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ART. 1 — TYPOLOGY

The University of Pavia is active for the year 2023/2024 the University Master of **Level I** in "**explainable Artificial Intelligence in healthcare Management (xAIM)"** at the Department of Economics and Management.

Edition: II
Areas of Afference: Scientific-technological

ART. 2 — TEACHING OBJECTIVES, CAREER OPPORTUNITIES AND COURSE APPEAL

The objective of the xAIM Master is to provide digital skills in the area of healthcare management by training highly qualified professionals in the healthcare area, as well as sensitizing learners to emerging ethical issues and the impact that Artificial Intelligence (AI) is having on society.
This Masters course will create an interdisciplinary environment, allowing students to be trained to work in those contexts where Data Science, AI, and healthcare management meet. Students will learn the fundamentals of Machine Learning and Data Science, meaning that they will have the knowledge to manage and analyze large amounts of heterogeneous and complex data that characterize the healthcare sector. In order to allow a clear understanding of the data and a correct interpretation of the results, emphasis will be placed on their impact in the health sector. The entire program focuses on the current situation and on possible future applications of AI in the healthcare sector. The acquisition of practical knowledge, as well as the development of the ability to apply the acquired skills, are key aims of the course. To complete the program, emphasis will be placed on the ethical and social implications of AI applications, as well as on legal considerations. By taking part in seminars and attending an internship at partner institutions across Europe, students will be able to develop and evaluate reliable AI solutions, as well as understand its potential, limitations and related implications for the healthcare professions, patients and society as a whole.
At the end of the course, students will be able to find employment in contexts that require transversal skills in AI and health management. They will also be able to perform data analysis and interpret the results, assessing emerging risks and using them to complete decision-making processes.
The xAIM Masters course is delivered in collaboration with European partners, namely the Goethe University of Frankfurt (Germany), the Leibniz University of Hannover (Germany), the University of Keele (United Kingdom) and the University of Ljubljana (Slovenia).

Graduates of the xAIM Masters course can find job opportunities in areas that require transversal skills between AI and healthcare as they will be able to analyze and process the data necessary to apply AI

solutions, as well as interpret the results provided by the AI by assessing the related risks and challenges.

Healthcare facilities will be able to exploit highly specialized individuals able to support doctors and health professionals providing support in the implementation of intervention and diagnosis protocols based on data and empirical evidence. These same individuals will be able to suggest the most effective approaches to the management of pathologies, the weight of comorbidities and the variables that most influence the evolution of clinical settings. They will also not only speed up prognostic evaluations but also make them more accurate and precise thanks to the implementation of the most suitable algorithms.

ART. 3 — COURSE PROGRAMME

The Master has a duration of 1 year and 6 months (2250 hours total — 90 CFU) and is organized into:

- frontal lessons
- practical exercises
- individual study
- internship (to be carried out remotely or in person based on the agreement taken with the host organization).

Students **must attend** 75% of the total number of course hours.
The training period cannot be suspended.
Transfers from similar Masters courses at other universities are not permitted.

Elective modules are activated if participants number 5 or more.
The teaching modules will be delivered online in English and each student is required to attend all the compulsory courses and to choose 4 optional modules (for a total of 10 modules). The compulsory modules include two courses (numbers 5 and 6), each with 6 credits, on the ethics of AI in the healthcare sector.

Course/ Module	SSD	Contents	Frontal Teaching Hours	Practical/Laboratoy hours	Individual study hours	Total hours	CFU
Compulsory Modules							
1) Transforming healthcare	SECS-P/07	—Management of Healthcare Organisations —Financial resources —Manage the complexity of the implementation of AI-based activities —Provide support to decision-making process in a multi-objective environment	48	30	72	150	6

2) AI and healthcare workforce	SECS-P/07	—Acceptance of AI by healthcare professionals/managing change; —Redesigning roles and systems; —Use of AI in Education and Training; —Patients safety and clinical governance considerations; —Who has primacy — doctor or machine? Medical-legal aspects; —AI and the Clinician patient relationship — interacting with expert patients, potential disempowerment of clinicians, potential to devalue clinical roles; —New roles/professions in healthcare — bioinformaticians, data managers, informatics; —Social and psychological aspects of computer-mediated communication.	48	30	72	150	6
3) Data Driven Healthcare	SECS-S/01 ING-INF/06	—Information modeling (files, databases) —Data in healthcare (biological, clinical, administrative and research) —Electronic data collection —Interoperability —Descriptive statistics —Univariate analysis —Bivariate analysis —Inferential statistics	48	30	72	150	6
4) Introduction to Data Science	SECS-S/02	—Introduction to data science. Typical problems and applications. Introduction to supervised and unsupervised learning. —Introduction to techniques of data mining and knowledge discovery in databases, with emphasis on their application in medicine. Data preprocessing, Visualisations (types and appropriate use). —Data clustering techniques, cluster explanation. —Dimensionality reduction techniques, projections. —Predictive models: classification, regression. —Overfitting. —Model evaluation. —Explanations of predictive models, SHAP values. —Practical examples of data science from medicine, bioinformatics, and healthcare.	48	30	72	150	6
5) Z-Inspection®: A process to assess trustworthy AI in practice	SECS-P/07	—Introduction to the EU framework for Trustworthy AI —The Z-Inspection® process —Assessment of AI use cases in healthcare	48	30	72	150	6

6) Trustworthy AI	SECS-S/01 SECS-P/07	—Assessment of (digital) health technologies —Framework for achieving Trustworthy AI —Trustworthy AI: principles and measurement —Statistical learning models — Machine learning models —Accuracy —Robustness —Explainability —Fairness	48	30	72	150	6
Total hours/partial CFU			288	180	432	900	36
Elective modules							
7) Advanced AI Assessment	SECS-P/07	—HTA principles —Implementation of HTA in different healthcare systems —Ai assessment	48	30	72	150	6
8) Introduction to healthcare management	SECS-P/07	—Quality in Healthcare Organisations —Performance Management —Financial Management in Health —Commissioning and Licensing —Project management —Leadership in Healthcare —International competition and cross-border healthcare services	48	30	72	150	6
9) Coding in Python	SECS-S/01	—What is a programming language and what can it be used for; —Python essential syntax —Variables and data structures: basic data types, strings, tuples, lists, and dictionaries; —Control structures: conditionals, loops, functions; —Intro to Object Oriented Programming: classes, objects and methods; —Leveraging external libraries: installing, importing and usage	48	30	72	150	6
10) Computer Vision and Deep Learning	SECS-S/01	Image processing; Image classification —Multi-layer Perceptrons + gradient descent —Deep learning —Convolutional neural networks and advanced architectures —Object detection —Image Segmentation —Recurrent neural networks —Video Analysis	48	30	72	150	6
11) Advanced topics in AI	SECS-S/02	—Search,mdps,CSPs — introduction to probability theory and Bayes' Nets, -Decision Networks —Value of Perfect Information Enforcement Learning —Hmms —Particular Filtering and Machine Learning	48	30	72	150	6

12) AutoML	SECS-S/02	—Hyperparameter Optimisation, —Neural Architecture Search, —Bayesian optimisation, —Evolutionary algorithms, —Multi-fidelity optimisation and gradient-based optimisation, —Useful meta strategies for speeding up the learning itself or AutoML	48	30	72	150	6
13) Text Mining	SECS-S/02	—Dealing with unstructured data in healthcare —Text preprocessing, concordances and Collocations —Clustering and cluster exploration on medical texts —Word enrichment and keyword techniques —Vector presentation of documents —Predictive modeling on text data —Topic modeling —Semantic analysis and document summarisation —Sentiment analysis	48	30	72	150	6
14) Information Ethics and legal aspect	SECS-S/02	Module A —What is information ethics? Why is it useful? —Introduction to ethical theories and frameworks. —Information ethics applied to specific issues, e.g., human rights, information access, privacy, cybersecurity, etc. —Scholarly and media literature on generally discussed/documented issues with AI/ML, including AI/ML causing/being used in ethically problematic situations with a progressive focus on medical applications. —Through experiments and trolley problems, their reasoned analysis will draw on information ethics principles. Module B —Digital Rights and Data ownership —Right to privacy and its legislation (GDPR) —Informed consent and patient autonomy —Legal design techniques in health —Data-driven decisions in health and AI and actors liability —Re-use of personal data in healthcare and research —Medical Device Regulation	48	30	72	150	6
Total hours/partial CFU			192	120	288	600	24
Total hours/CFUs			480	300	720	1500	60
Internship-Stage						450	18
Final test						300	12
Total hours/CFUs						**2250**	**90**

ART. 4 — ONGOING ASSESSMENTS

Ongoing assessment for each course/module is carried out through an intermediate test and/or at the end of the module itself in the forms of multiple-choice tests, exercises, reports, workshops or project work.

ART. 5 — FINAL TEST AND AWARD OF THE QUALIFICATION

The final test will consist in the discussion of a thesis related to a project carried out under the supervision of a member of the Masters teaching staff. This will be based on the issues tackled during the course, in the practical sections and during the internship.

At the end of the course, students who have carried out all the activities and complied with the required obligations, provided they pass the final test, will be awarded the Level I University Master's Diploma in "**eXplainable Artificial Intelligence in healthcare Management (xAIM)**".

ART. 6 — TEACHING STAFF

Teaching will be delivered by University of Pavia professors, by professors from other universities, including foreign ones, as well as by highly qualified external experts.

ART. 7 — ADMISSION REQUIREMENTS

The Master is aimed at those who have obtained the:

1. a degree (three-year) pursuant to DD.MM. 509/99 and 270/04, in one of the following classes:

Biotechnology L-2; 1	Civil and environmental engineering L-7; 8
Information Engineering L-8; 9	Industrial Engineering L-9; 10
Economics and Business Management Sciences L -18; 17	Sciences of Administration and Organisation L-16
Administration Sciences 19	Biological Sciences L-13; 12
Chemical Sciences and Technologies L-27; 21	Pharmaceutical Sciences and Technologies L-29; 24
Mathematical Sciences L-35; 32	Computer Sciences and Technologies L-31; 26
L-41 Statistics	Statistical science 37
Nursing and Obstetric Health Professions L/SNT1; SNT1	Health professions of rehabilitation L/SNT2; SNT2
Technical Health Care professions L/SNT3; SNT3	Health professions of prevention L/SNT4; SNT4

2) a specialist degree/single-cycle Masters degree in: *Medicina e chirurgia LM41,46/S.*

1. diploma obtained in accordance with previous legal systems in:

Biotechnology	Civil and Environmental Engineering
Information engineering	Industrial engineering
Biological sciences	Administration Sciences
Economics and Business Management Sciences	Chemical sciences and technologies
Pharmaceutical Sciences and Technologies	Computer science and technology
Mathematical sciences	Statistical sciences
Medicine and Surgery	

The maximum number of members is **35**.
The minimum number to activate the course is **25** participants.

The Teaching Board reserves the right to assess whether the conditions exist to expand these quotas.

Should the number of applicants be greater than the maximum foreseen, a Commission composed of the Coordinator and two members of the Masters teaching staff will make a selection and formulate a ranking list, expressed in hundredths, determined on the basis of the following criteria:

Up to **15 points** for the **degree mark** (refers to admission requirement qualification), as outlined below:

110/110 and honors	15 points
from 105/110 to 110/110	12 points
from 99/110 to 104/110	9 points
from 90/110 to 98/110	5 points
below 99/110	0 points

Up to a maximum of **10 points** for each other **post graduate degree** relevant to the themes of the Master, divided as follows:

- 10 points per Doctorate and/or Postgraduate Diploma and/or Master's Degree and/or Master's Degree (excluding the degree in Medicine and surgery LM41,46/S), achieved in related topics.

Up to a maximum of **15 points** for **professional experience** related to the topics of the master, which will be evaluated as follows:

- 15 points if greater than 2 years
- 10 points if between 1 and 2 years
- 5 points if less than 1 year

Up to a maximum of **10 points** for the **letter of reference**, which will be evaluated as follows:

- 5 points awarded to the relevance to the xAIM master's degree topics of the research topics/experience professional experience of the reference person
- 5 points assigned to the relevance of the referee's institution in reference to the themes of the xAIM master's degree.

The candidate will be admitted to the interview with a score of **25 or higher**.

The interview has a maximum value of 50 points and is aimed at assessing the motivation and knowledge of English.

It is considered passed with a **minimum score of 30**.

In the event of two or more candidates in the ranking list having the same score, the younger candidate will be favored.

Should one or more candidates withdraw, the places made available will be offered according to ranking list position until all places have been filled.

ART. 8 - ONLINE ENROLMENT DEADLINE

Candidates must complete the admission procedure described in the Call for Applications from **10 July 2023 and by the deadline of 30 September 2023**.
Candidates must be in possession of the course requisites, as established in the Call for Applications and Attachment by the registration deadline.

ART. 9 — ATTACHMENT TO THE ONLINE ENROLMENT PROCEDURE

During the Masters online enrolment procedure, candidates must attach:

● **a curriculum vitae** complete with an indication of the admission requirements and for eventual selection (degree mark, publications, postgraduate qualification and professional experience);

● a **reference letter**

ART. 10 — FEES

Enrolment:
Students enrolled on the Masters course will have to pay for the academic year 2023/2024 the sum of **€4,900.00** including: €16.00 (stamp duty) and €142.00 ("Administrative fees").
This amount will be paid in 3 installments:

- installment 1 of EUR **2.500,00**, to be paid **at the time of registration**
- installment 2 of EUR **1.200,00,** to be paid before **01/12/2023**
- installment 3 of EUR **1.200,00**, to be paid before **15/02/2024**

National or international third parties or individuals may contribute to the functioning of the Masters course by providing contributions aimed at covering in full or partially the registration fee.
In such cases, the candidates will be selected based on criteria established by the Teaching Board and published on the website of the Administration Office.

Final test:
To be admitted to the final test, candidates must submit a specific admission application and make the payment of €116.00 for the issue of the parchment (which includes two duty stamps of €16.00 paid virtually: one on the parchment and the other for the admission application).

ART. 11 — WEBSITE AND ORGANIZATIONAL SECRETARIAT

All correspondence will be published on the following website: https://xaim.eu

For more information related to the course organization:

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