



POLITECNICO
MILANO 1863

PhD School - Politecnico di Milano
Regulations of the PhD Programme in:
Data Analytics and Decision Sciences
Cycle XXXVIII

1. General Information

PhD School - Politecnico di Milano

PhD Programme: Data Analytics and Decision Sciences

Course start: November 2022

Location of the PhD Programme: Milano Leonardo and Milano Bovisa

Promoter Department:

- 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/01: Medical Statistics
- 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

Areas

- Information Technology
- Management
- Statistics

PhD School website: <http://www.polimi.it/phd>

Ph.D. programme website: <https://phd-dads.polimi.it>

2. General presentation

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

The program 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 Center for Health Data Science at Human Technopole. It gives the enrolled students the opportunity to work in a highly interdisciplinary environment with strong connections to international research centers and private companies. The program provides successful candidates with the opportunity to acquire a high degree of professional expertise in specific scientific and technological fields.

The program lasts three years: upon its successful completion and final exam, candidates will be awarded the title of PhD in Data Analytics and Decision Sciences. The first year is devoted to the courses that build the broad competence and the strong interdisciplinary set of skills required by data analytics. The next two years focus on the development of the Doctoral thesis. Students are required to spend at least one semester in a research institution abroad, taking advantage of the network of international collaborations of the three departments involved in the program.

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

3. Objectives

The program 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. These data scientists will be able to capture the relevant aspects of phenomena at play, develop adequate models, supervise the development of analytic pipelines, critically analyze the results, and support the technological transfer.

4. Professional opportunities and job market

Data Analytics and Decision Sciences graduates are equipped with distinctive 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, and other public bodies.

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 PhD School website for details. The admission to the programmes will be established according to the evaluation of the candidates' curricula, motivation letters, and an illustrative report about the development of a possible PhD research, which candidates 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 38th 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 Center for Health Data Science at Human Technopole and Humanitas University. Limited 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 PhD thesis. PhD candidates in Data Analytics and Decision Sciences must earn a minimum of 30 course credits (see paragraph 6.3 below), and to 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 him/her in the overall training programme. The tutor shall be a professor belonging to the Faculty Board. The tutors assist the candidates 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). The Faculty Board may assign extra course credits to one or more candidates, in case they need to complete their preparation in specific topics, relevant for their research projects.

6.2 Research development

The main aim of all 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 capacity of performing deep problem analysis, identifying original solutions, and evaluating 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 has to be coherent with the research topics developed in the Department 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 setting-out and in the everyday activities related to the thesis development. At least one of the supervisors must belong to one of the three founding departments (DEIB, DIG, and DMAT). The other one may also belong to an institution different from 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. The duration of the programme is normally three years.

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 both cover the basic research issues (problems, theories, methods), which represent the founding element of the PhD Programme and identify clearly its cultural position and deepening in a specialist way some research issues connected with the problems developed in the theses. Lessons are usually held in English, except when indicated otherwise. The PhD programme includes at least one complete path delivered in English language. Structured teaching activities allow to earn ECTS credits. Other activities, typically specialised and for which it is difficult to evaluate the learning and its quantification, fall within the scientific activities of which the Faculty Board takes into account in the overall evaluation, but they do not allow to earn ECTS. The PhD School of Politecnico di Milano proposes a set of 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 2022-2023 Academic Year are summarized in the following table:¹

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

| Professor | Course name |
|----------------------------|---|
| Armondi Simonetta | Strengthening Critical Spatial Thinking |
| Biscari Paolo | English for Academic Communication |
| Biscari Paolo | Industrial Skills |
| Biscari Paolo | Scientific Communication in English |
| Brunetto Domenico | Innovative Teaching Skills |
| Canina Maria Rita | Creative Design Thinking |
| Cardilli Lorenzo | European Culture |
| Di Blas Nicoletta | Professional Communication |
| Fuggetta Alfonso | Project Management Basics |
| Oxoli Daniele | The Copernicus Green Revolution for Sustainable Development |
| Iarossi Maria Pompeiana | Power of Images and Visual Communication for Research Dissemination |
| Masarati Pierangelo | Ethical Aspects of Research on Dual-Use Technologies |
| Mauri Michele | Research Communication. Issue mapping: exploring public debates surrounding academic topics |
| Ossi Paolo Maria | Sulla responsabilità tecnica |
| Oppio Alessandra | How to support Complex decisions: Approaches and Tools |
| Paganoni Anna Maria | La comunicazione nella Scienza |
| Pizzocaro Silvia Luisa | Practicing Research Collaboration |
| Raos Guido | Science, Technology, Society and Wikipedia |
| Sancassani Susanna | Teaching Methodologies, Strategies and Styles |
| Sciuto Donatella | Research Skills |
| Volonte' Paolo Gaetano | Introduction to Academic Research |
| Mancini Mauro | Project Management (In Action) |
| Tanelli Mara | Cognitive biases and discriminations: implications, risks and opportunities |
| Balducci Alessandro | Approaches to Resilience: Social, Economic, Environmental and Technological Challenges of Contemporary Human Settlements Modeling and Automated Verification of Real-Time Systems |

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 Courses** listed in Table A that must be completed by the end of the first year.
- B. The PhD School organises every year general and Interdoctoral courses. The acquisition of **at least 10 credits** is **mandatory** among the courses of B type. The 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. A maximum of 5 ECTS can be obtained by choosing among courses provided by other PhD programmes at Politecnico di Milano and/or external Institutions. These courses must be agreed in advance with the tutor. A tentative list of pre-approved courses is listed in Table B.

PREPARATORY COURSES (only if foreseen)

If the supervisor and the tutor find it useful or necessary, that the candidate attends preparatory courses (chosen among the activated courses at the Politecnico di Milano) the Faculty Board of the PhD programme may assign some extra-credits 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 |
| ING-INF/05 | Interpretability and Explainability in Machine Learning | Daniele Loiacono | English | 5 |
| SECS-S/01 | Statistical Inference for the Information Age | Piercesare Secchi | English | 5 |

Table B: SUGGESTED CROSS –SECTORAL COURSES

| Name of the Course | Language | Credits |
|---|----------|---------|
| Biostatistics and Experimental Design | English | 5 |
| Dealing with uncertainty in data-based learning | English | 5 |
| Data-Driven Approaches to Uncertain Optimization and Decision-Making: Theory and Applications | English | 5 |
| Models of Opinion Dynamics in Social Networks | English | 5 |
| Data management and analysis for computational biology | English | 5 |
| Advanced Topics in Deep Learning: The rise of Transformers | English | 5 |
| Human-Computer Interaction for AI (HCI4AI) | English | 5 |
| Parallel computing on traditional core-based and emerging GPU-based architectures through OpenMP and OpenACC/CUDA | English | 5 |
| Innovation Management and Economics | English | 5 |
| Modelling and Data Analysis of Complex Systems | English | 5 |
| Survey and Experimental research methodologies | 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 plans 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 at least 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 at 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. In case the Faculty Board holds appropriate to assign directly an exclusion evaluation (Ei) without a previous repetition year, the request must be properly motivated, and validated 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.

6.6 PhD thesis preparation

The main objective of the PhD career is the development of an original research contribute. The PhD thesis is expected to contribute to the advance of the 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 course. Stages or study periods in (Italian or International) companies or external Institutions may complete the candidate's preparation. The resulting theses need to be coherent with the research issues developed in the Department where the PhD programme is developed. The candidate must present an original thesis, discuss its contribution to the state of the art in the research field in the research community. The PhD research is developed following the lead of a supervisor, who supports 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 Center for Analysis Decisions and Society (CADS) an international research center dedicated to the elaboration and analysis of the analyzing high-throughput data provided by the Human Technopole. Interaction with and exposure to non-academic sectors provides significant benefits to doctoral candidates as well as to research and innovation intensive employment sectors. 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

Pierluca Lanzi is full professor at Politecnico di Milano, Dipartimento di Elettronica, Informazione e Bioingegneria, School of Industrial Engineering and Information. He has been working in the area of Data Mining since 1995, when he did an internship in the Data Mining group of CSELT laboratories. He received his Ph.D. in 1999 with a thesis on Genetics-Based Machine Learning. His research interests include data mining, machine learning, and data-driven game design. He published several papers in international journals and conferences. He has been the editor-in-chief of ACM SIGEvolution from 2006 to 2014. He has served as associate editor of Applied Soft Computing (Elsevier), Evolutionary Computation (MIT Press), and IEEE Transactions on Computational Intelligence and AI in Games. He served as general chair of the 2009 IEEE Symposium on Computational Intelligence and Games (IEEE CIG- 2009) and the 2011 ACM Genetic and Evolutionary Computation (ACM GECCO-2011).

Attachment A2 – PhD Faculty Board

Description of the composition of the Faculty Board

| Name | Affiliation | Scientific Disciplinary Sector |
|------------------------------|------------------|--------------------------------|
| Lanzi Pierluca (coordinator) | DEIB | ING-INF/05 |
| Azzone Giovanni | DIG | ING-IND/35 |
| Caiani Enrico Gianluca | DEIB | ING-INF/06 |
| Ceri Stefano | DEIB | ING-INF/05 |
| Di Angeloantonio Emanuele | Human Technopole | MED/42 |
| Flori Andrea | DIG | ING-IND/35 |
| Guerini Massimiliano | DIG | ING-IND/35 |
| Ieva Francesca | DMAT | SECS-S/01 |
| Mangiaracina Riccardo | DIG | ING-IND/17 |
| Matteucci Matteo | DEIB | ING-INF/05 |
| Punzo Fabio | DMAT | MAT/05 |
| Roveri Manuel | DEIB | ING-INF/05 |
| Secchi Piercesare | DMAT | SECS-S/01 |
| Spagnolini Umberto | DEIB | ING-INF/03 |
| Tanelli Mara | DEIB | ING-INF/04 |
| Tubaro Stefano | DEIB | ING-INF/03 |
| Vantini Simone | DMAT | SECS-S/01 |