

# 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	<b>Microprocessor architecture</b>   Dragomir MILOJEVIC (Coordinator) and Jan Tobias Mühlberg ⌚ 5 credits [lecture: 24h, practical work: 36h] 📅 second term 🗨 English
INFO-F403	<b>Introduction to language theory and compiling</b>   Gilles GEERAERTS (Coordinator) ⌚ 5 credits [lecture: 24h, tutorial classes: 24h, project: 30h] 📅 first term 🗨 English
INFO-F404	<b>Real-Time Operating Systems</b>   Joël GOOSSENS (Coordinator) ⌚ 5 credits [lecture: 24h, tutorial classes: 12h, project: 30h] 📅 first term 🗨 English
INFO-F405	<b>Introduction to cryptography</b>   Christophe PETIT (Coordinator) and Gilles VAN ASSCHE ⌚ 5 credits [lecture: 24h, tutorial classes: 24h, project: 30h] 📅 first term 🗨 English
INFO-F408	<b>Computability and complexity</b>   Jean-François RASKIN (Coordinator) ⌚ 5 credits [lecture: 36h, tutorial classes: 12h, practical work: 12h] 📅 first term 🗨 English
MEMO-F403	<b>Preparatory work for the master thesis</b>   Maarten JANSEN (Coordinator) ⌚ 5 credits [personal assignments: 60h] 📅 second term 🗨 English

### 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 (optional)	<b>Embedded systems design</b>   Jean-François RASKIN (Coordinator) ⌚ 5 credits [lecture: 12h, tutorial classes: 12h, project: 60h] 📅 second term 🗨 English
INFO-F412 (optional)	<b>Formal verification of computer systems</b>   Jean-François RASKIN (Coordinator) ⌚ 5 credits [lecture: 36h, tutorial classes: 12h] 📅 first term 🗨 English

INFO-F514 (optional) [Protocols, cryptanalysis and mathematical cryptology](#) | Christophe PETIT (Coordinator)  
⌚ 5 credits [lecture: 24h] 📅 second term 🗨 English

## Module 1.2. Computational Intelligence

INFO-F409 (optional) [Learning dynamics](#) | Tom LENAERTS (Coordinator)  
⌚ 5 credits [lecture: 24h, practical work: 12h, project: 60h] 📅 first term 🗨 English

INFO-F422 (optional) [Statistical foundations of machine learning](#) | Gianluca BONTEMPI (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 📅 second term 🗨 English

INFO-F439 (optional) [Methods in Bioinformatics](#) | Matthieu DEFRANCE (Coordinator) and Wim VRANKEN  
⌚ 5 credits [lecture: 24h, project: 90h] 📅 second term 🗨 English

INFO-H410 (optional) [Techniques of artificial intelligence](#) | Hugues BERSINI (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h] 📅 second term 🗨 English

## Module 1.3. Optimization

INFO-F424 (optional) [Combinatorial optimization](#) | Bernard FORTZ (Coordinator) and RENAUD CHICOISNE  
⌚ 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  
⌚ 5 credits [lecture: 24h, project: 60h] 📅 second term 🗨 English

INFO-H413 (optional) [Heuristic optimisation](#) | Thomas,T STUTZLE (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 second term 🗨 English

## Module 1.4. Algorithms

INFO-F413 (optional) [Randomized algorithms](#) | Jean CARDINAL (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 📅 first term 🗨 English

INFO-F420 (optional) [Computational geometry](#) | Stefan LANGERMAN F. SWARZBERG (Coordinator)  
⌚ 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] 📅 first term 🗨 English

## Module 1.5. Data Science

INFO-H415 (optional) [Advanced databases](#) | Esteban ZIMANYI (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] 📅 first term 🗨 English

INFO-H417 (optional) [Database systems architecture](#) | Mahmoud SAKR (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 first term 🗨 English

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



# Master in Computer science

## Focus Professional

### 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  
 ⌚ 5 credits [seminars: 36h, project: 60h] 📅 first and second terms 🗨 English
- MEMO-F524 **Masters thesis** | Jean-François RASKIN (Coordinator)  
 ⌚ 20 credits [mfe/tfe: 240h] 📅 academic year 🗨 English/French

*An alternative chosen from the two following*

## Options 1

35 ECTS à choisir dans les options 1 dont minimum 2 modules complets au cours des 2 blocs. (60 crédits sur l'ensemble du cycle)

Le cours INFO-H-410 est à prendre seulement par les étudiants qui n'ont pas eu de cours d'intelligence artificielle en bachelier.

*Up to 60 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 🗨 English
- INFO-F514 **Protocols, cryptanalysis and mathematical cryptology** | Christophe PETIT (Coordinator)  
 (optional) ⌚ 5 credits [lecture: 24h] 📅 second term 🗨 English

### Module 1.2 Computational Intelligence

- INFO-F409 **Learning dynamics** | Tom LENAERTS (Coordinator)  
 (optional) ⌚ 5 credits [lecture: 24h, practical work: 12h, project: 60h] 📅 first term 🗨 English
- INFO-F422 **Statistical foundations of machine learning** | Gianluca BONTEMPI (Coordinator)  
 (optional) ⌚ 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 📅 second term 🗨 English
- INFO-H410 **Techniques of artificial intelligence** | Hugues BERSINI (Coordinator)  
 (optional) ⌚ 5 credits [lecture: 24h, tutorial classes: 12h] 📅 second term 🗨 English

### Module 1.3 Optimization

- INFO-F424 **Combinatorial optimization** | Bernard FORTZ (Coordinator) and RENAUD CHICOISNE  
 (optional) ⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 12h, project: 30h] 📅 second term 🗨 English
- INFO-F524 **Continuous optimization** | Bernard FORTZ (Coordinator) and Dimitrios PAPADIMITRIOU  
 (optional) ⌚ 5 credits [lecture: 24h, project: 60h] 📅 second term 🗨 English
- INFO-H413 **Heuristic optimisation** | Thomas, T STUTZLE (Coordinator)  
 (optional) ⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 second term 🗨 English

## Module 1.4 Algorithms

- INFO-F413 (optional) **Randomized algorithms** | Jean CARDINAL (Coordinator)  
 5 credits [lecture: 24h, tutorial classes: 12h, project: 60h] 📅 first term 🗣 English
- INFO-F420 (optional) **Computational geometry** | Stefan LANGERMAN F. SWARZBERG (Coordinator)  
 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] 📅 first term 🗣 English

## Module 1.5 Data Science

- INFO-H415 (optional) **Advanced databases** | Esteban ZIMANYI (Coordinator)  
 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] 📅 first term 🗣 English
- INFO-H417 (optional) **Database systems architecture** | Mahmoud SAKR (Coordinator)  
 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 first term 🗣 English
- 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

## Module 2.1 Software and critical systems

- INFO-H503 (optional) **GPU computing** | Jan LEMEIRE (Coordinator) and Daniele Bonatto  
 5 credits [lecture: 18h, practical work: 30h, project: 12h] 📅 second term 🗣 English
- INFO-Y082 (optional) **Distributed and mobile programming paradigms**  
 6 credits [lecture: 26h, tutorial classes: 26h, project: 30h] 📅 first term 🗣 English
- INFO-Y085 (optional) **Functional programming** | Wolfgang DE MEUTER (Coordinator)  
 6 credits [lecture: 26h, tutorial classes: 26h] 📅 second term 🗣 English
- INFO-Y099 (optional) **Multicore programming**  
 6 credits [lecture: 26h, tutorial classes: 26h] 📅 second term 🗣 English
- INFO-Y110 (optional) **Higher Order Programming**  
 6 credits [lecture: 26h, tutorial classes: 26h] 📅 first term

## Module 2.2 Computational Intelligence

- INFO-H414 (optional) **Swarm Intelligence** | Marco DORIGO (Coordinator) and Mauro BIRATTARI  
 5 credits [lecture: 12h, practical work: 48h] 📅 second term 🗣 English
- 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) **Natural language processing** | VAN EECKE Paul  
 6 credits [lecture: 26h, tutorial classes: 26h] 📅 first term 🗣 English
- INFO-Y087 (optional) **Declarative programming**  
 6 credits [lecture: 26h, tutorial classes: 26h] 📅 first term 🗣 English

## Module 2.3 Optimization

## Module 2.4 Algorithms

- INFO-F440 (optional) **Algorithms for big data** | John IACONO (Coordinator)  
 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] 📅 first term 🗣 English

## Module 2.5 Data Science

- INFO-H419 (optional) **Data warehouses** | Esteban ZIMANYI (Coordinator)  
 5 credits [lecture: 24h, tutorial classes: 24h, practical work: 12h] 📅 first term 🗣 English



- INFO-H420 (optional) **Management of Data Science and Business Workflows** | Dimitrios SACHARIDIS (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 36h] 📅 first term 🗨 English
- INFO-H423 (optional) **Data Mining** | Mahmoud SAKR (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 first term 🗨 English
- INFO-H509 (optional) **Geo-Spatial and web technologies** | Mahmoud SAKR (Coordinator)  
⌚ 5 credits [lecture: 24h, tutorial classes: 12h, practical work: 24h] 📅 second term 🗨 English
- INFO-Y528 (optional) **Information visualisation**  
⌚ 6 credits [lecture: 26h, tutorial classes: 26h] 📅 second term 🗨 English
- Module 2.6 Internship**
- GEST-S483 (optional) **Digital and IT Governance** | Georges ATAYA (Coordinator)  
⌚ 5 credits [lecture: 24h] 📅 second term 🗨 English
- TRAN-F501 (optional) **Internship** | Gianluca BONTEMPI (Coordinator) and Maarten JANSEN  
⌚ 15 credits [project: 200h] 📅 first term 🗨 English

or

## 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) **Large Scale Optimisation**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y516 (optional) **Discrete Constraint Programming**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y517 (optional) **Global Optimization**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y518 (optional) **Black-box Optimization**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y519 (optional) **Multi-Objective Optimization**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y520 (optional) **Cloud Artificial Intelligence Services**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year 🗨 English
- INFO-Y521 (optional) **Transportation and Logistics**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y522 (optional) **Planning and Scheduling**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y523 (optional) **Bioinformatics**  
⌚ 3 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y524 (optional) **OR Special Topic II**  
⌚ 2 credits [lecture: 13h, tutorial classes: 13h] 📅 academic year
- INFO-Y525 (optional) **Conferences**  
⌚ 1 credit [tutorial classes: 26h] 📅 academic year
- INFO-Y526 (optional) **Master Thesis (track research)**  
⌚ 20 credits 📅 academic year
- INFO-Y527 (optional) **Internship (track application)**  
⌚ 10 credits 📅 academic year



