Data Science - Engineering of Intelligent Systems

PACE UNIVERSITY - CAMPUS BIO-MEDICO UNIVERSITY

Program description

The Program title will allow Students to obtain the Master of Science Degree in "Data Science" ("US Degree") from PACE and the Master's Degree in "Engineering of Intelligent Systems" ("Italian Degree") from UCBM. The Program aims to fully integrate Italian, US, and foreign students and professors and will be open to students of all nationalities. All courses and activities will be in English at both PACE and UCBM.

a. The duration of the Program for each Student will be two (2) years (four full-time semesters).
b. Administrative offices of the Program will be at PACE and UCBM. The staffing and location of such offices will be determined by each institution in its sole discretion.
c. Students moving to PACE from Italy will be allowed transfer of up to twelve (12) American credits (36 Italian CFU) from UCBM to PACE, which will count towards the fulfillment of the US Degree requirements, and eighteen (18) American credits (54 Italian CFU) from PACE to UCBM, which will count towards the fulfillment of the Italian Degree requirements. Students moving to UCBM will be allowed transfer of up to eighteen (18) credits from PACE to UCBM, which will count towards the fulfillment of the Italian Degree requirements. Further details on the study plan and credit transfers are listed Section 3.1 and 3.2 of this Agreement.
d. Students moving to UCBM from USA will be allowed transfer of up to twenty-one (21) credits (60 Italian CFU) from PACE to UCBM, which will count towards the fulfillment of the Italian Degree requirements, and twelve (12) American CFU (36 Italian CFU) from UCBM to Pace, which will count towards the fulfillment of the US Degree requirements. Students will be allowed transfer of up to eighteen (18) credits from PACE to UCBM, which will count towards the fulfillment of the Italian Degree requirements. Further details on the study plan and credit transfers are listed Section 3.1 and 3.2 of this Agreement.
e. The departmental coordinators of each institution shall have the role of academic advisor to all incoming students to the Program during their academic activities at both institutions.

Enrollment criteria

All students can apply to the program, but they must have completed all 1st year exams according to Section 3.1 and 3.2 of this Agreement, before their departure to the foreign institution. Students from Italy will apply using the PACE online application tool and must provide a certified TOEFL score as part of the application process for the VISA requirement. Students who are admitted by PACE will be enrolled in the MSc in "Data Science"

Students from USA will apply using UCBM online application. UCBM will admit students who are enrolled as full-time graduate students at PACE who apply for participation in the Program. PACE students entering the program will be enrolled in the Master's Degree programme in "Engineering of Intelligent Systems" at UCBM.

Responsibilities of students

a. Each Student will abide by the laws and customs of the host country and by the policies and regulations of the host institution.

b. The host institution will have the right to terminate the participation of any Student in the Program (and in any other program, service or benefit of the host institution) if at any time, and in the sole judgment of the host institution, such Student fails to maintain satisfactory academic performance or violates the policies of the host institution. The host institution will inform the other institution of any such action, subject to applicable law.

c. Each Student must either purchase medical insurance required by the host institution or demonstrate to the satisfaction of the host institution that the medical insurance carried by or on behalf of such Student is sufficient for all purposes of the host institution.

d. Each Student is required to have proof of immunizations satisfactory to the host institution in order to participate in the Program.

e. The cost of any medical insurance or immunizations required pursuant to this Agreement as well as any medical expenses or immunizations not covered by such insurance will be the personal responsibility of the Student.

f. Each Student is fully responsible for making personal travel arrangements related to the Program.

g. Each Student is fully responsible for all personal expenses related to the Program, including but not limited to textbooks, supplies, room and board, and travel costs.

h. Each Student is fully responsible for all charges related to room and board. The Student may withdraw from the Program at any time, but will be subject to the refund policy of PACE.

PROGRAM STRUCTURE

General Program Rules

Level	Master of Science
Duration	2 years
Partner Universities	Pace University and Campus Bio-Medico University

Degrees obtained	If compliant with both UCBM and Pace academic requirements: ● UCBM students will obtain the MS in Data Science (issued by Pace) and the MS in Engineering of Intelligent Systems (issued by UCBM) ● Pace students will obtain the MS in Data Science (issued by Pace) and the MS in Engineering of Intelligent Systems (issued by UCBM) * Pace degree must always be completed first
Number of students	There is not a minimum of maximum number of students that will move from and to UCBM and Pace. However, both University will properly advertise this program on their official webpages.
Grade/Course Recognition	The tables below describe the students' mobility scenario and the activities to be completed are listed. The academic activities recognized by the partner university will be transferred according to a conversion tables commonly agreed between UCBM and Pace.
Tuition Fees	Students will be charged the tuition fees applicable at the institution where they study and are registered as in attendance. Students will themselves be responsible for any expenses incurred as a result of their participation in the Programme, e.g. travel and accommodation.
Academic Calendar	UCBM ● Semester 1 (Fall Semester): from late September to late January ● Semester 2 (Spring Semester): from early March to early June ● Summer Break: from early July to early September Pace ● Semester 1 (Fall Semester): from early September to end of December ● Semester 2 (Spring Semester): from end of January to half of May ● Summer semester: from half of May to half of July (Summer I) and from half of July to end of August (Summer II)

Mobility Structure

UCBM students	Year 1: UCBM (Intelligent System Engineering MS) Year 2: Pace (Data Science MS)
Pace students	Year 1: Pace (Data Science MS) Year 2: UCBM (Intelligent System Engineering MS)

UCBM students must apply to Pace program before the start of the Spring Semester of the first year (March 1st). They must complete the TOEFL (Pace University TOEFL code 2635, with a minimum grade requirement of TOEFL iBT® score of 78 or TOEFL® Essentials™ score of 8.5). The J1 Visa application, required to study in

USA, must be completed by the end of the Spring Semester of the first year (June 1st). The application to Pace dorms should be completed before the start of the Spring Semester of the first year (March 1st), and all the students coming from Italy will be accommodated together in the room if available. Students may contact the Pace international students office for further details.

Pace students must apply to UCBM program before the start of the Spring Semester of the first year (March 1st). The Italian Visa application, required to study in Italy, must be completed by the end of the Spring Semester of the first year (June 1st). The application to UCBM dorms should be completed before the start of the Spring Semester of the first year (March 1st), and all the students coming from USA will be accommodated together in the room if available. Students may contact the UCBM International Students Office for further details.

Final Thesis

- Students must respect the thesis procedures and deadlines from UCBM.
- Students will draft their theses during their mobility period with one UCBM supervisor.
- Students will defend their theses only at UCBM at one of the available graduation sessions: July, October, December, February or May.

ACADEMIC SCOPE

UCBM students moving to Pace

Year 1 at UCBM for Italians

Course taken at UCBM	Semester	ECTS	Recognition for Pace Degree	Credits
Digital Twins for Control, Automation and Predictive Maintenance	1	9	IT 600 Overview of Computer Networks and Internet Technology	3
Models and methods for optimization and statistics	1	9	CS 660 Mathematical Foundations of Analytics	**3**
Distributed system architecture	2	9	CS 642 Network Programming and Distributed Applications	3
Fundamentals of Artificial Intelligence: developments tools and methods	2	15	CS 672 Introduction to Deep Learning	3
Fundamentals of Cybersecurity	2	9		
Fundamentals of Robotics	2	9		
English language (TOEFL) (recognized for General English exam)	1	3		
		63	**4 COURSES TRANSFERRED TO PACE**	**12**

Year 2 at Pace for Italians

Course taken at Pace	Semester	Credits	Recognition for UCBM Degree	ECTS
CS 673 Scalable Databases	1	3	Generative AI	6

CS 675 Introduction to Data Science	1	3	Innovazione e trasformazione digitale	6
CS 619 Data Mining	1	3	Deep Learning	6
CS 677 Machine Learning	2	3	Smart Systems	6
CS 676 Algorithms for Data Science	2	3	Ethical Hacking	6
CS 668 Analytics Capstone Project	2	3	Thesis (first part) + Il fattore umano per la trasformazione digitale	9
			Thesis integration (back in Italy)	18
		18		**57**

Students must first finalize the Degree at Pace and only in a second stage at UCBM.

Pace students moving to UCBM

Year 1 at Pace for Americans

Course taken at Pace	**Semester**	**Credits**	**Recognition for UCBM Degree**	**ECTS**
CS 673 Scalable Databases	1	3	Distributed system architecture	9
CS 675 Introduction to Data Science	1	3	Fundamentals of Cybersecurity	9
CS 619 Data Mining	1	3	Digital Twins for Control, Automation and Predictive Maintenance	9
CS 677 Machine Learning	2	3	Fundamentals of Artificial Intelligence: developments tools and methods	15
CS 676 Algorithms for Data Science	2	3	Fundamentals of Robotics	9
CS 668 Analytics Capstone Project	2	3	Innovation and digital transformation + Human Factor in Digital Transformation + General English	12
CS 660 Mathematical Foundations of Analytics	2	3	Models and methods for optimization and statistics	9
		21		**72**

Year 2 at UCBM for Americans

Course taken at UCBM	**Semester**	**ECTS**	**Recognition for Pace Degree**	**Credits**
Smart systems	1	6	CS 671 Computer Vision	3
Ethical Hacking	1	6	CYB 651 Cyber Intelligence Analysis & Modeling	3
Generative AI	1	6	CS 677 Machine Learning	3
Deep Learning	1	6	CS 672 Introduction to Deep Learning	3
Thesis	2	24		
		48	**4 COURSES TRANSFERRED**	**12**

Students must first finalize the Degree at Pace and only after at UCBM Bio-Medico.

APPLICATION PROCESS

UCBM students moving to Pace

- By December 15th (first semester first year) Italians students going to Pace in September of the following year (first semester second year) must apply on the online Pace website following the instruction of the host institution.
- Upon the approval of the application, each student must apply for USA J1 (student) VISA. Among the mandatory documents TOEFL English certification is needed. TOEFL code for Pace University (New York City Campus) is 2635. Students must reserve and exam date in accordance with the deadlines for the VISA interview. The VISA must be obtained within July (before the start of the first semester second year).
- UCBM students must compile the Study Plan by selecting the courses according to this agreement, and with the due date as per traditional students.
- Final confirmation of students admission to Pace is bounded by the completion of all the courses at UCBM within July (before the start of the first semester second year).
- Transfer students from UCBM must pay the tuition fees before the beginning of each semester of the second year at PACE, and will continue to pay a reduce tuition fee for the second year at UCBM

- UCBM will send the transcript of records to Pace within September (first semester second year) to allow the credit transfer.
- Pace will complete the recognition of the transfer credits from Italy, as per this agreement, within December (first semester second year).
- Once graduated at Pace, students will come back in Italy to discuss the thesis and obtain the Italian degree, according to fees and requirements as Italian students not participating in the programs.

Pace students moving to UCBM

- By October 30th (first semester first year) Pace students going to UCBM in September of the following year (first semester second year) must apply to the UCBM Italian program on the online Italian website Universitaly as per the instruction reported in the link https://www.studiare-in-italia.it/studentistranieri/.
- By November 30th (first semester first year) Pace students going to UCBM in September of the following year (first semester second year) must apply on the online Italian website Universitaly for the VISA request as per the instruction reported in the link https://www.studiare-in-

italia.it/studentistranieri/. Pace students are exempt from the academic prerequisite requirements for the enrolment in the UCBM degree (as per point 4 of the UCBM Academic Directive Regulation).

- Transfer students from PACE must pay the tuition fees before the beginning of each semester of the second year at UCBM.
- PACE students must compile the Italian Study Plan by selecting the courses according to this agreement, and with the due date as per traditional Italian students (once in Italy).
- PACE will send the transcript of records (in case PACE students will earn the Italian degree) to UCBM within September (first semester second year) to allow the credit transfer.
- UCBM will complete the recognition of the transfer credits from USA, as per this agreement, within December (first semester second year).
- Once graduated at Pace, students will come back in Italy to discuss the thesis and obtain the Italian degree, according to fees and requirements as Italian students not participating in the programs.

ADDITIONAL ACADEMIC ACTIVITIES

Pace summer courses and internship

UCBM students can attend summer courses and internship programs at Pace University always with a 15% discount in tuition and housing fees.

UCBM semester abroad and thesis

Pace students can attend single courses as well as to conduct a thesis/project at Campus Bio-Medico University during a semester in Italy.

GRADES EQUIVALENCE

Transfer courses will follow the following grades equivalence.

Courses transferred from Italy to USA		**Courses transferred from USA to Italy**	
30 cum laude - 30/30	A	A	30 cum laude
28 - 29/30	A-	A-	29
26 - 27/30.	B+	B+	27
24 - 25/30	B	B	25
22 - 23/30	B-	B-	23
20 - 21/30	C+	C+	21
18 - 19/30	C	C	19

SYLLABUS FOR THE TRANSFER STUDENTS

Pace University courses

CS 673 Scalable Databases (3 credits) - Fall

After reviewing relational databases and SQL, students will learn the fundamentals of alternative data storage schemas to deal with large amounts of data (structures and unstructured). The course covers big data and the development of the Hadoop file system, the MapReduce programming paradigm, and database management systems such as Cassandra, HBase and Neo4j. Students will learn about NoSQL, distributed databases, and graph databases. The course emphasizes the differences between traditional database

management systems and alternatives with respect to accessibility, cost, transaction speed, and structure. Part of the course is dedicated to access, handle and process data from different sources and of different types using Python. The course provides hands-on practice.

CS 675 Introduction to Data Science (3 credits) - Fall
This course introduces the concepts of data science. The course teaches students the interdisciplinary basis of data science, and the data science process. Additionally the course covers data visualization, data wrangling, ethics of designing and conducting data analysis and research, bias in research, data privacy issues surrounding the use of data, and, research reproducibility. Students will learn about statistical learning methods, and then move on to more advanced topics including: database queries, working with spatial data, text mining, networks and big data. The course also emphasizes writing technical reports and presenting results. The course prepares students for further study in data mining, machine learning, and artificial intelligence, and introduces students to R.

CS 676 Algorithms for Data Science (3 credits) - Fall
This course focuses on the algorithms needed for data analytics, and has a computational emphasis. Students will develop proficiency in Python and R, as they build algorithms and analyze data. Topics include data reduction: data mapping, data dictionaries, scalable algorithms, Hadoop, and MapReduce; gaining information from data: data visualization, regression modeling, and cluster analysis; and, predictive analytics: k-nearest neighbors, naïve Bayes, time series forecasting, and analyzing streaming data.

CS 677 Machine Learning (3 credits) - Spring
This course teaches students machine learning theory and algorithms. Students will learn about probably approximately correct (PAC), empirical risk minimization (ERM), structural risk minimization (SRM), and minimum description length (MDL) learning rules. Students will then study various machine learning algorithms, such as linear models, gradient descent, support vector machines (SVM), kernel methods, and trees, and how they connect to the theoretical framework. Finally, the course culminates with additional topics such as clustering, dimensionality reduction, generative models, and feature selection.

CS 619 Data Mining (3 credits) - Spring
This course will provide an overview of topics such as introduction to data mining and knowledge discovery; data mining with structured and unstructured data; foundations of pattern clustering; clustering paradigms; clustering for data mining; data mining using neural networks and genetic algorithms; fast discovery of association rules; applications of data mining to pattern classification; and feature selection. The goal of this course is to introduce students to current machine learning and related data mining methods. It is intended to provide enough background to allow students to apply machine learning and data mining techniques to learning problems in a variety of application areas.

CS 668 Analytics Capstone Project (3 credits) - Spring
The purpose of the Analytics Capstone Project is for students to apply the knowledge and skills acquired during their master's program to a project involving actual data in a real world setting. During the project, students will apply the entire data science process from identifying a problem or opportunity, and collecting and processing actual data to applying suitable and appropriate analytic methods to find a solution. Both the problem statement for the project and the datasets will come from real-world domains similar to those that students might typically encounter within industry, government, or academic research. The course will culminate with each student making a presentation of his or her work, and submitting a final paper, and, if applicable, a computer application. This course requires a great deal of self-directed work and the ability to manage time and meet deadlines.

Cybersecurity (9 ECTS) - Spring
The course aims to provide the learner with the basic concepts of cyber security in order to permit to the student to introduce those elements in the design stage, management, maintenance and dissolution of a cyber-physical system. The course illustrates both the basics for preparing, organizing and monitoring a cyber attack and the main methodological, technological and operational tools to prevent such threats. The course focuses in particular on the problems of the monitoring systems and the control of OT systems, analyzing the effects on a cyber-attack to a physical system and to control systems. Furthermore, the course provides a brief overview about the techniques of social engineering and the legal aspects related to the cyber-security.

Computer vision (9 ECTS) - Fall
The course aims to teach students the fundamental principles and applications of Computer Vision (CV), i.e. the technologies that lie at the heart of modern Artificial Intelligence (AI) applications that can perceive, understand and reconstruct the complex visual world and that deal with developing the set of processes that aim to create a model of the real world starting from two-dimensional images. CV is one of the fastest growing and most challenging AI disciplines in industry and academia today. This course has been designed to open the doors of this discipline to students who are interested in learning about its fundamental principles and important applications.

Deep Learning for Big Data (9 ECTS) - Fall
The course will explore the main Deep Learning approaches based on deep neural networks for the analysis of multidimensional data. Deep learning algorithms are general nonlinear models that are capable of learning features directly from data, making them an excellent choice for robotic, natural language processing, healthcare, and computer vision applications. Concepts and technologies relating to Big Data analysis will be explored. The purpose of the final project will be to learn how to independently address a real or laboratory problem by applying a neural network model to create an application or to experimentally evaluate the ability of Deep Learning approaches in various contexts. The course will consist of two parts, one consisting of theoretical lectures and a second part carried out in a concerted laboratory on the application of the models analyzed using the Python language.

Ethical Hacking (9 ECTS) - Fall
The course aims to provide students with advanced cybersecurity concepts in order to allow them to manage and conduct vulnerability assessment and penetration testing activities on IT and OT infrastructures in full autonomy. Furthermore, the course aims to define solutions useful for the construction of one's own suite necessary for ethical hacking activities.
The course will deal with: Setting a machine for VA/PT activities (introducing to Unix world and arranging KALI Linux); Analyze attacks and vulnerabilities; perform penetration testing and finally conducting a vulnerability assessment.

Project Management (9 ECTS) - Fall
The course aims to provide:
- The fundamental notions, both theoretical and practical, on software development project management processes
- Knowledge of project management areas of expertise, as well as practical knowledge of related techniques and tools
- The value chain, process quality standards, process analysis and representation, projects in organizations
- Awareness of innovation processes and the development of soft skills to face the digital transition in a co-operative and collaborative perspective.
- The principles of Design Thinking.

Strategic Management and Valuation (9 ECTS) - Fall

The course aims at providing students with the elements to make corporate strategy decisions, and financial valuations of projects and firms. Students will understand the various strategies that can be undertaken by firms, through the analysis of the external and the internal environment of the organization. Moreover, business strategy and corporate strategy options will be dissected. In addition to this, tools for business valuation will be considered theoretically and empirically, with the aim to gain knowledge on how to select best project to be started, and how to estimate the value of an entire firm. In such a way, it is intended to give students an overview of how it is possible to compete in the market, how to choose which project to start, and how to assign value to organizations.

Digital Twins for Control, Automation and Predictive Maintenance (9 ECTS)
The course aims to provide theoretical and practical knowledge on the use of modern control techniques based on the concept of state and how it can be deduced through the use of a Digital Twin. Students will learn to use advanced methodologies for modeling and simulating real systems integrating optimal control, observers such as the Kalman filter, and fault detection techniques. Knowledge of the main elements of industrial automation with particular reference to Programmable Logic Controllers (PLC) and their programming languages. Use of Digital Twin algorithms within industrial automation schemes.

Distributed System Architecture (9 ECTS)
The course has the aim of providing the student with knowledge and skills related to hardware and software architectures of information systems with particular emphasis on systems capable of acquiring, storing, and processing, offline and online, data from sensors and other data sources distributed in the physical environment, involving intelligent systems for intermediate data processing and tuning of the involved systems. The student is also introduced to methods and techniques for configuring and scaling such systems in order to optimize their performance.

Fundamentals of Artificial Intelligence: developments tools and methods (15 ECTS)
The course consists of two modules: Development Tools and Methods.
The learning objectives of the module Development Tools provide the student with knowledge and skills necessary to use high-level programming languages for the development of software applications oriented to data processing. The student will deepen the use of programming methods and tools allowing the efficient development of software through the generation and reuse of high-quality modular components. Programming skills are applied to strategies and algorithms for data analysis in Artificial Intelligence applications.
The learning objectives of the module Methods is to acquire the basic concepts of Machine Learning (ML) and of symbolic AI, i.e., the systems and algorithms that rely on observations of data for the synthesis of new knowledge. For example, learning can take place by capturing features from examples, data structures or sensors, to analyse and to evaluate the relationships between the observed variables.
In particular, the student should:
- Acquire an adequate level of knowledge of the theoretical foundations of the main computational models for learning (e.g. supervised and unsupervised learning, classifiers and regressors, distance-based and model-based learning models, linear and kernel classifiers, evolutionary models, time series mining, etc.);
- Understand methods for the synthesis of new knowledge;
- Understand the fundamentals of methods for defining an experimental procedure and for performance evaluation;
- Understand the potential of AI for the development of decision support systems, data mining and big data analytics;
- Learn the use of appropriate development environments for the application of AI methods.

Smart systems (6 ECTS)
The course aims at providing students with basic knowledge about measurement systems, sensors and computational techniques for the analysis and interpretation of the results. The course also aims at providing students with theoretical and programming elements about sensors-processors interfaces.

Generative AI (6 ECTS)

The course aims at providing students with knowledge and competences on hardware and software information system architectures. Particular attention will be devoted to the systems able to acquire, memorize and elaborate, both offline and online, data coming from sensors and other sources in the physical environment, involving systems for data processing and tuning.

Thesis - Spring

The student, under the supervision of a Professor of Campus Bio-Medico University, will develop a scientific project based on a research or practical experience.