POLITECNICO
MILANO 1863

PhD School - Politecnico di Milano

Regulations of the Ph.D. Programme in:

Data Analytics and Decision Sciences

Cycle XL

1. General Information

PhD School - Politecnico di Milano

Ph.D. Programme: Data Analytics and Decision Sciences

Course start: September 2024

Location of the Ph.D. Programme: Milano Leonardo and Milano Bovisa

Promoter Departments:

- Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB)
- Dipartimento di Ingegneria Gestionale (DIG)
- Dipartimento di Matematica (DMAT)

Scientific Disciplinary Sectors

- ING-INF/05: Information processing systems
- SECS-S/01: Statistics
- SECS-P/08: Management
- MAT/05: Mathematical Analysis
- MED/42: Hygiene and public health
- ING-IND/35: Business and Management Engineering
- ING-IND/17: Industrial Mechanical Systems Engineering
- ING-INF/06: Electronic and Informatics Bioengineering
- ING-INF/04: Systems and control engineering
- ING-INF/03: Telecommunications
- INF/01: Informatics

Areas

- Information Technology
- Management and public policies
- Statistics

Ph.D. School website: http://www.polimi.it/phd
Ph.D. programme website: https://phd-dads.polimi.it

2. General presentation

The Ph.D. programme in Data Analytics and Decision Sciences (DADS) aims at training highly qualified senior data scientists, data analysts and data managers capable of carrying out research at universities and research centers, international institutions, tech and financial companies, consultancies, regulatory authorities, and other public and private bodies.

The programme stems from the cooperation between three departments - Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB), Dipartimento di Ingegneria Gestionale (DIG), Dipartimento di Matematica (DMAT) - and the Health Data Science (HDS) Center at Human Technopole. It allows the enrolled students to work in a highly interdisciplinary environment with strong connections to international research centers and private companies. The programme provides successful candidates with the opportunity to acquire a high degree of professional expertise in specific scientific and technological fields.

The programme lasts three years: upon its successful completion and final exam, candidates will be awarded the title of Ph.D. in Data Analytics and Decision Sciences. The initial year is dedicated to two primary objectives: completing courses that cultivate a comprehensive competency and a robust interdisciplinary skill set essential for data analytics, and establishing the research plan. The following two years focus mainly on the development of the Doctoral thesis. Students are highly encouraged to undertake a semester (with a minimum duration of 3 months and a maximum of 18 months) at a research institution abroad, leveraging the extensive network of international collaborations fostered by the three departments participating in the programme. During this period, they may receive a 50% increase in their PhD fellowship for up to 6 months.

A Coordinator and a Faculty Board run the Ph.D. Programme. The Coordinator chairs the Faculty Board, coordinates the preparation of the annual Educational Programme, and organises the general educational activities of the Ph.D. course (see Attachment A1). The Faculty Board is responsible for the educational programme and administrative activities related to the Ph.D. course (see Attachment A2).

3. Objectives

The programme aims at breeding the next generation of data scientists who will tackle the challenges and the opportunities created by the increasing availability of massive amount of data in different fields of application, from health to mobility, from automation to environmental protection, from the design and operation of infrastructures to strategic investments. These data scientists will be able to capture the relevant aspects of phenomena at play in the specific domain knowledge under study, to develop adequate models, to supervise the development of analytic pipelines, to critically analyze the results, and to support the technological transfer.

Specifically, the primary focus of the PhD program in Data Analytics and Decision Science lies in data science. This entails the capacity to analyze massive datasets of high quality derived from diverse and varied sources of data, and to employ the most appropriate methodologies to extract valuable insights and address practical challenges across various application domains. For this purpose, methods and

approaches for data retrieval, fusion, and integration are explored in depth, along with analysis strategies tailored to address both well-defined and complex problems.

4. Professional opportunities and job market

Data Analytics and Decision Sciences graduates are equipped with unique skills and advanced knowledge that open up career opportunities at universities, international research centers and institutions, R&D departments, regulatory authorities, financial institutions, tech companies, consulting companies, and other public bodies.

Specifically, the main, but not unique, pillars of the DADS's PhD programme are:

- Data Science for healthcare domain
- Data Science for industry and technology development
- Data Science for mobility and urban sustainability
- Data Science for management, economics and finance

5. Enrolment

5.1 Admission requirements

Italian and International citizens can apply. They are requested to have graduated in accordance with the pre-existing laws D.M. 3.11.1999 n. 509, or to have a Master of Science degree in accordance with D.M. 3.11.1999 n. 509, or a Master of Science in accordance with D.M. 22.10.2004 n. 270, or similar academic title obtained abroad, equivalent for duration and content to the Italian title, with an overall duration of university studies of at least five years. The certified knowledge of the English language is a requirement for admission. Please refer to the Ph.D. School website for details. Admission to the programme will be established according to the evaluation of the candidate's curriculum, motivation letter, and an illustrative report about the development of a possible PhD research, which the candidate will send contextually with their application to the admission announcement.

5.2 Admission deadlines and number of vacancies

The number of positions is indicated in the Call for admission to the 40th PhD cycle programmes: http://www.polimi.it/phd

Scholarships on specific themes are available, in accordance with what is specified in the call for admission. Each year full scholarships are available for oriented research topics. Financial support for oriented topics is provided by private companies and research institutions like the Health Data Science Center at Human Technopole and Humanitas University. Annual support is also available for research periods abroad and to attend conferences.

6. Contents

6.1 Requirements for the PhD title achievement

The achievement of the PhD title in Data Analytics and Decision Sciences requires a study and research activity of at least three years equivalent of full-time study, research and development of a PhD thesis. PhD candidates in Data Analytics and Decision Sciences must earn a minimum of 30 course credits (see paragraph 6.3 below), and continuously conduct studies and research.
At the beginning of the course, the Faculty Board assigns one tutor to each PhD candidate to supervise and assist them in the overall training programme. The tutor shall be a professor belonging to the Faculty Board. The tutor assists the candidate in the choice of courses to be included in the study plan, which is eventually submitted for approval to the Coordinator of the PhD Programme (see also section 6.4 below). If necessary to enhance their preparation in specific topics relevant to their research projects, the Faculty Board has the authority to allocate additional course credits to one or more candidates. Candidates will be asked to demonstrate knowledge of the Italian language, equal to at least the A1 level of the Common European Framework of Reference for the knowledge of languages. This requirement is needed to register for the final exam. Italian native speakers and all those who can demonstrate knowledge of the Italian language to the required level will be exempt.

6.2 Research development

The main aim of Politecnico di Milano PhD programmes is the development in the candidates of a research-oriented mind-set, with expertise and skills in a specific research topic. To this end, candidates develop a problem-solving capability in complex contexts, including the ability to perform deep problem analysis, identify original solutions, and evaluate their applicability in practical contexts. These skills provide the PhD candidates with major opportunities of development in their research, both in the academic field and in public and private organizations. PhD candidates are requested to develop an original research contribution. The PhD thesis must thus contribute to increase the knowledge in the candidate's research field. Besides, it must be coherent with the research topics developed in the Departments where the PhD Programme is carried out. The original research results are collected in the PhD thesis, where the candidate's contribution is put in perspective with respect to the research state of the art in the specific research field.

The PhD research is developed under the guidance of two supervisors, who support the candidate in the thesis setting-out and in the everyday activities related to the thesis development. At least one of the supervisors must belong to the Politecnico di Milano. The other one may belong to an institution different from the Politecnico di Milano. These supervisors can be supported by an additional co-supervisor. Further activities intended to develop the candidate's personal skills and research expertise are encouraged during the PhD path. Candidates must acquire the capability to present and discuss their work in their research community. Consequently, both the participation to international conferences and the publication of the research results in peer-reviewed journals are encouraged. The PhD programme favors the candidates' research interactions with other groups in their research field, preferably abroad. Research visits of at least three months are strongly encouraged, as through them the candidates may acquire further skills to develop their research work and thesis.

6.3 Objectives and general framework of the teaching activities

The PhD Programmes and the PhD School activate teaching forms of different kind and credit value, including courses, seminars, project workshops, laboratories. Teaching activities encompass fundamental research topics, including problems, theories, and methods, which form the cornerstone of the PhD Programme, defining its cultural stance. Additionally, they delve into specialized research topics related to the issues explored in the theses, providing in-depth understanding. Lessons are held in English. Structured teaching activities allow to earn ECTS credits. Other specialized activities, which often pose challenges in assessing learning outcomes and quantifying them, are considered as part of the scientific endeavors by the Faculty Board during the annual evaluation. However, they do not contribute to earning ECTS credits. The PhD School of Politecnico di Milano proposes courses aiming to train the PhD candidates in soft and transferable skills. The skills and abilities provided by these courses are expected to help candidates across different areas of their careers in order to respond to the rapidly evolving needs of the global economy and society at large. Some of the PhD School courses activated for the 2024-2025 Academic Year are summarized in the following table:[1]

Professor	Course name
ALIVERTI ANDREA	ETHICS IN RESEARCH
ARMONDI SIMONETTA	STRENGTHENING CRITICAL SPATIAL THINKING
ARNABOLDI MICHELA	ADVANCED INTERACTION SKILLS FOR ACADEMIC PROFESSIONALS
BISCARI PAOLO	INDUSTRIAL SKILLS
BISCARI PAOLO	ENGLISH FOR ACADEMIC COMMUNICATION
BISCARI PAOLO	SCIENTIFIC COMMUNICATION IN ENGLISH
BISCARI PAOLO	RESEARCH SKILLS
BOBADILLA RODRIGUEZ HERNAN FELIPE	SCIENTIFIC MODELS: CONCEPTUAL FOUNDATIONS AND PHILOSOPHICAL ISSUES
BOERI ELISA	RECORDING WORK 4 BUILDING MEMORY: METHODS, PRACTICES, TOOLS, SKILLS TO MANAGE THE KNOWLEDGE
BROVELLI MARIA ANTONIA	THE COPERNICUS GREEN REVOLUTION FOR SUSTAINABLE DEVELOPMENT
BRUNETTO DOMENICO SAVIO	INNOVATIVE TEACHING SKILLS
CANINA MARIA RITA	CREATIVE DESIGN THINKING
CARDILLI LORENZO	EUROPEAN CULTURE
COLOMBO GABRIELE	RESEARCH COMMUNICATION. ISSUE MAPPING: EXPLORING PUBLIC DEBATES SURROUNDING ACADEMIC TOPICS
CONCI CLAUDIO	COMMUNICATION STRATEGIES THAT SCORE IN WORLDWIDE ACADEMIA
DI BLAS NICOLETTA	PROFESSIONAL COMMUNICATION
FUGGETTA ALFONSO	PROJECT MANAGEMENT BASICS
HESSELBEIN CHRISTOPHER LORENZ	TECHNOLOGY AND SOCIETY
IAROSSI MARIA POMPEIANA	POWER OF IMAGES AND VISUAL COMMUNICATION FOR RESEARCH DISSEMINATION

[1] The updated list of PhD School courses is available at http://www.dottorato.polimi.it/en/during-your-phd/phd-level-courses/

LAVAGNA MONICA	SUSTAINABILITY METRICS, LIFE CYCLE ASSESSMENT AND ENVIRONMENTAL FOOTPRINT
MANCINI MAURO	PROJECT MANAGEMENT (IN ACTION)
MASARATI PIERANGELO	ETHICAL ASPECTS OF RESEARCH ON DUAL
OPPIO ALESSANDRA	HOW TO SUPPORT COMPLEX DECISIONS: APPROACHES AND TOOLS
OSSI PAOLO MARIA	SULLA RESPONSABILITÀ DELLA TECNICA
PAGANONI ANNA MARIA	LA COMUNICAZIONE NELLA SCIENZA
PARMEGGIANI FABIO	SCIENCE, TECHNOLOGY, SOCIETY AND WIKIPEDIA
PIZZOCARO SILVIA LUISA	PRACTICING RESEARCH COLLABORATION
ROCCHI DANIELE	ETHICS OF ARTIFICIAL INTELLIGENCE
SANCASSANI SUSANNA	TEACHING METHODOLOGIES, STRATEGIES AND STYLES
SHENDRIKOVA DIANA	SCIENCE DIPLOMACY FOR RESEARCHERS. FILLING THE GAP BETWEEN SCIENCE AND POLICY WITHIN THE GLOBAL CHALLENGES
VOLONTE PAOLO GAETANO	INTRODUCTION TO ACADEMIC RESEARCH

At least 10 of the 30 course credits that each candidate is required to earn shall be obtained through soft and transferable skills courses organized by the PhD School. The tables below summarize the candidate's path (as regards coursework activities). At the same time, the programme foresees that the candidates are devoted to research activity in a continuous way, following the lead of their supervisors, and of the Faculty Board.

First/Second Year

Courses	Details or Reference	Number of credits (min-max)	Note
PhD School Courses	See table and School website	10	
Courses characterizing the PhD Programme		15-20	
Other PhD courses	Summer/Winter Schools Reading Courses Elective Ph.D. courses	0-5	To be agreed in advance with the tutor

Third year

The third year should be devoted entirely to the research and to the development of the PhD thesis.

PhD Course List

A. The PhD Programme in Data Analytics and Decision Sciences organizes the three **Characterising Mandatory Courses** listed in Table A that must be completed by the end of the first year.

B. The PhD School organizes every year general and inter-doctoral courses. The acquisition of **at least 10 credits** is **mandatory** among the courses of B type. The updated list of PhD courses organized by the PhD School is available at the website http://www.dottorato.polimi.it/en/during-your-phd/phd-school-courses

C. Up to 5 credits can be obtained by choosing among courses provided by other PhD programmes at Politecnico di Milano or external Institutions. These courses must be agreed in advance with the tutor and can be chosen according to the specific scientific domain the candidate is specializing in. A tentative list of pre-approved courses is listed in Table B.

PREPARATORY COURSES (only if foreseen)

If useful or necessary, the Faculty Board of the PhD Programme may assign some extra-credits to the PhD candidate to be acquired to complete the training path. The credits acquired in this way will be considered as additional, in relation to the mandatory credits to be acquired with the PhD courses.

SPECIALISTIC COURSES, LONG-TRAINING SEMINARS

The attendance of Specialist Courses, Workshops, Schools, Seminars cycles is strongly encouraged and (if these seminars, workshops are certified and evaluated) may permit to acquire credits according the modalities established by the Faculty Board and previous approval of the study plan submitted by the candidate. These courses and workshops can be inserted in the study plan, even if they are not evaluated (and therefore not qualified as credits), as optional "additional teaching".

The scheduled course planning for the first academic year follows. Other courses may be activated during the year. In this case the candidates will be promptly informed and will be allowed to insert these new courses in their study plan.

Table A: PHD COURSES CHARACTERISING THE PHD PROGRAMME

SSD	Name of the Course	Professor	Language	Credits
ING-IND/35	Analytics for Society	Andrea Flori	English	5
SECS-S/01	Statistical Inference for the Information Age	Piercesare Secchi Simone Vantini	English	5
ING-INF/06	Geospatial Data Science for Environmental Health	Lorenzo Gianquintieri Enrico Gianluca Caiani	English	5

Table B: SUGGESTED CROSS –SECTORAL COURSES

Name of the Course	Language	Credits
Advanced Deep Learning Models and Methods for 3D spatial data	English	5
Advanced Modelling in Signal Image and Data Analysis	English	5
AI Methods for Bioengineering Challenges	English	5
Biostatistics and Experimental Design	English	5
Introduction and Research Perspective on Business Process Mining	English	5
Mathematical and numerical foundations of scientific machine learning	English	5
Online Learning and Monitoring	English	5
Software Engineering for ML and ML for Software Engineering	English	5

6.4 Presentation of the study plan

PhD candidates must submit a study plan, which may be revised periodically (approximately every three months), in order to adequate them to possible changes in the course list, or to needs motivated by the development of their PhD career. The study plan must be approved by the PhD Programme Coordinator, according to the modalities established by the Faculty Board of the PhD Programme itself.

6.5 Yearly evaluations

Candidates present their work to the Faculty Board once a year. In particular, the candidates must pass an annual evaluation in order to be admitted to the following PhD year. The third-year evaluation establishes the candidate's admission to the final PhD defense.

As a result of each annual evaluation, the candidates who pass the exam receive an evaluation (A/B/C/D) and may proceed with the enrolment to the following year. Candidates who do not pass the exam are qualified either as “Repeating candidate” (Er) or “not able to carry on with the PhD (Ei)”. In the former case (Er), the candidates are allowed to repeat the PhD year at most once. The PhD scholarships – if any – are suspended during the repetition year. In the latter case (Ei) the candidates are excluded from the PhD Programme and lose their scholarships – if any. If the Faculty Board deems it appropriate to directly assign an exclusion evaluation (Ei) without requiring a repeat year, the request must be substantiated adequately and endorsed by the PhD School. After the final year, candidates who have achieved sufficient results but need more time to draw up their theses, may obtain a prorogation of up to 12 months, but these are not covered by the Scholarship funding their PhD.

6.6 PhD thesis preparation

The main objective of the PhD career is the development of an original research contribution. The PhD thesis is expected to contribute to the advance of knowledge in the candidate's research field. The PhD study and research work is carried out, full time, during the three years of the PhD Programme. Stages or study periods in (Italian or International) companies or external Institutions may complete the candidate's preparation. The resulting thesis need to be coherent with the research developed in the Departments where the PhD programme is developed. The candidate is required to present an original thesis and engage in discussions with the pertinent research community regarding its contribution to the current state of research within the field. The PhD research is developed following the lead of their supervisors, who support the candidate in the setting out and in the everyday activities regarding the thesis development. At the conclusion of the PhD studies, the Faculty Board evaluates the candidates. Candidates who receive a positive evaluation submit their theses to two external reviewers for

refereeing. If the evaluation provided by the reviewers is positive (o after the revisions required by the external reviewers), the candidates defend their thesis in a final exam, in front of a Committee composed of three members (at least two of which must be external experts).

7. Laboratories, PhD Secretary Services

The secretary service of the PhD programme can be reached by at phd-dads@polimi.it

8. Internationalization and inter-sectoriality

Carrying out study and research activities at external laboratories is strongly recommended.
Politecnico di Milano supports joint PhD paths with International Institutions, as well as Joint and Double PhD programmes. Further information is available on the PhD School website and on the PhD programme website.

More specifically, the PhD programme in Data Analytics and Decision Sciences collaborates with the Health Data Science (HDS) Center of Human Technopole. Engaging with and being exposed to non-academic sectors offer substantial advantages for doctoral candidates, as well as for industries focused on research and innovation-intensive employment. Direct exposure to the challenges and opportunities in non-academic sectors of the economy and society at large is fostered by networking, connectivity, inter-sectoral mobility and wide access to knowledge.

Attachment A1 – PhD Programme Coordinator

Piercesare Secchi is Professor of Statistics at the Department of Mathematics, Politecnico di Milano, member of MOX, the departmental laboratory in modelling and scientific computing, and head of the faculty board of the Data Analytics and Decision Science PhD program of Politecnico di Milano. He was born in Milano, Italy, in 1962. In 1988 he received the Laurea cum Laude in Mathematics from the Università di Milano, in 1993 the Doctorate in Methodological Statistics from the Università di Trento and in 1995 the Ph.D. in Statistics from the University of Minnesota. From 1991 to 1997 he has been Assistant Professor in Statistics at the Università di Pavia while from 1998 to 2004 he has been Associate Professor in Probability at the Politecnico di Milano, where he became Full Professor of Statistics in 2005. From 2009 to 2016 he served as Director of the Department of Mathematics of the Politecnico di Milano; from 2011 to 2016 he has been a member of the Academic Senate of Politecnico di Milano and the Rector's delegate for clusters and consortia. During the last three decades, he has taught scores of courses in different areas of statistics and probability, at the bachelor, master and doctoral level; today he is in charge of two courses in Applied Statistics, respectively for the master programs in Mathematical Engineering and in Management Engineering at Politecnico di Milano, whereas every other year he teaches a course in Statistical Inference in the Computer Era for the doctoral program in Data Analytics and Decision Sciences at Polimi. He has been the thesis advisor of many master students graduating in Economics, Mathematics, Mathematical Engineering and Mangament Engineering, as well as many doctoral students in Statistics. His recent research interests focus on statistical methods for object oriented spatial statistics, classification of complex data, functional data analysis, data fusion and integration. He is member of the Società Italiana di Statistica, of the Institute of Mathematical Statistics and of the American Statistical Association. He joined many different important research projects both privately and publicly funded. He coordinated the statistical unit within the Aneurisk Project, financed by Siemens Medical Solutions and Fondazione Politecnico, for the functional data analysis of inner carotid centrelines aiming at the evaluation of aneurysms rupture risk. He directed the research activity sponsored by the Italian Regulatory Authority for Electricity and Gas (AEEG) for the development of statistical models and methods aiming at quality of service evaluation and control in energy distribution. He has been principal investigator for different blue sky research projects financed by ENI, by Terna, by ATM and by Trenord at the Politecnico di Milano. He contributed to the development of Urbanscope, a new macroscope for the analysis of the digital traces generated by urban systems, and is now member of the Trespassing transdisciplinary research group at the Politecnico di Milano. He is among the founders of Moxoff, a spin-off of the Politecnico di Milano; since 2010 Moxoff employs mathematics, statistics, numerical analysis and advanced algorithms and software to develop scientific models for business. From 2011 to 2021 he has been member of the board of MIP, the Business School of the Politecnico di Milano. He has been member of the board of CISE in the years 2013-2018. From 2015 to 2019 he was President of the European Center for Nanomedicine (CEN). In 2017, he was part of the expert team Casa Italia, the mission structure of the Italian Government dedicated to prevention and security against natural risks. From 2017 to 2020 he has been coordinator for Polimi of the Center for Analysis, Decision and Society (CADS), a joint research center between Politecnico di Milano and the Human Technopole research infrastructure based in MIND, Milano.

Attachment A2 – Ph.D. Faculty Board

Description of the composition of the Faculty Board

Name	Affiliation	Scientific Disciplinary Sector
Secchi Piercesare (coordinator)	DMAT	SECS-S/01 - Statistica
Azzone Giovanni	DIG	ING-IND/35 - Ingegneria Economico-Gestionale
Caiani Enrico Gianluca	DEIB	ING-INF/06 - Bioingegneria Elettronica E Informatica
Ceri Stefano	DEIB	ING-INF/05 - Sistemi Di Elaborazione Delle Informazioni
Di Angelantonio Emanuele	Fondazione Human Technopole	MED/42
Flori Andrea	DIG	ING-IND/35 - Ingegneria Economico-Gestionale
Ieva Francesca	DMAT	SECS-S/01 - Statistica
Lanzi Pierluca	DEIB	ING-INF/05 - Sistemi Di Elaborazione Delle Informazioni
Matteucci Matteo	DEIB	ING-INF/05 - Sistemi Di Elaborazione Delle Informazioni
Orsenigo Carlotta	DIG	INF/01 - Informatica
Punzo Fabio	DMAT	MAT/05 - Analisi Matematica
Roveri Manuel	DEIB	ING-INF/05 - Sistemi Di Elaborazione Delle Informazioni
Spagnolini Umberto	DEIB	ING-INF/03 - Telecomunicazioni
Tanelli Mara	DEIB	ING-INF/04 - Automatica
Tubaro Stefano	DEIB	ING-INF/03 - Telecomunicazioni
Tumino Angela	DIG	ING-IND/17 - Impianti Industriali Meccanici
Vantini Simone	DMAT	SECS-S/01 - Statistica