
ENGINEERING PROGRAMME

2025-2026

Year 2 / Year 3

Specialisation option

**Computer Science for Artificial
Intelligence**

OD INFOIA

PROGRAMME SUPERVISOR

Didier LIME



Autumn Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 73	12	Core course	ALGOA INDUR PAPY STASC	Advanced algorithmics Sustainability, ethics and computing Advanced programming in Python Introduction to statistics and data science with Python
UE 74	13	Core course	AGATH DEEP MVP PIIA1 QCM	Algorithmic game theory Deep Learning Probabilistic modelling and verification Project 1 Quality, design and modelling

Spring Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 83	14	Core course	GPGPU GRAAL PIIA2 PRLOG RL	Programming on graphical processor units Graphs and algorithms Project 2 Logic programming Reinforcement learning

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Advanced algorithmics [ALGOA]

LEAD PROFESSOR(S): Didier LIME

Objectives

At the end of this course, students will be able to:

1. Analyze algorithms
 - assess their complexity
 - prove their functional and non-functional properties
2. Design efficient algorithms:
 - by choosing adapted data structures
 - by using generic solving methods

Course contents

This course consists of three main parts:

1. Program analysis
 - basic properties of algorithms: termination, correctness, completeness, complexity
 - inductive proofs and invariants
 - computation models for complexity
 - decidability and complexity of algorithmic problems
 - complexity assessment : worst case, base case, recursive algorithms
 - complexity in average et randomized algorithms
2. Algorithm design paradigms
 - exhaustive enumeration
 - backtracking
 - divide and conquer
 - dynamic programming
 - greedy algorithms
 - problem transformations
3. Data structures
 - arrays and lists
 - amortized complexity
 - stacks and queues
 - priority queues and heaps
 - binary search trees and AVL trees
 - hash tables

Lab work will enable the practical application of these notions through the design and development of a file compression tool.

Course material

Thomas H. Cormen; Charles E. Leiserson; Ronald L. Rivest; Clifford Stein (2009) [1990]. Introduction to Algorithms (3rd ed.). MIT Press and McGraw-Hill. ISBN 0-262-03384-4. 1320 pp.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Climate action / Decent work and economic growth / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Algorithms are an essential part of the design of most today's systems. It allows not only their basic working, but also their efficiency at every level.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	18 hrs	0 hrs	12 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Sustainability, ethics and computing [INDUR]

LEAD PROFESSOR(S): Morgan MAGNIN

Requirements

Basic skills in computer science (methodology and technologies)

Objectives

Objectives in terms of knowledge:

1. Regulation and ethics:
 - Legal framework for automatic data processing
 - Ethics and responsibility
 - Possible biases of artificial intelligence (AI)
 - Autonomous agents and ethics
 - Moral reasoning and ethical responsibility in AI
 - Social issues
2. Green computing:
 - Identify the principles of green computing and the associated levers:
 - Direct and indirect issues and impacts
 - Hardware and software energy consumption
 - Digital Sobriety
 - Algorithms and green software: software eco-design
 - Green data centers

Objectives in terms of skills:

1. Know how to build an ethical and responsible analysis of automatic information processing (identification of the impact of this processing, possible biases, etc.)
2. Know how to implement a diagnosis of the energy consumption of computer applications

Course contents

Course outline:

1. General introduction to the concepts of sustainability and ethics in computer science
2. Case studies introduced at the beginning of the course and taken up again at the end to complete the knowledge acquired in the field of analysis and implementation of more responsible and sustainable solutions.
3. Series of lectures/lectures/talks on "green computing" and "ethics and responsibility"

Course material

- Cerna Collectif. Éthique de la recherche en apprentissage machine. [Rapport de recherche] CERNA; ALLISTENE. 2017, pp.51. hal-01643281 <https://hal.inria.fr/hal-01643281/document>
- Panorama de formations et de ressources pédagogiques existantes sur le thème « informatique verte » : <https://ecoinfo.cnrs.fr/2019/06/21/formations-abordant-les-aspects-environnementaux-du-numerique/>
- MOOC « Impacts environnementaux du numérique » <https://www.fun-mooc.fr/fr/cours/impacts-environnementaux-du-numerique/>
- Mehrabi, N., Morstatter, F., Saxena, N., Lerman, K., and Galstyan, A. (2021). A survey on bias and fairness in machine learning. ACM Computing Surveys (CSUR), 54(6), 1-35. <https://arxiv.org/pdf/1908.09635>

- Acar, Hayri. Software development methodology in a Green IT environment. PhD thesis. Université de Lyon, 2017. <https://tel.archives-ouvertes.fr/tel-01724069/file/TH2017ACARHAYRI.pdf>

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
 - C1C1 : Develop
 - Proficient
 - C1C2 : Dare
 - Intermediate
- C3 : Manage complex programmes or change responsibly
 - C3C3 : Finalise and leverage feedback
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Peace, justice and strong institutions

Sustainable Development and Social Responsibility Positioning

The Sustainable Computing course trains engineering students in sustainable development issues in the field of artificial intelligence: the environmental impact of AI at different levels (servers, client workstations), eco-design of applications, the legislative framework (both in terms of programs and data), and the process of developing an ethical report for any AI-based application.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	12 hrs	10 hrs	8 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Advanced programming in Python [PAPY]

LEAD PROFESSOR(S): Lucas LESTANDI

Objectives

At the end of this course, student will have the skills to:

1. Set up a robust Python environment and a suitable development environment.
2. Write efficient Python programmes using libraries and modern abstractions.
3. Ensure readability and maintenance by following modular architecture and community style guidelines.
4. Package their code for distribution on other machines including dependencies.

Course contents

1. The right way to work with Python
 - setting up the right environment: IDE, jupyter notebooks, Python environments (conda, etc.)
 - language philosophy, syntax
 - Python interpreter
 - good practice for programming in Python (PEP8 style guidelines, etc.)
2. Code structure and data types
 - variables, memory and references
 - data types and structures
 - object oriented programming (OOP): classes
 - writing robust code: architecture, introspection, exceptions, etc.
3. Using modules
 - native modules: os, sys, subprocess
 - external libraries: using pip and conda
 - useful examples: numpy, scipy, matplotlib
 - create your own modules
4. Towards production code
 - decorators
 - integration with other languages (C++, etc.)
 - testing and debugger
 - distribution and portability

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
 - C1C1 : Develop
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

This course contributes to the objectives of Industry, Innovation and Infrastructure by training students to design robust, efficient, and maintainable software. Emphasis is placed on code quality, performance optimization, and responsible use of

computational resources, which are essential in industrial and scientific contexts. The methods and tools introduced support digital innovation, reproducibility, and the long-term sustainability of software infrastructures.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	8 hrs	0 hrs	22 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Introduction to statistics and data science with Python [STASC]

LEAD PROFESSOR(S): Bertrand MICHEL

Objectives

This lecture is an introduction to statistical learning.

Main objectives:

- understanding the main concepts of statistical learning
- introduction to standard methods in statistical learning
- practice on real data using standard Python libraries

Course contents

- introduction to statistical learning
- standard methods for classification
- CART random forests and boosting
- unsupervised learning
- introduction to kernel methods

Course material

- The Elements of Statistical Learning, Data Mining, Inference, and Prediction. Trevor Hastie Robert Tibshirani Jerome Friedman, 2009 Springer.
- Hands-On Machine Learning with Scikit-Learn and TensorFlow by Aurélien Géron, O'Reilly 2017.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - Intermediate

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Les problématiques du cout environnemental de l'IA sont évoquées en introduction du cours.

Assessment

Collective assessment: EVC 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	15 hrs	17 hrs	0 hrs	0 hrs	0 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Algorithmic game theory [AGATH]

LEAD PROFESSOR(S): *Didier LIME*

Objectives

At the end of this course, students will know how to :

- model decision problems involving several agents in various environments as strategic games
- algorithmically compute strategies giving the best personal gain or the best global equilibrium
- program artificial intelligence agents based on these concepts

Course contents

The course is divided in three main parts:

1. Normal form games
 - games, payoffs, strategies
 - solution concepts : dominated strategies, Nash equilibria, maximal regret minimisation, correlated equilibria
 - two-player zero-sum games
2. Extensive form games
 - sequential games
 - subgame perfect equilibria
 - backward induction
 - approximations : Monte Carlo and statistical evaluation
3. Repeated games
 - finitely and infinitely repeated games
 - regret-based learning

Course material

- Ken Binmore. *Playing for Real : A Text on Game Theory*, OUP USA, 2007.
- *Algorithmic Game Theory*, Nisan, Roughgarden, Tardos, and Vazirani, Cambridge University Press, 2007.
- *Multiagent Systems*, Y. Shoham, K. Leyton-Brown, Cambridge University Press, 2009.
- Michael Maschler, Eilon Solan, Shmuel Zamir. *Game Theory*, Cambridge University Press, 2013.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Proficient
 - C2C2 : Solve and arbitrate
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Climate action / Decent work and economic growth / Industry, innovation and infrastructure / Reduced inequalities / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

Game theory, via its classical applications in economy (e. g., Nobel prizes in Economy in 1994, 2005, 2007, 2012 and 2014), mais aussi in many other scientific domains (e.g., Nobel prize in Chemistry 2024), gives tools to better understand the world and to open new approaches to innovation.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	16 hrs	0 hrs	14 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Deep Learning [DEEP]

LEAD PROFESSOR(S): Bertrand MICHEL / Didier LIME

Requirements

STASC

Objectives

At the end of this course, students will know the theory and algorithmics underlying feed-forward artificial neural networks, as well as the main theory elements for different representatives of the family of deep neural networks (recurrent networks, auto-encoders, generative networks).

They will also be acquainted with their practical use through dedicated software libraries.

Finally, they will see how these models can be applied to solve real-life problems through several case-studies.

Course contents

1. Feed-forward networks
 - Response computation
 - Optimization and learning
 - Convolutional networks
 - Principles of transfer learning and fine tuning
2. Recurrent networks
 - Long term Short Term Memories (LSTM)
 - Models for natural language processing: embeddings, attention, and transformers
3. Auto-encoders et generative models
 - Auto-encoders
 - Generative adversarial networks (GAN)
 - Diffusion Models
4. Case-studies
 - Autonomous vehicles
 - Biomedical applications.

Course material

- The Elements of Statistical Learning, Data Mining, Inference, and Prediction. Trevor Hastie Robert Tibshirani Jerome Friedman, 2009 Springer.
- Hands-On Machine Learning with Scikit-Learn and TensorFlow by Aurélien Géron, O'Reilly 2017.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

The environmental impact of AI is mentioned in the course introduction of STASC

Assessment

Collective assessment: EVC 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	15 hrs	5 hrs	12 hrs	0 hrs	0 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Probabilistic modelling and verification [MVP]

LEAD PROFESSOR(S): *Benoit DELAHAYE / Didier LIME*

Objectives

Students will learn about probabilistic state modeling techniques such as Markov chains, Markovian decision processes and their timed and imperfect information extensions, as well as the formal verification techniques dedicated to them.

The methods and techniques of this course will be illustrated and evaluated during tutorials in Python.

Course contents

The course is divided in two main parts:

1. Probabilistic Modeling
 - Discrete-time Markov chains (DTMC)
 - Markov decision processes (MDP)
 - Imperfect information extensions (HMC and PO-MDP)
2. Formal verification for probabilistic models
 - Probabilistic Model-Checking
 - Statistical Model-Checking

Course material

Christel Baier and Joost-Pieter Katoen. Principles of model checking. MIT press, 2008.

Pedro R. D'Argenio, Arnd Hartmanns, and Sean Sedwards. Lightweight statistical model checking in nondeterministic continuous time. In Tiziana Margaria and Bernhard Steffen, editors, ISoLA'18, volume 11245 of LNCS, pages 336–353. Springer, 2018.

David Henriques, Joao G Martins, Paolo Zuliani, André Platzer, and Edmund M Clarke. Statistical model-checking for markov decision processes. In 2012 Ninth international conference on quantitative evaluation of systems, pages 84–93. IEEE, 2012.

Vikram Krishnamurthy. Partially observed Markov decision processes. Cambridge university press, 2016.

Axel Legay, Benoît Delahaye, and Saddek Bensalem. Statistical model checking : An overview. In International conference on runtime verification, pages 122–135. Springer, 2010.

Martin L Puterman. Markov decision processes. Handbooks in operations research and management science, 2 :331–434, 1990.

Koushik Sen, Mahesh Viswanathan, and Gul Agha. On statistical model checking of stochastic systems. In International Conference on Computer Aided Verification, pages 266–280. Springer, 2005.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Decent work and economic growth / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Probabilistic models allow the study of many systems in varied domains (healthcare, ecology, transportation, etc.). Verification is a cornerstone of the safety of critical systems.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	16 hrs	6 hrs	8 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Project 1 [PIIA1]

LEAD PROFESSOR(S): *Didier LIME*

Objectives

Apply in practice the knowledge and skills acquired during the year.

Course contents

Starts in late September, ends early January. Can be merged with the second project (PIIA2).

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
 - C1C1 : Develop
 - Intermediate
 - C1C2 : Dare
 - Intermediate
 - C1C3 : Deliver and create value
 - Intermediate
- C3 : Manage complex programmes or change responsibly
 - C3C1 : Design a project/programme
 - Intermediate
 - C3C2 : Manage/lead a project/programme
 - Intermediate
 - C3C3 : Finalise and leverage feedback
 - Intermediate
- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Climate action / Decent work and economic growth / Good health and well-being / Industry, innovation and infrastructure / Reduced inequalities / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

Projects are an essential tool for the application of the theoretical notions acquired during lectures, often to real case-studies, related to healthcare, industry or other domains.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	1	0 hrs	0 hrs	0 hrs	32 hrs	0 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Quality, design and modelling [QCM]

LEAD PROFESSOR(S): Myriam SERVIÈRES

Objectives

The course covers three key themes of computer development in business: Software Engineering, Databases, and Computer Development Methods. The objectives of these three topics are, respectively:

- To acquire the basics of Software Engineering and IT Project Management.
- To acquire the basics of software engineering and computer project management, to master the elements of design and use of relational databases.
- To develop using tools and methods that allow the construction of software applications of industrial quality.

Following this course, the skills acquired should allow to:

- Design and model software and write specifications.
- Master the elements of design and use of relational databases.
- Collaborate in developing software, and automated test suites, and guarantee the quality of the code.

Course contents

1. Software engineering. We will cover here:

- Software development cycles: specification, life cycle, planning, quality, specification, production, acceptance.
- UML design models: use cases, class diagrams, sequence diagrams, state-transition diagrams, and activity diagrams.

2. Databases

- Conceptual and physical modeling, relational model
- SQL queries
- Design of database query programs

3. Methods of computer development.

We will discuss version management tools, unit tests, and code metrics here.

Course material

- Modélisation objet avec UML, Pierre-Alain Muller, Best of Eyrolles, 2005.
- UML2 et les design patterns, Craig Larman, Pearson Education, 2005.
- Software Engineering 8, Ian Sommerville, Addison Wesley, 2007.
- Le génie logiciel et ses applications, Ian Sommerville, InterEdition, 1988.
- Processus d'ingénieries du logiciel, méthodes et qualité, Claude Pinet, Pearson Education, 2002.
- UML2, Benoit Charroux, Aomar Osmani, Yann Thierry-Mieg, Pearson Education, 2005.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - Intermediate

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education

Sustainable Development and Social Responsibility Positioning

This course on Quality, Design and Modeling contributes to sustainable development objectives by training students in the analysis, representation and design of structured information systems, while addressing software quality issues throughout the development life cycle. It contributes to Sustainable Development Goal No. 4 (Quality Education) by fostering the acquisition of fundamental and intermediate skills in software engineering, databases and development methods, which are essential for understanding and modeling complex systems. It also contributes to Sustainable Development Goal No. 9 (Industry, Innovation and Infrastructure) by preparing students to design reliable, well-structured software solutions that meet quality requirements in professional and industrial contexts.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	9 hrs	8 hrs	13 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Programming on graphical processor units [GPGPU]

LEAD PROFESSOR(S): Pierre-Emmanuel HLADIK

Objectives

Integrate the concepts of parallel computing (communication and synchronization),
Understand how these principles can be implemented,
Gain insight into higher-level mechanisms,
Practise to understand the specific features of concurrency
Learn about proving properties of concurrent systems.

Course contents

1. General
- 2 Introduction: why parallel programs?
- 3 Synchronization through shared variables
- 4 Synchronization through communication
- 5 Verification of properties of (distributed) computer systems
- 6 Temporal logics, model-checking
- 7 Time checking
- 8 Conclusion
- 9 Bibliography

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

This course raises awareness of responsible and sustainable computing by highlighting the energy impact of high-performance computing and the role of parallel architectures in improving computational efficiency. It aims to train engineers capable of designing efficient, reliable, and resource-aware software, taking into account concurrency and system reliability constraints.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	18 hrs	0 hrs	23 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Graphs and algorithms [GRAAL]

LEAD PROFESSOR(S): Gaëtan STAQUET

Objectives

This course aims at giving an overview of graphs and their algorithms, while highlighting their practical applications.

Course contents

First, multiple notions about graphs and algorithms will be presented.

After that, a set of topics will be proposed to the students. Each of them (as a group) will have to work on one of these subjects and present it to the class. These topics will cover graph theory (coloring, coupling, independent sets, etc.), visual representation of graphs, usage of graphs as a modeling tool, efficient implementation of algorithms, etc. This list is not exhaustive.

Course material

- E. Goodaire, M. Parmenter. Discrete Mathematics with Graph Theory. 2018.
- D. Beauquier, J. Berstel, P. Chrétienne. Eléments d'algorithmique. 1992. (disponible en ligne)
- M. Gondran, M. Minoux. Graphes et algorithmes. 2009.
- J.-C. Fournier. Théorie des graphes et applications. 2006.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

The course raises awareness of the use of graphs to model various applications in an efficient and energy-efficient manner, in particular by searching for suitable algorithms and optimizing them.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Project 2 [PIIA2]

LEAD PROFESSOR(S): *Didier LIME*

Objectives

Apply in practice the knowledge and skills acquired during the year.

Course contents

Starts early January, ends late March. Can be merged with the first project (PIIA1).

Skills developed through this course

- C1 : Design and prototype innovative systems that create value
 - C1C1 : Develop
 - Intermediate
 - C1C2 : Dare
 - Intermediate
 - C1C3 : Deliver and create value
 - Intermediate
- C3 : Manage complex programmes or change responsibly
 - C3C1 : Design a project/programme
 - Intermediate
 - C3C2 : Manage/lead a project/programme
 - Intermediate
 - C3C3 : Finalise and leverage feedback
 - Intermediate
- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

- C1 : Design and prototype innovative systems that create value
 - Proficient
- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - Proficient
- C3 : Manage complex programmes or change responsibly
 - Proficient

Sustainable Development Goals (SDGs) covered by this course

Climate action / Decent work and economic growth / Good health and well-being / Industry, innovation and infrastructure / Quality education / Reduced inequalities / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

Projects are an essential tool for the application of the theoretical notions acquired during lectures, often to real case-studies, related to healthcare, industry or other domains.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	2	0 hrs	0 hrs	0 hrs	48 hrs	0 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Logic programming [PRLOG]

LEAD PROFESSOR(S): Carito GUZIOLOWSKI

Objectives

This course is an overview of the logic programming paradigm, which is a declarative paradigm of programming. We will use Answer Set Programming (ASP) as a modeling language and framework. The aim of ASP is to propose a solution to a problem (notably a combinatorial search problem) by modelling this problem instead of coding its solution. Modelling is performed in the form of logical rules (first order predicates) that have a defined syntax and semantics. The resolution of ASP logic programmes is carried out with very powerful solvers. In this course we will use gringo and clasp.

Course contents

The course presents an overview of the following aspects :

- Declarative programming
- ASP Syntax
- ASP Semantics
- Modelling of a problem

This course will be strongly articulated around practical tutorial and lab sessions. The main idea of these sessions will be to propose logic programmes to solve classical combinatorial search problems.

Course material

Knowledge representation, Reasoning, and Declarative Problem Solving. Chitta Baral.
Cambridge University Press New York, NY, USA, 2003.

Gelfond, M., & Kahl, Y. (2014). Knowledge Representation, Reasoning, and the Design of Intelligent Agents: The Answer-Set Programming Approach. Cambridge: Cambridge University Press. doi:10.1017/CBO9781139342124

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

This course provides a learning space where respect and listening are prioritized; as well as clear limits of teacher and students responsibilities.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	20 hrs	0 hrs	10 hrs	0 hrs	2 hrs

ENGINEERING - OD INFOIA

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Reinforcement learning [RL]

LEAD PROFESSOR(S): *Didier LIME*

Objectives

At the end of this course, students will know how to model decision problems in uncertain and unknown environments, in which some actions give a reward (or a punishment). They will also know how to learn algorithmically a strategy/policy optimizing the long-term cumulative reward.

Course contents

1. Introduction and modelling
 - Markov decision processes with rewards;
 - Utility functions for states and actions, optimal policies;
 - Bellman optimality equations and dynamic programming.
2. Utility-based learning
 - Monte Carlo methods;
 - Temporal differences;
 - Approximation of utility functions.
3. Parameterized strategy-based learning
 - Policy gradients;
 - Actor-critic methods.

Course material

Richard S. Sutton and Andrew G. Barto. Reinforcement Learning: An Introduction (2nd Edition). MIT Press, 2020.

Skills developed through this course

- C2 : Analyse a complex system from all angles (scientific, economic, human, social) and propose a solution
 - C2C1 : Represent and model
 - Intermediate
 - C2C2 : Solve and arbitrate
 - Intermediate
 - C2C3 : Think and act in an unpredictable and uncertain environments
 - Intermediate

Skills assessed through this course

No skill observed

Sustainable Development Goals (SDGs) covered by this course

Decent work and economic growth / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Reinforcement learning is at the heart of many of the current edge technologies, with applications in energy handling, chemistry, transportation, etc.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	12 hrs	4 hrs	16 hrs	0 hrs	0 hrs