



MA-INFO | 2024-2025

# Master in Computer science

Programme mnemonic MA-INFO > Focus Professional : M-INFOS

Studies level Master 120 credits

Learning language english

Schedule office hours

**Studies category / subcategory** Sciences and technics / Sciences

Campus Plaine

## Programme objectives

The Master program aims to train students to become highlevel computer scientists in the IT industry and/or research. The program wishes to form a new generation of IT executives, managers and researchers who are autonomous, aware of their role in society, and can efficiently acquire new knowledge all along with their career. In particular the students are expected to

# be able to gather information and acquire new knowledge autonomously and with scientific rigour, and adopt a critical attitude in this process.

# master the main mathematical and formal tools needed in computer science.

# be able to read technical literature in English and engage in a technical conversation in English

# master the main concepts and skills related to programming, programming languages, algorithms, software engineering, operating systems, computational intelligence and theoretical results in computer science.

# be able to design—alone or within a group—a computer application of significant complexity, efficiently using the tools of software engineering.

#### Programme's added value

The Master program offers a mandatory common core of 30 ECTS and five optional modules covering major advanced topics in Computer Science:

# Software and critical systems,

# Computational intelligence,

# Optimization,

# Algorithms,

# Web and information systems.

Other optional courses are made available by other related MA programs (e.g. in Applied Sciences).

The advanced classes benefit from the excellence of the research conducted in the Computer Science Department of the Faculty of Science, as witnessed by the publications record and the several awarded prizes, and collaboration with researchers from ULB Applied Sciences and VUB (Vrije Universiteit Brussel).

In the second year of the Master, students can take a three-month full-time internship in either a private company or a research centre.

The program is completed by a MA thesis intended to prepare the student to enter the labour market or to pursue a research career (e.g. by enrolling in doctoral studies).

## Teaching methods

Courses are typically structured in two parts: a theoretical part, in which concepts and theories are developed, and a more practical part, where those concepts are applied to examples and case studies. Courses are complemented by medium- to large-size projects, often inspired by recent and challenging applications of Computer Science.

Teaching assistants are always present during the many practical sessions to offer help and are often available to answer student questions.

Computer rooms, equipped with state-of-the-art hardware and operating systems, are available to students for practicals and projects.

## Succeed in your studies

Choose

The information and guidance counsellors at the InfOR-études [https://www.ulb.be/en/studies-info-desk-1] service will help you choose your studies throughout the year.

#### Succeed

Take part in preparatory courses [https://www.ulb.be/en/studiesinfo-desk-1] or get help to succeed [https://www.ulb.be/en/ studies-info-desk-1], before or during your studies.

#### Get help

Apply for financial aid, look for accommodation or a student job, get support [https://www.ulb.be/fr/aides-services-et-accompagnement/aid-services-and-support-1] for your specific needs.

#### International/Openness

Students can participate in international exchange programs (e.g. Erasmus) to attend classes abroad during one semester. The Computer Science department has several ongoing agreements with other departments around Europe and North America. More specifically, students who follow the specialisation on Optimization may complete one or two semesters at the Université de Nantes (France) and earn a joint degree from the two institutions.

#### Job opportunities

Graduates find work in various sectors: banks, insurance companies, software industry, consulting, hospitals, schools, universities, national and international administrations. They can work as project leaders, IT specialists, data scientists, network architects, security experts, teachers, or researchers. Some conduct their businesses, and others are high-level executives in administrations.

In summary, the main occupations that the program provides access to are:

# IT Project Manager

- # IT Consultant
- # IT Manager
- # Computer security architect
- # Teacher
- # Data scientist
- # Researcher

Contacts

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https://sciences.ulb.be/departement-d-informatique

#### **Jury President** Jean-François RASKIN

**Jury Secretary** Joël GOOSSENS



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## Master in Computer science Focus Professional

The master programme includes three main types of courses: computer science lectures, an introduction to research through the writing of a Master's dissertation, and courses intended to prepare students to enter the job market.

The programme is designed for students who have general skills in computer science, which they can have acquired during the Bachelor in Computer Science at ULB:

- > they are able to gather information and acquire new knowledge autonomously and with scientific rigour, and are able to adopt a critical attitude in this process.
- > they master the main mathematical and formal tools needed in computer science.
- > they can read technical literature in English and engage in a technical conversation in English, as most of the courses in the programme are taught in English (with a few exceptions for electives).
- > They master the main concepts and skills related to programming, programming languages, algorithms, software engineering, operating systems, and fundamental theoretical results in computer science.
- > they are able to design—alone or within a group—a computer application of significant complexity, efficiently using the tools of software engineering.

Students who have not acquired the appropriate background during their Bachelor may, in some cases, have the opportunity to compensate for deficiencies with a tailored curriculum.

## Bloc 1 M-INFOS MA-INFO

## **Cours obligatoires**

ELEC-H473	Microprocessor architecture   Dragomir MILOJEVIC (Coordinator) and Jan Tobias Mühlberg ③ 5 credits [lecture: 24h, practical work: 36h]
INFO-F403	Introduction to language theory and compiling       Gilles GEERAERTS (Coordinator)         Image: State of the state of t
INFO-F404	Real-Time Operating Systems       Joël GOOSSENS (Coordinator)         Image: Standard Stan
INFO-F405	Introduction to cryptography   Christophe PETIT (Coordinator) and Gilles VAN ASSCHE ② 5 credits [lecture: 24h, tutorial classes: 24h, project: 30h]  first term  Final Constant of the second
INFO-F408	O       5 credits [lecture: 36h, tutorial classes: 12h, practical work: 12h]       Image: first term       English
MEMO-F403	Preparatory work for the master thesis       Maarten JANSEN (Coordinator)         ③ 5 credits [personal assignments: 60h]

## Options 1

Option - 2 modules complets dans la liste des modules 1.1 à 1.5 à choisir au cours des deux blocs. Le cours INFO-H-410 est à prendre seulement par les étudiants qui n'ont pas eu de cours d'intelligence artificielle en bachelier.

A total of 30 credits chosen from the following

Module 1.1. Software and critical systems

 INFO-F410
 Embedded systems design | Jean-François RASKIN (Coordinator)

 (optional)
 © 5 credits [lecture: 12h, tutorial classes: 12h, project: 60h]
 🖻 second term 🔎 English

 INFO-F412
 Formal verification of computer systems | Jean-François RASKIN (Coordinator)

 (optional)
 © 5 credits [lecture: 36h, tutorial classes: 12h]
 🖻 first term  $\bigcirc$  English



INFO-F514 (optional)	Protocols, cryptanalysis and mathematical cryptology   Christophe PETIT (Coordinator) and Liran LERMAN ② 5 credits [lecture: 24h] 📋 second term 🔎 English
	Module 1.2. Computational Intelligence
INFO-F409 (optional)	Learning dynamics │ Tom LENAERTS (Coordinator) ② 5 credits [lecture: 24h, practical work: 12h, project: 60h]
INFO-F422 (optional)	Statistical foundations of machine learning   Gianluca BONTEMPI (Coordinator) <ul> <li>5 credits [lecture: 24h, tutorial classes: 12h, project: 60h]</li> <li>second term</li> <li>English</li> </ul>
INFO-F439 (optional)	Methods in Bioinformatics       Matthieu DEFRANCE (Coordinator) and Wim VRANKEN         ③ 5 credits [lecture: 24h, project: 90h]
INFO-H410 (optional)	O 5 credits [lecture: 24h, tutorial classes: 12h]
	Module 1.3. Optimization
INFO-F424 (optional)	Combinatorial optimization Bernard FORTZ (Coordinator) and RENAUD CHICOISNE ③ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 12h, project: 30h] 🗎 second term 🔎 English
INFO-F524 (optional)	Continuous optimization Bernard FORTZ (Coordinator) and Dimitrios Papadimitriou ② 5 credits [lecture: 24h, project: 60h] 📋 second term 📿 English
INFO-H413 (optional)	Heuristic optimisation       Thomas STUTZLE (Coordinator)         ③ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h]
	Module 1.4. Algorithms
INFO-F413 (optional)	Randomized algorithms   Jean CARDINAL (Coordinator)         ③ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] <sup>(1)</sup> first term <sup>(2)</sup> English
INFO-F420 (optional)	Computational geometry       Stefan LANGERMAN F. SWARZBERG (Coordinator)         ③ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h]
INFO-F521 (optional)	Graph theory   Gwenaël JORET (Coordinator) and Yelena YUDITSKY ⊙ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 🛗 first term 🔎 English
	Module 1.5. Data Science
INFO-H415 (optional)	Advanced databases   Esteban ZIMANYI (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] 🛗 first term 🔎 English
INFO-H417 (optional)	Database systems architecture   Mahmoud SAKR (Coordinator)         ③ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h]
INFO-H515 (optional)	Big Data: Distributed Data Management and Scalable Analytics   Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI ② 5 credits [lecture: 24h, tutorial classes: 12h, project: 24h] 🛗 second term 📿 English



# Master in Computer science

# Bloc 2 | M-INFOS | MA-INFO

# Cours obligatoires

INFO-F530	Computer science seminar Tom LENAERTS (Coordinator), Bernard FORTZ, John IACONO, Olivier MARKOWITCH and Dimitrios Papadimitriou
MEMO-F524	Masters thesis   Jean-François RASKIN (Coordinator)
	🕑 20 credits [mfe/tfe: 240h]   academic year 👂 English/French
An alternative cl	hosen from the two following
Options 1	
35 ECTS à chois	sir dans les options 1 dont minimum 2 modules complets au cours des 2 blocs. (60 crédits sur l'ensemble du cycle)
Le cours INFO-I	H-410 est à prendre seulement par les étudiants qui n'ont pas eu de cours d'intelligence artificielle en bachelier.
Up to 60 credit	ts chosen from the following
	Module 1.1 Software and critical systems
INFO-F410 (optional)	Embedded systems design   Jean-François RASKIN (Coordinator) ② 5 credits [lecture: 12h, tutorial classes: 12h, project: 60h]
INFO-F412 (optional)	Formal verification of computer systems   Jean-François RASKIN (Coordinator)         ③ 5 credits [lecture: 36h, tutorial classes: 12h] <sup>(1)</sup> first term <sup>(2)</sup> English
INFO-F514 (optional)	Protocols, cryptanalysis and mathematical cryptology   Christophe PETIT (Coordinator) and Liran LERMAN ② 5 credits [lecture: 24h] 🛗 second term 🔎 English
	Module 1.2 Computational Intelligence
INFO-F409 (optional)	Learning dynamics Tom LENAERTS (Coordinator) ③ 5 credits [lecture: 24h, practical work: 12h, project: 60h]
INFO-F422 (optional)	Statistical foundations of machine learning Gianluca BONTEMPI (Coordinator) I credits [lecture: 24h, tutorial classes: 12h, project: 60h] 🛗 second term 🔎 English
INFO-H410 (optional)	Techniques of artificial intelligence   Hugues BERSINI (Coordinator)         ③ 5 credits [lecture: 24h, tutorial classes: 12h]
	Module 1.3 Optimization
INFO-F424 (optional)	Combinatorial optimization Bernard FORTZ (Coordinator) and RENAUD CHICOISNE ② 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 12h, project: 30h] 📋 second term 👂 English
INFO-F524 (optional)	Continuous optimization Bernard FORTZ (Coordinator) and Dimitrios Papadimitriou ② 5 credits [lecture: 24h, project: 60h] 🛗 second term 💭 English
INFO-H413 (optional)	O       5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h]       C       English

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	Module 1.4 Algorithms
INFO-F413 (optional)	Randomized algorithms   Jean CARDINAL (Coordinator) ③ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h]
INFO-F420 (optional)	Computational geometry Stefan LANGERMAN F. SWARZBERG (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 🛗 first term 🔎 English
INFO-F521 (optional)	Graph theory   Gwenaël JORET (Coordinator) and Yelena YUDITSKY ⊙ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h]
	Module 1.5 Data Science
INFO-H415 (optional)	Advanced databases   Esteban ZIMANYI (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h]
INFO-H417 (optional)	Database systems architecture   Mahmoud SAKR (Coordinator)         Ø 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h]
INFO-H515 (optional)	Big Data: Distributed Data Management and Scalable Analytics   Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI Image: Source of the second term in the second term is the seco
	Module 2.1 Software and critical systems
INFO-H503 (optional)	GPU computing   Daniele Bonatto (Coordinator) ④ 5 credits [lecture: 18h, practical work: 30h, project: 12h] 🛗 second term 💬 English
INFO-Y082 (optional)	Programming Distributed and Replicated Systems         ∅ 6 credits [lecture: 26h, tutorial classes: 26h, project: 30h]         🗂 first term $\bigcirc$ English
INFO-Y085 (optional)	Image: Second
INFO-Y099 (optional)	O 6 credits [lecture: 26h, tutorial classes: 26h]  🗎 second term 🔎 English
INFO-Y110 (optional)	Higher Order Programming         Image: Order State of Control of Contro of Control of Control of Control of Contro of
	Module 2.2 Computational Intelligence
INFO-H414 (optional)	Swarm Intelligence Marco DORIGO (Coordinator) and Mauro BIRATTARI  3 credits [lecture: 12h, practical work: 48h]
INFO-H515 (optional)	Big Data: Distributed Data Management and Scalable Analytics   Dimitrios SACHARIDIS (Coordinator) and Gianluca BONTEMPI © 5 credits [lecture: 24h, tutorial classes: 12h, project: 24h] 🛗 second term 🔎 English
INFO-Y004 (optional)	O       6 credits [lecture: 26h, tutorial classes: 26h]       Image: first term       Image: First term       Image: First term
INFO-Y087 (optional)	O       6 credits [lecture: 26h, tutorial classes: 26h] <sup>(1)</sup> first term          Ç English
	Module 2.3 Optimization
	Module 2.4 Algorithms
INFO-F440 (optional)	Algorithms for big data John IACONO (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 🛗 second term 🔎 English
INFO-H514 (optional)	Quantum information and computation Ognyan ORESHKOV (Coordinator) © 5 credits [lecture: 24h, tutorial classes: 36h]  (f) first term  (colored English)
	Module 2.5 Data Science
INFO-H419 (optional)	Data warehouses   Esteban ZIMANYI (Coordinator) ⊙ 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h]

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INFO-H420 (optional)	Management of Data Science and Business Workflows   Dimitrios SACHARIDIS (Coordinator)         ∅ 5 credits [lecture: 24h, tutorial classes: 36h]
INFO-H423 (optional)	Data Mining Mahmoud SAKR (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] — first term — — English
INFO-H509 (optional)	Geo-Spatial and web technologies   Mahmoud SAKR (Coordinator) ② 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 🛗 second term 🔎 English
INFO-Y528 (optional)	<ul> <li>Information visualisation</li> <li>◎ 6 credits [lecture: 26h, tutorial classes: 26h]</li></ul>
	Module 2.6 Internship
GEST-S483 (optional)	Digital and IT Governance       Georges ATAYA (Coordinator)         Ø 5 credits [lecture: 24h] <sup>(1)</sup> second term <sup>(2)</sup> English
TRAN-F501 (optional)	Internship   Gianluca BONTEMPI (Coordinator) and Maarten JANSEN <ul> <li>If its term</li> <li>If first term</li> <li>If its term</li> </ul>

or

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## Variante Master ORO - Université de Nantes

Students attending one or two semesters at the University of Nantes in the framework of the double diploma register to the 30 or 60 ECTS corresponding to their stay in Nantes in Block 2.

INFO-Y515 (optional)	🗂 unknown term
INFO-Y516 (optional)	Discrete Constraint Programming         ③ 3 credits [lecture: 13h, tutorial classes: 13h]         △ academic year         ○ English
INFO-Y517	Global Optimization
(optional)	② 3 credits [lecture: 13h, tutorial classes: 13h]  🗂 academic year 📿 English
INFO-Y518	Black-box Optimization
(optional)	② 3 credits [lecture: 13h, tutorial classes: 13h] 🗂 academic year 🔉 English
INFO-Y519 (optional)	Multi-Objective Optimization         Ø 3 credits [lecture: 13h, tutorial classes: 13h]
INFO-Y520	Cloud Artifcial Intelligence Services
(optional)	◎ 3 credits [lecture: 13h, tutorial classes: 13h]
INFO-Y521 (optional)	Transportation and Logistics         ∅ 3 credits [lecture: 13h, tutorial classes: 13h]         □ academic year         ♀ English
INFO-Y522	Planning and Scheduling
(optional)	⊙ 3 credits [lecture: 13h, tutorial classes: 13h]
INFO-Y523	Bioinfomatics
(optional)	② 3 credits [lecture: 13h, tutorial classes: 13h]   academic year 🔉 English
INFO-Y524	OR Special Topic II
(optional)	② 2 credits [lecture: 13h, tutorial classes: 13h] 🖞 academic year 👂 English
INFO-Y525 (optional)	O 1 credit [tutorial classes: 26h]
INFO-Y526	Master Thesis (track research)
(optional)	⊙ 20 credits
INFO-Y527	Internship (track application)
(optional)	② 10 credits

