aspects related to medical education. The diversity of American universities programs is well known; however, most of them do consider the recommendations of American Medical Association.

Park et al. [8] added an interesting remark, that despite the progress of AI in medical applications, the real rate of use and spread is not yet high enough, being often limited to the teams and institutions who developed the tools. They analyzed the reluctant position expressed sometimes by the medical staff and cited the insufficient awareness or knowledge about the new technologies, especially about the AI applications and use, emphasizing that "even as a medical student, one should not passively accept stories related to AIM in the media or the Internet", insisting on "sufficient" basic knowledge.

Meskó and Görög [9] authored one of the most detailed descriptions of what they called "a short, visual and digestible repository of information and details every physician might need to know in the age of A.I.". It includes both basic knowledge, medical applications and the present challenges related to AI use in medicine.

Based on the experience and the opinions expressed by the professionals from other universities, we designed a structure adapted to our specific conditions, trying to harmonize the theoretical background with the current medical applications and also about the ethical and regulatory aspects linked to the AI use in medicine.

## 5. Structure of the Proposed AIM Course

The course is organized into three main parts, divided into specific topic chapters.

The first part, "Fundamental notions", comprises all introductive notions (AI definition, levels, approaches), problem solving (agents, searching), reasoning (logical inference), knowledge representation (knowledge bases, ontologies, expert systems), machine learning (supervised, unsupervised, reinforcement), neural networks (types, perceptron), deep learning, natural language processing (language models), perception (visual systems, speech recognition) and robotics (architecture, effectors, haptic systems).

The second part is dedicated to "Medical Applications", starting with classifications, then presentations of clinical applications (computer assisted diagnosis, medical imaging, surgical robotics and patient monitoring), including discussions on advantages and limits. Other courses comprise AI applications in biomedical research (personalized medicine, clinical trials and drug design), public health (population monitoring, environmental risks, epidemics, disaster medicine) and healthcare management (patient flow optimization, coding, scheduling, reporting and hospital management).

The last part covers the specific "Ethical and legal aspects": risks of AI use in medicine (technological, user level and ethical/legal risks), standards and regulations, European Parliament recommendation and limits and prospective of AIM [4].

A special attention was paid to the preparation of practical works to ensure a consolidation of the knowledge taught in the course. During the first semester we introduced: logical schemes for algorithms, predicate logic exercises, supervised learning for prediction (linear regression) and for classification (logistic regression), classifier quality (sensitivity, specificity, AUC etc.), probabilistic systems (Bayes rule) and demos for Neural networks – Perceptron. The second semester was entirely dedicated to the use of Chat GPT and Gemini for a list of medical applications, covering

a large variety of clinical and surgical topics including images, finalized with preparing reports and have presentations during the laboratory classes.

For the structure of the theoretical part we found the book of Russel and Norvig [10] as an excellent guide and for the discussions related the medical applications the books of Lee, Goldberg and Kohane [11] and Topol [12] were quite inspiring.

### 6. Conclusions

The task of starting a new course with a high technical allure for medical students requires a daring effort and berries high responsibilities. That is why it required an early preparation, a collective consultation and a well documented basis, in order to transform the experience into a success. Our study presented the details of the preparation, all potential influencing factors being considered and a thorough search of the literature. All these elements, combined with the long experience in teaching a closely related discipline – medical informatics, would represent the premises for a good start.

It is worth to reiterate that the course is prepared in a student-centered view [1], the main goal being to assure a high professional level of a physician of the 21st century, capable to understand and use the new technological advances.

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