



## DATE2M - Introduction

### Introduction

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#### Introduction

The digital transformation of society has led to explosive growth in the volume of data available. Most of the players in society now place great importance on using this data to help make objective decisions and develop their disciplinary focus. These specific needs have resulted in the emergence of **new data-oriented careers**.

The engineering master's in data science offers a course in **scientific methods and technology tools** for answering social or scientific questions based on **the processing of frequently massive data sets** ("big data"). This discipline usually requires a structured model of the problem in question to be combined with statistics and mathematics to deliver a rigorous, quantitative, operational solution to the question posed. Computer infrastructure and complex calculation algorithms thus complement scientific methods in structuring and processing the data.

A computer infrastructure and complex calculation algorithms also complement these scientific methods to enable the structuring and processing of data.

Finally, cybersecurity has become an essential element in a data-centric world: it will be a question of understanding and being able to manage the risks associated with the data itself, but also of being able to protect stored data and circulate it securely.

The **fields of application** of data science are extremely varied: political and security decision-making, e-commerce, processing network data, processing financial and industrial production data, natural language processing, biomedical research based on microbiological or imaging data.

#### Your profile

You have completed a bachelor's or master's degree in which you have acquired solid skills and a taste for the three basic building blocks of data science: mathematics, statistics and computer science, as well as a curiosity for the application areas of these disciplines.

You have a good command of technical English and are able to follow lectures, read scientific literature, write reports and express yourself orally in this language. You have the general skills and personal qualities necessary for computer science, such as autonomy, critical thinking, self-learning and the ability to research and process information.

An additional teaching block (of maximum 60 credits) may be offered to students who lack some of these skills.

#### Your future job

Your degree in data science prepares you for the posts of « data scientist », « data analyst », « security analyst », « data and analytics manager », « data engineer », « security engineer », or « security architect ».

#### Your programme

The programme: Engineering in Data Science at UCLouvain is based on a common core that provides a technical foundation in the fields of learning theory, databases, and linear statistical models.

This common core is completed by the choice of a focus on data analysis or a focus on cybersecurity.

The data analysis focus offers a range of algorithmic and statistical methods for data mining, learning, and visualization of large data sets.

The cybersecurity focus is structured around five pillars: cryptography, privacy, and hardware, software and system security, as well as an introduction to information theory.

These pillars are completed by majors and elective courses that allow students to deepen their knowledge of algorithmic, computer science, statistical, application or entrepreneurial aspects.

#### Your parcours

You will primarily develop strong, in-depth, cross-disciplinary skills to be able to address a broad spectrum of data science and cybersecurity problems and to carry out projects or develop research in the field.

Your programme will offer you opportunities to explore, through projects, internships or applied courses, the extremely varied fields of application of data science.

## DATE2M - Teaching profile

### Learning outcomes

Acquérir de solides bases méthodologiques en analyse et traitement de données et les appliquer dans des domaines variés tel que sciences humaines, ingénierie, marketing, finance, assurance ou sciences du vivant...

Au terme de la formation, l'étudiant maîtrisera les concepts fondamentaux en algorithmique, data mining, machine learning, informatique, mathématiques, statistique nécessaires à l'exercice du métier de « data scientist ». Il développera des compétences en communication et sera capable d'analyser un problème complexe, de collaborer à un projet de recherche. Selon les objectifs visés par l'étudiant, deux options non-exclusives sont proposées : systèmes informatiques, et méthodes numériques et optimisation.

On successful completion of this programme, each student is able to :

1. Démontrer la maîtrise d'un solide corpus de connaissances en sciences des données (finalité AD) ou sécurité des données (finalité CS), lui permettant de résoudre les problèmes qui relèvent de sa discipline
  - 1.1. Les structures de données et algorithmes pour l'analyse de données
  - 1.2. Les théories de l'apprentissage, la fouille de données et la visualisation de données de grande dimension
  - 1.3. L'inférence statistique, la modélisation et l'informatique statistique. L'étudiant dans l'orientation technologies de l'information se spécialise via des cours obligatoires ou au choix
  - 1.4. Les aspects industriels et entrepreneuriaux de la science des données. L'étudiant dans l'orientation en technologies de l'information se spécialise via une option
  - 1.5. La sécurité des données dans ses aspects logiciels, matériel ou cryptographiques.
  - 1.6 Les systèmes informatiques, y compris le calcul distribué, le calcul embarqué, les réseaux et la sécurité (cours optionnels).
  - 1.7 Les méthodes numériques et l'optimisation, y compris la programmation par contraintes, la recherche opérationnelle, l'identification et les mathématiques appliquées (cours optionnels)
2. Organiser et de mener à son terme une démarche de développement d'un système d'exploitation et sécurité de données répondant aux besoins généralement complexes d'un client.
  - 2.1. Analyser le problème à résoudre ou les besoins fonctionnels à rencontrer et formuler le cahier des charges correspondant.
  - 2.2. Formaliser et modéliser le problème et concevoir une ou plusieurs solutions techniques originales répondant à ce cahier des charges.
  - 2.3. Evaluer, justifier et classer les solutions au regard de l'ensemble des critères figurant dans le cahier de charges : efficacité, faisabilité, qualité, pertinence et sécurité.
  - 2.4. Implémenter, tester et valider la solution retenue et en interpréter les résultats.
  - 2.5. Formuler des recommandations pour améliorer le caractère opérationnel de la solution.
3. Organiser et de mener à son terme un travail de recherche pour appréhender une problématique inédite liée à l'exploitation et la sécurité des données selon une méthodologie ou dans un environnement nouveau.

## Programme structure

The 120-credit Master in Data Science programme consists of the following items.

**A common curriculum of 46 credits, including a final thesis and teaching units in:**

- Databases
- Machine Learning
- Statistics
- A seminar
- Professional integration work.

**One focus of 30 credits will be taken among a choice of two:**

- The data analytics focus offers a range of algorithmic and statistical methods for data mining, learning, and visualization of large data sets.
- The cybersecurity focus is structured around 5 pillars: cryptography, hardware, software and system security, and privacy, as well as an introduction to information theory.

**Elective courses and/or options are chosen so as to reach at least 120 credits.**

To the 120-credit programme may be added an additional preparatory module for students who do not have all the prerequisites for the Master. These teaching units will be selected with the study advisor.

### DATE2M Programme

## Detailed programme by subject

### CORE COURSES [46.0]

- Mandatory
- ✘ Optional
- △ Not offered in 2023-2024
- ⊙ Not offered in 2023-2024 but offered the following year
- ⊕ Offered in 2023-2024 but not the following year
- △ ⊕ Not offered in 2023-2024 or the following year
- Activity with requisites
- 🌐 Open to incoming exchange students
- 🚫 Not open to incoming exchange students
- (FR) Teaching language (FR, EN, ES, NL, DE, ...)

Click on the course title to see detailed informations (objectives, methods, evaluation...)

				Year	
				1	2
● LDATE2990	<b>Master thesis</b> <i>The graduation project can be written and presented in French or English, in consultation with the supervisor. It may be accessible to exchange students by prior agreement between the supervisors and/or the two universities.</i>		EN [q1+q2] [ ] [25 Credits] 🌐 > French-friendly	x	x
● LEPL2020	<b>Professional integration work</b> <i>Les modules du cours LEPL2020 sont organisés sur les deux blocs annuels du master. Il est fortement recommandé à l'étudiant.e de les suivre dès le bloc annuel 1, mais il.elle ne pourra inscrire le cours qu'au plus tôt l'année où il.elle présente son travail de fin d'études.</i>	Myriam Banaï Francesco Contino (coord.) Delphine Ducarme Jean-Pierre Raskin	EN [q1+q2] [30h+15h] [2 Credits] 🌐 > French-friendly	x	x
● LINFO2172	<b>Databases</b>	Siegfried Nijssen	x EN [q2] [30h+30h] [6 Credits] 🌐 > French-friendly		



				Year	
				1	2
<input checked="" type="radio"/> LINFO2262	Machine Learning :classification and evaluation	Pierre Dupont	EN [q2] [30h+30h] [5 Credits] > French-friendly	x	x

⊗ One course to choose from

<input checked="" type="checkbox"/> LINFO2399	Industrial seminar in computer science	Yves Deville Bernard Geubelle	EN [q2] [30h] [3 Credits] > French-friendly	x	x
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## ***LIST OF FOCUSES***

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- > Professional Focus : Data Analytics [ en-prog-2023-date2m-ldate210s ]
- > Professional Focus : Cybersecurity [ en-prog-2023-date2m-ldate230s ]

## ***PROFESSIONAL FOCUS : DATA ANALYTICS [30.0]***

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Year

1 2

○ LELEC2770	Privacy Enhancing technology	Thomas Peters (compensates Olivier Pereira) François- Xavier Standaert	EN [q1] [30h+30h] [5 Credits]  > French-friendly	x	x
○ LINFO2347	Computer system security	Ramin Sadre	EN [q2] [30h+15h] [5 Credits]  > French-friendly	x	x
○ LINFO2144	Secured systems engineering	Axel Legay	EN [q2] [30h+15h] [5 Credits]  > French-friendly	x	x
○ LMAT2450	Cryptography	Thomas Peters (compensates Olivier Pereira)	EN [q1] [30h+15h] [5 Credits]  > French-friendly	x	x
○ LINGI2348	Information theory and coding	Jérôme Louveaux Jérôme Louveaux (compensates Olivier Pereira) Benoît Macq	EN [q2] [30h+15h] [5 Credits]  > French-friendly	x	x





## MAJOR IN NUMERICAL METHODS AND OPTIMISATION

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- Mandatory
- ✂ Optional
- △ Not offered in 2023-2024
- ⊖ Not offered in 2023-2024 but offered the following year
- ⊕ Offered in 2023-2024 but not the following year
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[Click on the course title to see detailed informations \(objectives, methods, evaluation...\)](#)

*The student who wishes to validate this option chooses 15 credits among:*

Year

1 2

## ***ELECTIVE TECHNICAL COURSES***

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- Mandatory
  - ✘ Optional
  - △ Not offered in 2023-2024
  - ⊖ Not offered in 2023-2024 but offered the following year
  - ⊕ Offered in 2023-2024 but not the following year
  - △ ⊕
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**OPTIONS ET COURS AU CHOIX EN CONNAISSANCES SOCIO-ÉCONOMIQUES**  
**[3.0]**

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**BUSINESS RISKS AND OPPORTUNITIES**

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- Mandatory
  - ✂ Optional
  - △ Not offered in 2023-2024
  - ⊙ Not offered in 2023-2024 but offered the following year
  - ⊕ Offered in 2023-2024 but not the following year
  - △ ⊕ Not offered in 2023-2024 or the following year
  - Activity with requisites
  - 🌐 Open to incoming exchange students
  - 🚫 Not open to incoming exchange students
  - [FR] Teaching language (FR, EN, ES, NL, DE, ...)
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## **MAJOR IN INTERDISCIPLINARY PROGRAM IN ENTREPRENEURSHIP - INEO**

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Commune à la plupart des masters de l'EPL, cette option a pour objectif de familiariser l'étudiant-e avec les spécificités de l'entrepreneuriat et de la création d'entreprise afin de développer chez lui les aptitudes, connaissances et outils nécessaires à la création d'entreprise.

Cette option rassemble des étudiants de différentes facultés en équipes interdisciplinaires afin de créer un projet entrepreneurial. La formation interdisciplinaire en entrepreneuriat (INEO) est une option qui s'étend sur 2 ans et s'intègre dans plus de 30 Masters de 9 facultés/écoles de l'UCLouvain. Le choix de l'option INEO implique la réalisation d'un mémoire interfacultaire (en équipe) portant sur un projet de création d'entreprise. L'accès à cette option, ainsi qu'à chacun des cours, est limité aux étudiant-es sélectionnés sur dossier. Toutes les informations sur <https://uclouvain.be/fr/etudier/ineo> (<https://uclouvain.be/fr/etudier/ineo>).





## Supplementary classes

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**To access this Master, students must have a good command of certain subjects. If this is not the case, students must take supplementary classes chosen by the faculty to satisfy course prerequisites.**

- Mandatory
- ⌘ Optional
- △ Not offered in 2023-2024
- ⊙ Not offered in 2023-2024 but offered the following year
- ⊕ Offered in 2023-2024 but not the following year
- △ ⊕ Not offered in 2023-2024 or the following year
- Activity with requisites
- 🌐 Open to incoming exchange students
- 🚫 Not open to incoming exchange students
- [FR] Teaching language (FR, EN, ES, NL, DE, ...)

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[Click on the course title to see detailed informations \(objectives, methods, evaluation...\)](#)

### ⌘ Mathematics - Calculus and linear algebra

*The student follows one of the following blocks:*

∞ LINMA2111

Discrete mathematics II : Algorithms and complexity



## Course prerequisites

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The **table** below lists the activities (course units, or CUs) for which there are one or more prerequisites within the programme, i.e. the programme CU for which the learning outcomes must be certified and the corresponding credits awarded by the jury before registering for that CU.

These activities are also identified in **the detailed programme**: their title is followed by a yellow square.

### **Prerequisites and student's annual programme**

As the prerequisite is for CU registration puposes only, there are no prerequisites within a programme year. Prerequisites are defined. the

**DATE2M - Information**

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Bachelor in Engineering	For others institutions	Access based on application	degree may have an adapted master programme. See "Personalized access"
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### Non university Bachelors

> Find out more about [links](#) to the university

### Holders of a 2nd cycle University degree

Diploma	Special Requirements	Access	Remarks
<b>"Licenciés"</b>			
<b>Masters</b>			

## Teaching method

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### Active learning and soft skills

You will play an active role in your training. The teaching approach is a balanced mix of lectures, exercises, projects to be carried out alone or in groups. The teaching methods are varied. At certain times, you will be led to discover concepts or techniques independently, and the teaching staff is then seen as a resource made available to you to support your learning.

At other times, the pedagogy is more transmissive and provides you with the necessary keys to carry out subsequent tasks. An important place is reserved for non-technical skills (autonomy, organisational skills, time management, communication in different modes, etc.). In particular, through a pedagogy that emphasises project activities (including a large-scale project that puts groups of students in a semi-professional situation), the course develops a critical mind capable of designing, modelling, implementing and validating complex computer systems.

### Languages

The lingua franca of data science is mainly English. The use of English throughout the programme allows you to develop your command of this language, which will facilitate your professional integration. Course materials and supervision are in English. However, you can always ask questions or take the exam in French if you wish. In addition, the programme offers the possibility of attending extra language courses and participating in exchange programmes abroad.

### Interdisciplinarity

Like many academics, the data scientist will be required to manage projects and a team in the course of his or her career, and will have to take an interest in the complex socio-economic context in which data science is embedded. You will therefore be invited to open up your training to other disciplines via elective courses or certain options such as the option "interdisciplinary program in entrepreneurship".

## Evaluation

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***The evaluation methods comply with the regulations concerning studies and exams (<https://uclouvain.be/fr/decouvrir/rgee.html>). More detailed explanation of the modalities specific to each learning unit are available on their description sheets under the heading "Learning outcomes evaluation method".***

Each unit of the programme includes an oral or written examination, often supplemented by a project leading to a report which is part of the assessment. The optional internship and the master thesis each involve the writing of a document which is defended orally before a jury.

To compute the final grade, the marks obtained for the teaching units are weighted by their respective credits.

## Mobility and/or Internationalisation outlook

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Since their creation, the Ecole Polytechnique de Louvain (EPL) has participated in the various [mobility programmes](#) that have been set up both at the European level and at the global level.

## Possible trainings at the end of the programme

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The Master of Engineering in Data Science can be followed, under certain conditions, by a PhD thesis.

## Contacts

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### Curriculum Management

#### Entity

Structure entity	SST/EPL/DACS
Denomination	<a href="#">(DACS)</a>
Faculty	Louvain School of Engineering ( <a href="#">EPL</a> )
Sector	Sciences and Technology ( <a href="#">SST</a> )
Acronym	DACS
Postal address	Avenue Georges Lemaître 4-6 - bte L4.05.01 1348 Louvain-la-Neuve
Website	<a href="http://www.uclouvain.be/epl">www.uclouvain.be/epl</a>
Academic supervisor:	<a href="https://uclouvain.be/repertoires/laurent.jacques">Laurent Jacques</a> ( <a href="https://uclouvain.be/repertoires/laurent.jacques">https://uclouvain.be/repertoires/laurent.jacques</a> )

Jury

- Président: Claude Oestges

