



CentraleSupélec

université
PARIS-SACLAY

MSc AI

Applied to Society

MSc in Artificial Intelligence Applied to Society

CentraleSupélec



EDITO

Artificial intelligence has become a game changer in our lives. This program aims to provide students with the foundations and most advanced techniques in the field, enabling them to become technical leader of this transformation.

Our program is unique in terms of curriculum, tackling the field with model / symbolic-driven and data-driven artificial intelligence methods, while also assessing their applications to critical domains of the society such as ethics, internet of people, networks, logistics, and biomedical sciences.

This unique program, offering an end-to-end approach from theory to practice, is delivered entirely in English by outstanding teachers and classes, and offers a uniquely excellent curriculum to those preparing for a future as artificial intelligence architects and who are in search of exceptional career perspectives in the hottest discipline of the 21st century.



Céline Hudelot
Academic Co-Director

Professor and Head of the Mathematics and Informatics Laboratory for Complexity and Systems (MICS). She also heads the Randstad chair.



Vincent Mousseau
Academic Co-Director

Professor and Researcher at the Mathematics and Informatics Laboratory for Complexity and Systems (MICS). He studies preference modelling and decision systems.



Dave Jacob
Program Manager

CENTRALESUPÉLEC, THE SCHOOL OF THE 21ST CENTURY

Our world today is undergoing unprecedented changes. The digital revolution, massive data and globalization are real revolutions that raise huge challenges and expectations for society.

Businesses are looking for high-level scientific professionals who are true "integrator-innovators", able to pool wide fields of expertise, generate new solutions, initiate and bring about change with a strong sense of ethics, responsibility and civic engagement, particularly in the face of social and environmental concerns.

Today, CentraleSupélec has all the assets to meet the needs of 21st century companies and businesses:

- training multidisciplinary engineers-entrepreneurs and experts in complex systems.
- developing innovative responses to major technological, economic, social and environmental challenges through research.
- enabling working professionals to acquire the skills they need to adapt to change and make their companies more competitive.



It develops its academic excellence and research through robust and fruitful cooperation with major national organizations such as CNRS, CEA, INRIA, INSERM and ONERA.

CentraleSupélec is a founding member of the University of Paris-Saclay, the T.I.M.E. network, the Alliance 4Tech, a strategic partner of the ESSEC Business School and president of the Écoles Centrale Group.

4,500 students and **370** teachers and faculty members, 20% of whom are international

600 students in **18** laboratories and research teams

3 schools abroad (China, India and Morocco) and **4** associated international laboratories (Brazil, Canada, United States and China)

176 foreign partner universities

140 partner companies in the engineering curriculum, including 30 SMEs

45,000 active graduates around the world and in all sectors

A leading, internationally recognized institution

Like other top higher education institutions, CentraleSupélec is continuously developing its presence in the major countries of the future: In 2005, École Centrale Paris, with the Écoles Centrale Group over which it presides, became the first major French engineering school to export its educational model abroad with the creation of École Centrale Beijing in China. In 2015, École Centrale Casablanca was launched in Morocco. The School also implements an active policy of partnerships with academic and research institutions worldwide, with 4 associated international laboratories (China, United States, Singapore and Canada).

In this way, CentraleSupélec is building a worldwide group of interconnected schools and laboratories, which will continue to expand.

A founding member of Paris-Saclay University

With 275 laboratories shared with the CEA, CNRS, IHES, INRAE, INRIA, INSERM, ONERA, Paris-Saclay University represents 13% of the French research potential. Composed of 65,000 students, 9,000 teachers and lecturers and 11,000 technical and administrative staff, Paris-Saclay University is a driving force for the development of its territory and one of the top institutions in France.

CentraleSupélec coordinates the "Engineering and Systems Sciences" Graduate School

In a unique ecosystem that brings together academic centres and industrial partners within the same territory, the "Engineering and Systems" Graduate School will offer recognised master's and doctoral level training in the fields of Engineering Sciences and associated digital sciences. These courses open the door to professional integration into the Research and Development community in France and abroad. The Graduate School will have more than 1,000 Master's students and 600 PhDs graduating each year in several major research areas: materials, mechanics, civil engineering, industrial engineering, optics, electronics, telecommunications, electrical engineering, robotics, applied mathematics, high-performance computing, biomedical imaging, biotechnologies...

The Graduate School will bring together more than sixty research laboratories that respond to major societal challenges through research and innovation. To prepare for tomorrow's world, it will seek a balance between the ecological and economic development of our societies by conducting research at the highest global level. The increase in the international visibility of French engineering science education will enable the Graduate School to attract the best students in its various training cycles.

Paris-Saclay University is ranked 13th worldwide and N°1 European Institution in the 2021 Shanghai World Ranking

CENTRALESUPÉLEC: A significant player in Data Science and Artificial Intelligence



75

Professors and Researchers, and **150** doctoral students engaged in this scientific field



7

Laboratories are involved on our three campuses: Paris-Saclay, Metz and Rennes



12

Business partners companies



4

Research and teaching chairs in Data Science and Artificial Intelligence.



2

Masters' Agreements

- In December 2016, CentraleSupélec signed a masters' agreement with Assistance Publique Hopitaux de Paris (AP-HP) in the field of data science applied to health.



- In September 2017, CentraleSupélec signed a masters' agreement with the Gustave Roussy Institute to strengthen partnerships in the field of big data and artificial intelligence in the fight against cancer.

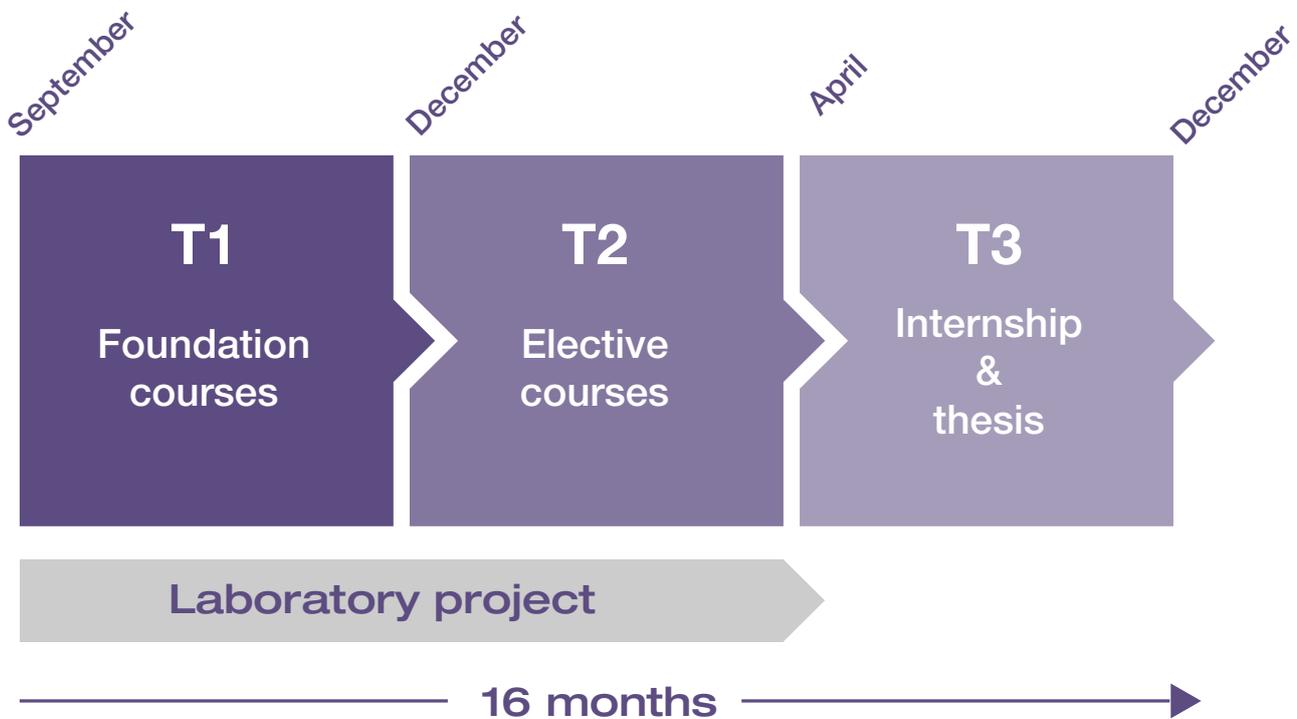


CentraleSupélec, founding member of the DATAIA Institute

CentraleSupélec is a very active, founding member of the DATAIA Institute, the first convergence institute in France specializing in Data Sciences, Artificial Intelligence and Society. The Agence Nationale de la Recherche has selected it as part of the «Investments for the Future» program, and its vocation is to bring together and structure wide-ranging, high-visibility expertise in Artificial Intelligence for the benefit of Humans.

The DATAIA Institute, based since the 1st January 2021 on the outskirts of Paris-Saclay University, brings together 120 researchers and faculty members from 12 institutions, providing an interface between disciplines such as Mathematics, Computer Science and Big Data, and the Human and Social Sciences.

PROGRAM CALENDAR



PROGRAM OUTLINE

1st period: Foundations

Foundations of Machine Learning

This course provides an overview of the most important trends in machine learning, with a focus on statistical risk and its minimization with respect to a prediction function. A substantial lab section involves group projects on data science competitions and gives students the ability to apply the course theory to realworld problems.

Foundations of Artificial Intelligence

An history and overview of the different approaches of Artificial Intelligence: from reflex agent (low level AI) to expert systems and xIA (high level AI). Each notion will be the subject of individual practical work. In addition, students will work in groups to develop IA to enter in a tournament.

Foundations of Decision Modeling

References are present and pervasive in many situations involving human interaction and decisions. References are expressed explicitly or implicitly in numerous applications and relevant decision should be made based on these preferences. This course aims at introducing preference models for multicriteria decisions. We will present concepts and methods for preference modelling and multicriteria decision-making.

Foundations of Optimization

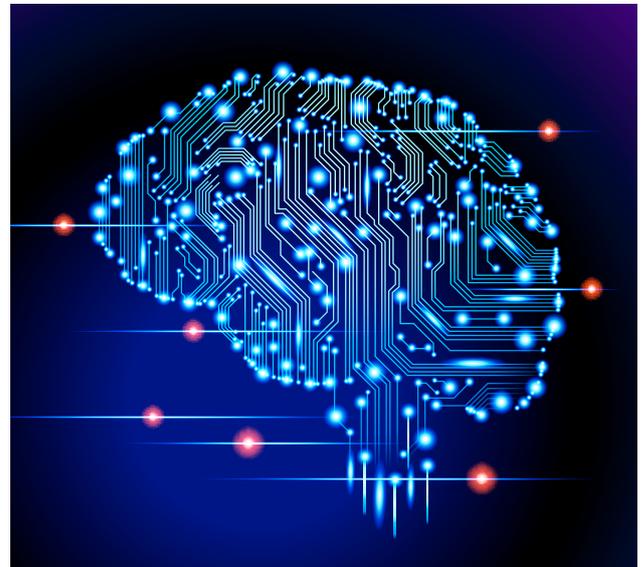
This course covers foundational theory and methods for the solution of optimization problems, iterative techniques for unconstrained minimization, linear and nonlinear programming, as well as discrete methods for engineering applications associated with programming exercises in Python.

Foundations of Deep Learning

This course will introduce the modern theory of convolutional neural networks, both in terms of theoretical concepts as well as in terms of practice with different training and programming architectures. Concrete examples on various applications domains will demonstrate the interest of these methods in artificial intelligence.

Foundations of Big Data & AI programming languages & platforms

This course will teach you all about big data management - algorithms, techniques and tools needed to support big data processing with emphasis on the computational aspects related with programming of artificial intelligence methods based on machine learning.



Foundation Courses	Elective courses	
	Theoretical Courses	Applied Courses
Foundations of Machine Learning	Reinforcement learning	Ensemble Learning
Foundations of AI	Game Theory	Computer Vision
Foundations of Decision modeling	Graphical Models	Natural language processing
Foundations of Optimization	Multi-agent Systems	Internet of People
Foundations of Deep Learning	Advanced Statistics	Explainable AI
Big Data & AI Programming Languages & Platforms	Advanced Deep Learning	Medical Imaging
AI and Ethics		Computational Social Choice

2nd period: Electives

► Theoretical AI: At least 3 electives to choose

Graphical Models

This course addresses mathematical foundations and computational solutions for training and optimizing (higher order) probabilistic graphical models. These are powerful middle-level representations that once endowed with efficient optimization algorithms produce state of the art results for problems with average volume of training data.

Multi-agent Systems

The aim of this course is to study multi-agent systems, i.e. systems composed of multiple interacting computing elements, known as agents, as a paradigm for implementing autonomous and complex intelligent systems.

Advanced Deep Learning

Deep learning methods are very efficient in machine learning tasks; but as they are still poorly understood, neural networks are still difficult to train, and results are black boxes missing explanations. Decisions should be explainable and to offer guarantees. Besides, real world problems usually do not fit the standard assumptions (data quantity and quality, expert knowledge availability...). This course provides insights and tools to address practical aspects, based on mathematical concepts.

Game Theory

This course will, first, present the main principles concerning decision under uncertainty, and the use of graphical models when making decisions under uncertainty. Second, we will consider principles of game theory and show how such theory can model and analyse decision in situations where uncertain and strategic interactions are involved.

Reinforcement Learning

This course will introduce the foundations of dynamical problem modeling in artificial intelligence through reinforcement learning strategies. We will discuss optimization strategies, sampling strategies and rewards selection strategies at the concept and application level for various problems of artificial intelligence.

Advanced Statistics

This course first introduces the general methodology of mathematical statistics through the fundamental concepts (statistical modelling and sampling, estimation problems, decision theory and hypothesis testing). The course then provides advanced statistical techniques for multivariate analysis with a focus on computational statistics and robust estimation approaches. Regularized / penalized techniques are also presented.

► Applied AI: Choose at least 3 electives

Ensemble Learning

The course introduces ensemble methods when dealing with both classification and regression problems. These methods build a global prediction combining a set of simpler base models, e.g., Random Forests aggregate of a collection of trees. This course introduces methods such as: Classification and Regression Trees (CART), boosting trees, Random Forests, etc. Recent challenges of interpretability are also discussed.

Computer Vision

This course will present an overview of trends, modern methods and applications of computer vision technologies in various problems of visual computing, namely visual analytics, object recognition, 3D scene modeling from multiple-views, cross training of multimodal data, etc.

Natural language processing

This course addresses fundamental questions at the intersection of human languages and computer science. In this course we explore methods inspired from symbolic and sub-symbolic artificial intelligence towards language understanding, parsing, translation & generation.

Internet of people

The problem of extracting meaningful information from large scale graph data in an efficient and effective way has become crucial and challenging with several important applications in AI. The goal of this course is to present recent and state-of-the-art methods and algorithms for analyzing, mining and learning large-scale graph data, as well as their practical applications in various domains.

Computational social choice

This course addresses the fundamentals collective choice and elections system that studies the aggregation of individual preferences towards a collective choice. It will also present how to apply of social choice theory to computational environments. For example, social choice theory can provide tools for making joint decisions in multiagent systems, which are populated by heterogeneous, possibly

selfish, software agents. Applications also involve group recommendation systems, information retrieval, and crowd-sourcing.

Medical Imaging

Medical imaging technologies provide the means to study the structure and function of the human body in vivo. The interpretation of medical images is difficult because of the need to consider three-dimensional, time-varying information from multiple types of medical images. AI holds great promises and deep learning technologies have led to impressive advances in medical image processing and interpretation. This course covers both theoretical and practical aspects of deep learning for medical imaging.



Explainable AI

Artificial Intelligence solves problems automatically, and in particular, with Deep Learning, interaction with humans is no longer necessary. However, in some application areas, users need to understand the decision provided by an algorithm. This is especially true for human-centered fields (medicine, security), or those affected by laws offering a right to explanation. eXplainable Artificial Intelligence (XAI) has taken on great importance, and this module presents tools which help to understand opaque models

Laboratory project (October to March)

Students, working in pairs, select a research topic tutored by a professor or researcher in an associated laboratory. The topic corresponds to a state-of-the-art problem. Students are asked to assess the existing literature, propose an algorithmic solution to the problem at hand, implement it, and provide a numerical validation.

3rd period: Internship & Master Thesis (4 to 6 months)

To complete the CentraleSupélec MSc in Artificial Intelligence, students must undertake a professional experience (4 to 6 months internship or job in a position related to the program) and complete the related Master's Thesis. This corresponds to a natural extension of the course work carried out during the academic year.



▶ WHO CAN APPLY?

- Recent graduates or soon-to-be graduates from top universities/schools with good degrees (Bachelor/Master1) Engineering, Mathematics, Statistics, Informatics, Physics ...;
- ... with little to no work experience ...
- ... a good level of English, and looking to study entirely in English ...
- ... and aiming to become an expert and leader in AI.

▶ FINANCING

Tuition fees: 20,000€ including 2,000€ deposit.

The deposit is payable upon acceptance into the program and before registration. This amount is later deducted from your tuition fees. Your remaining tuition fees can be paid each year in 2 equal instalments in August & October.

▶ ADMISSIONS

Online Application deadlines:

- Round 1: Nov 20th, 2021
- Round 2: Jan 22nd, 2022
- Round 3: March 5th, 2022
- Round 4: April 23rd, 2022
- Round 5: June 30th, 2022

▶ APPLICATION

For any question, or / further information, please contact Morgane Jaunay (morgane.jaunay@centralesupelec.fr)

<https://apply.centralesupelec.fr/mscai>

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As a French person, I was well aware of the reputation of CentraleSupélec. It is one of the best schools in France. Among that, the description of the course interested me a lot : Most schools that have AI programs are focused on Machine and Deep Learning but AI is not only about that. There are plenty of issues that exist in AI that Deep Learning would not solve.

I would describe the MSc AI of CentraleSupélec as:

- *Demanding: the program is short and intense*
- *Global: we study a lot of different fields in depth*
- *Balanced: we did both research opportunities and application.*

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LOUIS DE VITRY

Computer Vision
Research Engineer at
TheraPanacea

ACADEMIC TEAM

Academic Co-Directors

Céline Hudelot

Vincent Mousseau

Program Manager

Dave Jacob

MORE INFORMATION

For any question / further information,

Please contact **Morgane Jaunay**

morgane.jaunay@centralesupelec.fr



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More information:
www.centralesupelec.fr/en



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