

<p align="center">PhD Programme in MATHEMATICS AND COMPUTER SCIENCE</p> <p align="center">Curriculum 1: MATHEMATICS Curriculum 2: COMPUTER SCIENCE Curriculum 3: BIG DATA</p>	
DISCIPLINARY SCIENTIFIC AREAS	01 - MATHEMATICS AND INFORMATICS; 13 - ECONOMICS AND STATISTICS
COORDINATOR	PROF. ANTONIO IANNIZZOTTO
HEAD DEPARTMENT	DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
DURATION	3 years
LEARNING OUTCOMES AND RESEARCH TOPICS	<p>The PhD programme in Mathematics and Computer Science covers a broad spectrum of disciplines, connected to each other on the cultural, methodological and applicative levels. The doctorate, through the practice of scientific research in leading sectors of Mathematics and Computer Science, aims to train people of an adequate cultural level, able to contribute to the current needs of innovation and development of the industry and the information society, both on the level of scientific creativity, and of design ability. In particular, the doctoral course is aimed at training specialists with advanced methodological and technical knowledge, as well as with adequate linguistic preparation. The doctoral activity is supported by professors and researchers belonging to groups actively engaged in research at international level, ensuring ample opportunities for exchange of doctoral students with prestigious Italian and foreign universities, research bodies and companies. The investigation themes offered by the three available curricula (Mathematics, Computer Science and Big Data) largely refer to the research activities of the members of the teaching staff, and concern both the fundamental and application aspects of many sectors of Mathematics and Information Technology. The training acquired during the PhD programme will allow our graduates to autonomously perform research and development in universities, in public and private research institutions, and in the industrial sector. In particular, the main employment opportunities envisaged are the continuation of university research activities, the coordination and direction of research and development activities in industries, public bodies or national and international research centers. The analysis and elaboration skills acquired by training through research will also allow to take paths leading to managerial tasks in both the private and public sectors, or to undertake your own activities as a consultant for public bodies, companies and software houses.</p> <p>The PhD programme in Mathematics and Computer Science covers a wide spectrum of disciplines connected to each other both on a cultural, methodological and applicative level. The doctorate, through the practice of scientific research in leading sectors of Mathematics and Computer Science, aims to train people of an appropriate cultural level to contribute to the current demands for innovation and development of industry and the information society, both in terms of scientific creativity and design capacity. The Doctorate is able to propose numerous study paths aimed at training personnel specialized in applied and industrial research, able to operate in work situations of excellence in the areas of specialization established. The articulation of the doctoral courses will be oriented to the achievement of useful and innovative results. Some of the possible paths are described on the site and are summarized succinctly below: research activities in the fields of computer vision and geometry processing with direct interest in the</p>

creation and modification of digital characters, a typical problem in the entertainment industry and also repercussions on the cultural heritage sector; applications of game theory to wireless networks in which each node of the network acts as a player identifying optimal paths for the transmission of information packets; study of the use of electric vehicles in freight transport by formulating new optimization models and developing appropriate resolution algorithms; experimentation of models for the scheduling of production, distribution and packaging processes; construction of a national center for testing, validation, certification and training of unmanned aerial platforms (drones) for civil applications; research for the development of image analysis techniques to support clinical decisions in biomedicine; applications of fractional equations to biological models; analysis of the problems of planning tourist itineraries based on individual preferences regarding destinations, means of transport and time constraints. This problem falls into the class of problems known as "vehicle routing with profits"; analysis of the latest concept in blockchain platforms for practical applications to the management of online voting, the certification of agri-food supply chains, the management and certification of the production and exchange of green energy.

Objectives of the course:

In particular, the doctoral course is aimed at training specialists with advanced methodological and technical knowledge, as well as an adequate linguistic preparation, able to carry out research and development activities in large autonomy in the university environment, in public and private research institutions and in the industrial field. The activity of the doctorate is supported by professors and researchers who are part of groups actively engaged in research at an international level, ensuring wide opportunities for exchange and reception of doctoral students at prestigious Italian and foreign universities, research institutions and companies. The research topics offered by the three available curricula are largely related to the research activities of the members of the teaching staff and concern both the fundamental and applicative aspects of many sectors of Mathematics and Computer Science. The specific objectives are diversified according to the research areas of the teachers involved. A common guideline is achieved by specifying generic goals based on the course year.

The first year will be dedicated to the analysis of the state of the art and to the formation of a solid basic preparation, as well as of course to start the research activity on the chosen theme. In the same period, in the absence of a previous certificate of knowledge of the English language at least at level B2, the PhD student will follow an English course offered by the University Language Center. The existing contacts between the professors of the college and numerous researchers operating abroad will also be exploited, in order to choose a location where doctoral students can spend a period of study and research lasting at least 6 months.

Within the second year the research activity will come to life and, as soon as the first results are available, the active participation of the PhD student in national and international congresses will be planned, with the presentation of posters and / or oral communications. The PhD student will also be involved in the drafting of scientific articles to be submitted on congress proceedings or, in case of sufficiently consistent results, in international scientific journals. The PhD student will also begin the period of stay abroad.

The third year will see the realization of the project envisaged by the course, and will lead to the publication of the results in international journals, favoring those indexed on the main scientific databases. The PhD student will continue his/her activity abroad in a more independent way, in order to establish collaborative relationships with researchers working in his area of

	interest.
ELIGIBILITY AND OTHER REQUIREMENTS FOR CANDIDATES (ART. 2 - NOTICE OF COMPETITION)	EVERY ITALIAN 2ND CYCLE DEGREE (<i>LAUREA MAGISTRALE/SPECIALISTICA/VECCHIO ORDINAMENTO</i>) AND EQUIVALENT AND SUITABLE FOREIGN ACADEMIC DEGREES
ADMISSION TESTS	<p>ASSESSMENT OF QUALIFICATIONS AND CURRICULUM VITAE, AND INTERVIEW</p> <p>The interview will aim to ascertain the candidate's ability to orient on the main areas of study inherent in the doctorate and to verify his/her analytical, processing and communication skills.</p> <p>During the interview, a three-year research project proposed by the candidate will be discussed, which must be presented, in addition to the documents required by art. 3 of the call for applications (Annex A "Titoli valutabili e Curriculum Vitae"; Annex B 'Dichiarazione sostitutiva di certificazioni del/i titolo/i di accesso con esami e voti'; two-sided coloured scanned copy of a valid ID, with a clear photo), by uploading it to the system by the call expiry date (file name: <i>research_project_surname_name</i>).</p> <p>Candidates unable, for justified reasons, to take the interview at the established venue, may be granted the possibility of carrying it out by videoconference, on the same date and time established for face-to-face interviews, according to the procedure indicated in the notice of competition.</p>
ADMISSION TESTS FOR FOREIGN CANDIDATES APPLYING FOR RESERVED POSITIONS SUPPORTED BY A SCHOLARSHIP	<p>ASSESSMENT OF QUALIFICATIONS AND CV, VIDEO CONFERENCE INTERVIEW</p> <p>During the interview, the candidate will discuss his/her 3-year research project. The project (preferably written in English) must be uploaded along with the documents listed in art. 3 of the PhD notice of competition (<i>certificate attesting the award of a 2nd level foreign degree needed to access a PhD programme, including exams and marks, with a translation in Italian or English; certificate attesting the award of a 1st level foreign degree, including and marks, with a translation in Italian or English; signed Curriculum Vitae preferably in EU format, in English or Italian; additional qualifications, certifications, publications (up to 5) and work experiences, detailed in English or in Italian; two-sided coloured scanned copy of a valid ID, with a clear photo</i>), within the deadline (file name: <i>progetto_di_ricerca_surname_name</i>).</p> <p>Reference letters (up to 3) must be written in English, using the form available on the webpage https://unica.it/dottoraticerca (How to apply for PhD selection: Guidelines and forms- Annex D), by a university professor or an expert in the research fields of the PhD programme, on letterhead of their institution, dated and signed. Evaluators will send their letters directly to the email address phdcall_referenceletter@unica.it (object: surname and name of the candidate being evaluated and name of the PhD programme for which he/she is applying).</p>
POSITIONS	12 (1 of which, with scholarship, reserved for a foreign candidate with a foreign degree)
SCHOLARSHIPS	10: 1 funded by UniCa; 5 funded by Ministerial Decree no. 118/2023: 1 NRRP Research, 3 Public Administration, 1 Digital and Environmental Transitions; 4 funded by Ministerial Decree no. 117/2023
POSITIONS WITHOUT SCHOLARSHIP	2
CONTACT PERSON	<p>PROF. ANTONIO IANNIZZOTTO</p> <p>EMAIL: antonio.iannizzotto@unica.it – TEL: +39 070/6755603</p>
WEBSITE	http://dottorati.unica.it/matematicaeinformatica/

SCHOLARSHIPS FUNDED BY MINISTERIAL DECREE NO. 118/2023	
SCHOLARSHIP 1	
TYPOLOGY	Digital and Environmental Transitions
RESEARCH PROJECT	Mathematical applications for the study and implementation of digital and environmental transitions
PRINCIPAL INVESTIGATOR	Prof. Roberto Tonelli
DESCRIPTION OF DOCTORAL TRAINING	The training activity planned for the doctoral course aims at proposing, studying and developing new mathematical models and methods for the implementation of the digital and ecological transition and will concern the thematic areas in which the themes and research groups of the doctorate are inserted, such as those of pure and applied mathematics: mathematical logic, algebra, geometry, complementary mathematics (didactics and history of mathematics), mathematical analysis, probability and mathematical statistics, mathematical physics, numerical analysis, operations research and other areas of research currently evolving. Other thematic areas may relate to information technologies.
COMPANY/RESEARCH INSTITUTION	The company or the research institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION	6
FOREIGN INSTITUTION	The foreign institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 2	
TYPOLOGY	NRRP Research
RESEARCH PROJECT	Study and application of new and innovative technologies and methods for the analysis of large data sets
PRINCIPAL INVESTIGATOR	Prof. Roberto Tonelli
DESCRIPTION OF DOCTORAL TRAINING	The training activity planned for the doctoral course aims at studying and applying innovative technologies and methods for the analysis of large data sets and will concern the thematic areas in which the themes and research groups of the doctorate are inserted, such as the different areas of Big Data analysis, for which clusters of computers are needed, both with purely computer processing techniques, analysis and algorithms, and with statistical-mathematical tools. The track offers several possible specific research areas, in particular related to artificial intelligence and machine learning, such as non-linear language processing (NLP), neural networks, deep learning, associated with recognition and classification techniques. Possible areas of research also concern time series analysis and related prediction techniques, supervised learning, Bayesian and non-Bayesian inference models, and nonlinear regression models and even mathematical methods and theories
FOREIGN INSTITUTION	The foreign institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 3	
TYPOLOGY	Public Administration
RESEARCH PROJECT	Study of new information technologies for public administration

PRINCIPAL INVESTIGATOR	Prof. Roberto Tonelli
DESCRIPTION OF DOCTORAL TRAINING	The training activity planned for the doctoral course aims to study new information technologies and / or models for innovation in public administration and will cover the thematic areas in which the themes and research groups of the doctorate are inserted, such as software engineering in general and its applications to distributed and decentralized systems, research in the fields of computer vision and geometry processing, applications to control theory, analysis of human-machine interactions and user friendly GUIs, development of image analysis techniques to support clinical decisions in biomedicine and other research areas such as pure and applied mathematics.
COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	The company/research institution/public administration where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	6
FOREIGN INSTITUTION	The foreign institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 4	
TYPOLOGY	Public Administration
RESEARCH PROJECT	Analysis of digital transition in public administrations
PRINCIPAL INVESTIGATOR	Prof. Roberto Tonelli
DESCRIPTION OF DOCTORAL TRAINING	The training activity planned for the doctoral course aims to study models and methods, mathematical and / or informatic, for the digital transition of the public administration and will concern the thematic areas in which the themes and research groups of the doctorate are inserted, such as software engineering in general and its applications to distributed and decentralized systems, research in the fields of computer vision and geometry processing, applications to control theory, analysis of human-machine interactions and user-friendly GUIs, development of image analysis techniques to support clinical decisions in biomedicine and other research areas such as pure and applied mathematics.
COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	The company/research institution/public administration where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	6
SOGGETTO ESTERO	The foreign institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 5	
TYPOLOGY	Public Administration
RESEARCH PROJECT	Innovative and enabling technologies for Public Administration innovation
PRINCIPAL INVESTIGATOR	Prof. Roberto Tonelli

DESCRIPTION OF DOCTORAL TRAINING	The training activity planned for the doctoral course aims to propose, to study and develop new models and methods, mathematical and / or from computer science, and technologies for innovation and digitization of public administration and will concern the thematic areas in which the themes and research groups of the doctorate are inserted, such as software engineering in general and its applications to distributed and decentralized systems, research in the fields of computer vision and geometry processing, applications to control theory, analysis of human-machine interactions and user-friendly GUIs, development of image analysis techniques to support clinical decisions in biomedicine and other research areas such as pure and applied mathematics.
COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	The company/research institution/public administration where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION/PUBLIC ADMINISTRATION	6
FOREIGN INSTITUTION	The foreign institution where the activity will be carried out and the relative contact person will be defined after the conclusion of the selection proceedings.
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIPS FUNDED BY MINISTERIAL DECREE NO. 117/2023	
SCHOLARSHIP 1	
TYPOLOGY	Innovative doctorates responding to the innovation needs of companies and promoting the recruitment of researchers by companies (M4C2 - Inv. 3.3)
RESEARCH PROJECT	XR Mixer
PRINCIPAL INVESTIGATOR	Prof. Lucio Davide Spano
DESCRIPTION OF DOCTORAL TRAINING	<p>The research focuses on supporting end users without skills on 3D programming or modeling to create eXtended Reality (XR) experiences, promoting their adoption, particularly in industrial contexts.</p> <p>During the PhD the candidate will answer the following research questions:</p> <ul style="list-style-type: none"> • Identify a meta-design process for XR environments. • Create tools that can be used to support users in creating one XR scene and its behaviour. • Create intelligent agents to guide end-user developers in the XR configuration task. • Validate research through user studies. <p>The research is supported by the DMI of the University of Cagliari and co-financed by State Space Labs, a leading company in the sector for the creation of XR software for training, with expertise in neuroscience, data analysis, development of training experiences in XR. The candidate's training will be completed at the EDM group of the University of Hasselt, one of the most renowned European centers dealing with VR/AR/MR.</p>
COMPANY/RESEARCH INSTITUTION	State Space Lab, Inc., (branch of Cagliari) Regus, Via Mercato Vecchio 9/11, 09124 Cagliari Legal head office: 7461 South Avenue, Boardman OH 44512, New York
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION	6
SOGGETTO ESTERO	University of Hasselt, Expertise Centre for Digital Media - Flanders Make Legal head office: Wetenschapspark 2, 3590 Diepenbeek, Belgium Contact person: prof. Kris Luyten

NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 2	
TYPOLOGY	Innovative doctorates responding to the innovation needs of companies and promoting the recruitment of researchers by companies (M4C2 - Inv. 3.3)
RESEARCH PROJECT	Advanced methodologies and tools for translating from HTML to JSON in the digital field
PRINCIPAL INVESTIGATOR	Prof. Diego Reforgiato Recupero
DESCRIPTION OF DOCTORAL TRAINING	The proposed doctoral program focuses on investigating the most advanced Artificial Intelligence (AI) techniques for translating HTML templates into formats compatible with digital applications (JSON). A mixed approach will be used, combining two techniques: the first based on identifying and classifying elements through HTML interpretation and the second based on comparing input and output preview images. Reinforcement Learning techniques will be used to improve the effectiveness of the identified solutions. The ultimate goal of the project is to develop a highly performant system for translating HTML templates into JSON that can be used in a wide range of digital applications. A demonstrative prototype will validate the applicability of the results in enterprise.
COMPANY/RESEARCH INSTITUTION	Growens S.p.A. Legal head office: via Pola 9, 20124 Milano
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION	12
FOREIGN INSTITUTION	Knowledge Media Institute of the Open University Legal head office: Walton Hall, Milton Keynes, MK7 6AA, Regno Unito Contact person: Francesco Osborne
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 3	
TYPOLOGY	Innovative doctorates responding to the innovation needs of companies and promoting the recruitment of researchers by companies (M4C2 - Inv. 3.3)
RESEARCH PROJECT	Advanced methodologies and tools for collecting, classifying, and recommending the use of elements from digital content
PRINCIPAL INVESTIGATOR	Prof. Diego Reforgiato Recupero
DESCRIPTION OF DOCTORAL TRAINING	The proposed doctoral research focuses on investigating advanced Artificial Intelligence (AI) techniques for content scraping, classification of identified elements, and a recommendation system that provides useful combinations for end users. A mixed approach will be used, combining techniques for element identification and classification through HTML interpretation, image recognition, and a recommendation system that composes reusable element blocks. The ultimate goal of the project is to develop a highly performing system that facilitates the generation of new digital content from existing ones. A demonstrative prototype will allow for the validation of the results' applicability in the industry.
COMPANY/RESEARCH INSTITUTION	Growens S.p.A. Legal head office: via Pola 9, 20124 Milano
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION	12
FOREIGN INSTITUTION	Knowledge Media Institute of the Open University Legal head office: Walton Hall, Milton Keynes, MK7 6AA, Regno Unito

	Contact person: Francesco Osborne
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6
SCHOLARSHIP 4	
TYPOLOGY	Innovative doctorates responding to the innovation needs of companies and promoting the recruitment of researchers by companies (M4C2 - Inv. 3.3)
RESEARCH PROJECT	Advanced methodologies and tools for image classification in the industrial field
PRINCIPAL INVESTIGATOR	Prof. Diego Reforgiato Recupero
DESCRIPTION OF DOCTORAL TRAINING	The PhD will investigate the most advanced AI techniques for image classification (i.e. ViT), to improve management of objects with robotic arms in industrial contexts. The work will adopt tools such as augmentation and annotation techniques, taxonomies for each object type, multilevel classifications (e.g. object category vs specific object), always guided by the Industry 5.0 paradigm "human in the loop". A demo platform will allow to validate the applicability of the results in the Industry.
COMPANY/RESEARCH INSTITUTION	R2m Solution s.r.l. Legal head office: Polo Tecnologico di Pavia, via Fratelli Cuzio 42, 27100 Pavia
NO. OF MONTHS TO BE SPENT IN THE COMPANY/RESEARCH INSTITUTION	6
FOREIGN INSTITUTION	Knowledge Media Institute of the Open University Legal head office: Walton Hall, Milton Keynes, MK7 6AA, Regno Unito Contact person: Francesco Osborne
NO. OF MONTHS TO BE SPENT IN THE FOREIGN INSTITUTION	6