INTERNATIONAL BACHELOR IN DATA SCIENCE

Data Science by Design

SYLLABUS

GENERAL OVERVIEW

A 4-year Bachelor

FIRST YEAR

The basics in mathematics, an initiation to data analysis

SECOND YEAR

More mathematics, a bit of computer science and statistics

THIRD YEAR

Intensive year focused on data science and statistics

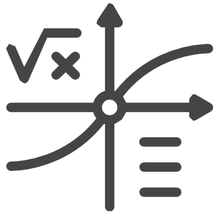
FOURTH YEAR

More computer science, data visualization, big data

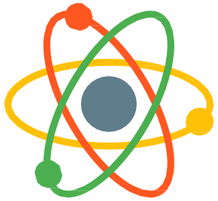
AFTER

You land a job, or you go for a Master

GENERAL OVERVIEW

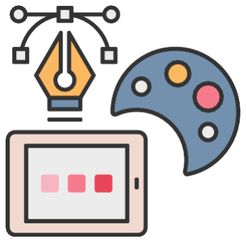


10 Classes of Mathematics



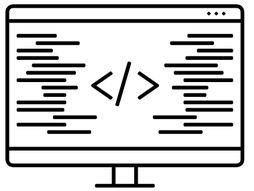
3 Classes of Physics

16 Classes of Data Science

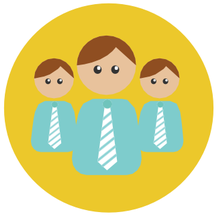


4 Classes of Economics

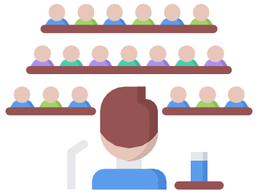
14 Classes of Computer Science



14 short and long-term projects



10 Conferences a year



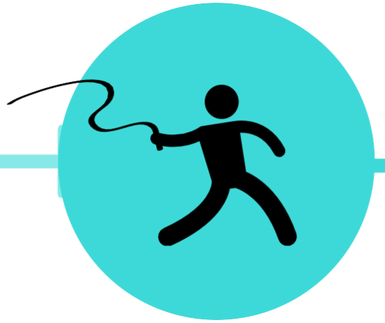
12 Classes of Human Sciences

INTERNSHIPS

FIRST YEAR

4 weeks

SECOND YEAR



8 weeks

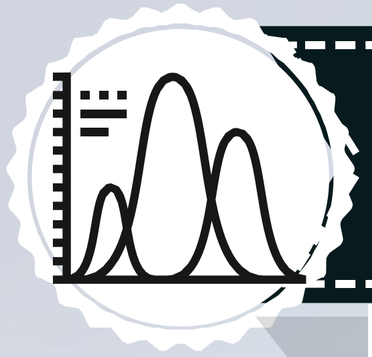
THIRD YEAR

16 weeks

FOURTH YEAR

16 or 24 weeks

Internships are mandatory and represent one of the most important aspects of the training in the Bachelor. Their length increase every year. Students are encouraged to do such internships abroad.



Algorithms and Programming 1

Duration : 60 hours (5 ECTS)

- Assignment statement
- Loop statement
- Conditional statement
- Functions and procedures
- Recursion
- Basics of Python
- Arrays

First year - first semester (B1S1)

Basic Tools in Mathematics

Duration : 60 hours (5 ECTS)

- Logic
- Propositional calculus
- Sets and relations
- Functions
- Arithmetic
- Trigonometry
- Complex Numbers
- Polynomials
- Rational functions

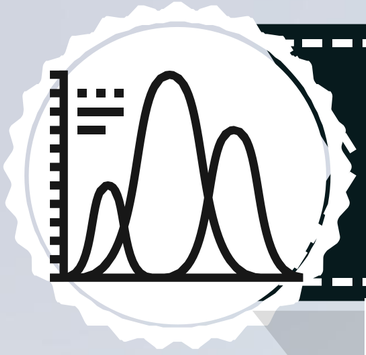
First year - first semester (B1S1)

Analysis 1

Duration : 60 hours (5 ECTS)

- Real Numbers
- Sequences of real numbers
- Elementary functions
- Limits
- Continuity

First year - first semester (B1S1)



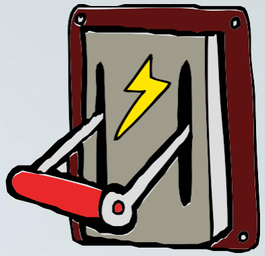
Probability 1

Duration : 30 hours (3 ECTS)

- Probability space
  - Sample space
  - Events
  - Probability
- Conditioning and dependence
  - Conditional probability
  - Total probability and Bayes formulas
  - Independence

First year - first semester (B1S1)

Electricity



Duration : 30 hours (2 ECTS)

- Fundamentals of electricity
- Direct current
- Principle of alternating current
- Inductive and capacitive circuits
- General RCL circuits
- Introduction to Arduino

First year - first semester (B1S1)

Microeconomics

Duration : 30 hours (2,5 ECTS)

- Scarcity, work and choice
- Social interactions
- The firm and its customers
- Supply and demand
- Price-setting, rent-setting and market dynamics
- Markets, efficiency and public policy
- Economics of environment

First year - first semester (B1S1)

Principles of accounting

Duration : 30 hours (2,5 ECTS)

- Fundamentals of accounting
- Recording process of transactions
- Operations concerning the Jounral and the financial statements
- Internal control in companies and the corresponding limits

First year - first semester (B1S1)

Linear Algebra

Duration : 60 hours (5 ECTS)

- Vector spaces
- Bases
- Linear functions
- Matrices, determinants
- Linear systems
- Matrix diagonalization and applications

First year - second semester (B1S2)

Analysis 2

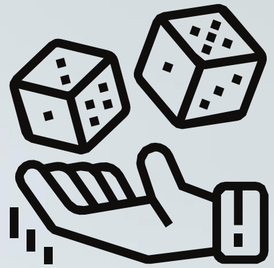
fx

Duration : 60 hours (5 ECTS)

- Derivatives
- Polynomial approximation
- Integration
- Differential equations
- Basics in convex analysis

First year - second semester (B1S2)

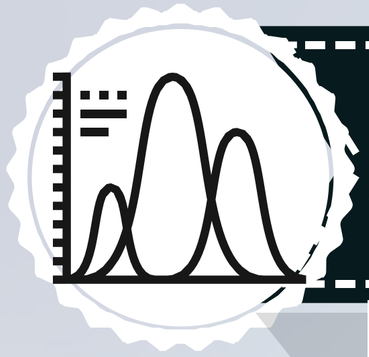
Probability 2



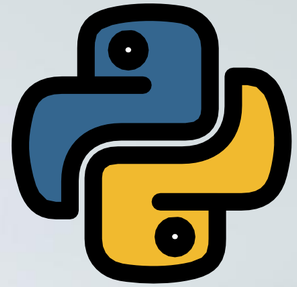
Duration : 30 hours (3 ECTS)

- Discrete random variables
  - Expectation, variance, standard deviation
  - Common discrete distributions
- Continuous random variables
  - Probability density function
  - Expectation, variance, standard deviation
  - Common continuous distributions

First year - second semester (B1S2)



Algorithmics and Programming 2



Duration : 50 hours (5 ECTS)

- Data structure axiomatization
- Linear and non linear structures
- Implementation of data structures
- Basics of complexity analysis

First year - second semester (B1S2)

Introduction to Modelling

Duration : 30 hours (2 ECTS)

- Confidence Models
- Axelrod Model
- Schelling Models
- Contagious Models

First year - second semester (B1S2)

Macroeconomics

Duration : 30 hours (2,5 ECTS)

- The capitalist revolution and technology
- Population and growth
- Economic fluctuations and unemployment
- Government policies to fight economic fluctuations
- Fiscal policy and unemployment
- Technological progress and employment

First year - second semester (B1S2)

Principles of Finance

Duration : 30 hours (2,5 ECTS)

- Financial concepts: time value of money, discount of cash flow and capitalization
- Valuation of bonds and common stocks
- Portfolio theory
- Capital asset pricing model

First year - second semester (B1S2)

Bilinear Algebra

Duration : 45 hours (4 ECTS)

- Bilinear forms, quadratic forms, scalar product
- Euclidean and Hilbert spaces, norms
- Orthogonality
- Linear operators
- Applications

2nd year - first semester (B2S1)

Multivariable Calculus

Duration : 70 hours (6 ECTS)

- Parametric equations and polar coordinates
- Vectors and
- geometry Vector
- functions
  Introduction to partial
- differential equations
- Multiple integrals
  Vector calculus

2nd year - first semester (B2S1)

Applied Maths for Data Science

Duration : 30 hours (3 ECTS)

- Discrete dynamical systems
- Introduction to finite-state Markov chains
- Steady states and Perron-Frobenius theorem
- Communication classes
- The fundamental matrix

2nd year - first semester (B2S1)

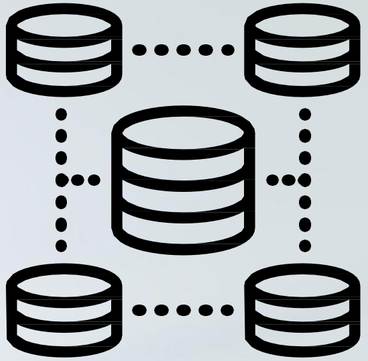
Object oriented and Java Programming

Duration : 60 hours (5 ECTS)

- Software Developement Life Cycle
- Object-oriented principles
- UML
- Java
- Preliminary to design patterns

2nd year - first semester (B2S1)

Relational Databases



Duration : 60 hours (5 ECTS)

- Basic theoretical concepts
- SQL Language
- Entity-relationship model
- Schema optimization
- Index and views
- Transaction processing
- Query optimization
- Database tunning

2nd year - first semester (B2S1)

Project Management

Duration : 30 hours (2 ECTS)

- Return on investment and interest rate
- Work breakdown and responsability assignment matrix
- Gantt chart
- Report design
- Evalution of a team efficiency

2nd year - first semester (B2S1)

Series

Duration : 60 hours (5 ECTS)

- Local comparison of functions
- Infinite series
- Sequences and series of functions
- Power series
- Fourier series

2nd year - second semester (B2S2)

Statistics

Duration : 40 hours (3 ECTS)

- Random vectors
- Joint, marginal and conditional distributions
- Sequences of random variables and convergence
- Inferential statistics

2nd year - second semester (B2S2)

Data Analysis

Duration : 50 hours (4 ECTS)

- General principles of factor analysis
- Analysis of variance
- Simple and multiple linear regression
- Correlation analysis
- Non linear regression
- Principal components analysis

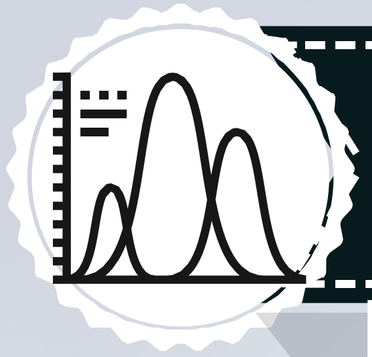
2nd year - second semester (B2S2)

Computer Networks

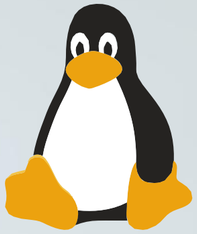
Duration : 30 hours (2,5 ECTS)

- Introduction to data communication and networking
- OSI Model
- ICP/IP Model
- IP Addressing
- Networking Services

2nd year - second semester (B2S2)



Operating Systems



Duration : 30 hours (2,5 ECTS)

- Navigating the system
- Users and permissions
- Packages and software management
- File systems
- Process management

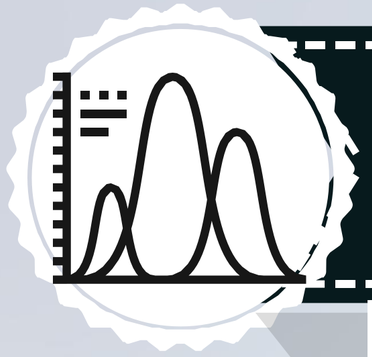
2nd year - second semester (B2S2)

Advanced Modelling

Duration : 60 hours (5 ECTS)

- Multilayer dynamics
- Dynamics on temporal networks
- Dynamics on high-order networks
- Reinforcement learning agents

2nd year - second semester (B2S2)



Dynamic Web Programming

Duration : 30 hours (3 ECTS)

- Getting started with the Java EE environment
- Servlet (Facade pattern)
- JSP, MVC Architecture applied to a Java project
- JavaBeans and Scopes
- EL/JSTL (2 slots)
- Cookies

2nd year - second semester (B2S2)

Introduction to Machine & Deep Learning

Duration : 60 hours (5 ECTS)

- Neural networks (NN)
- Architectures of NN
- Model training and Gradient Descent
- Activation Functions
- Keras
- Tensorflow

3rd year - first semester (B3S1)

Intermediate Statistics

Duration : 30 hours (2 ECTS)

- Bases of the linear model
- Logistic regression and Generalized linear model
- Survival analysis
- Mixed-effects models

3rd year - first semester (B3S1)

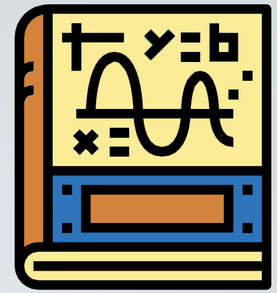
Data and Critical Thinking

Duration : 30 hours (3 ECTS)

- Decomposing an argument
- Argument validity, fallacy
- Questionnable cause
- Inductive reasoning and informal fallacies
- Formal fallacies
- Refutation
- Specific issues with data reporting

3rd year - first semester (B3S1)

Introduction to Information Theory



Duration : 30 hours (3 ECTS)

- Entropy
- Conditional and mutual information
- Data processing inequalites
- Transition probability matrix
- Random walks
- Coding theory
- Channel capacity

3rd year - first semester (B3S1)

Social Network Analysis

Duration : 30 hours (2 ECTS)

- Vizualisation of social networks
- Centrality measures
- Betweeness centrality measure
- Adajency matrix
- Hierarchical clustering

3rd year - first semester (B3S1)

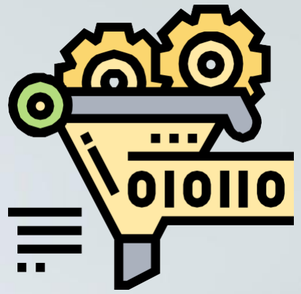
Mobile Programming

Duration : 30 hours (3 ECTS)

- Introduction, history, Android Studio, Hello Word
- Activity, intent, service, activity cycle life
- Interfaces, icons, menus
- Persistent data, files, shared preferences
- Web service (REST), Kotlin, JNI, Android NDK

3rd year - first semester (B3S1)

Data Wrangling and Preprocessing



Duration : 30 hours (3 ECTS)

- Manipulating dtat with dplyr
- Merging, filtering and applying functions
- Dealing with missing data
- Identifying and treating abnormalities in a dataset

3rd year - first semester (B3S1)

Text Mining and Natural Language Processing

Duration : 30 hours (2 ECTS)

- Information unstructured vs (semi-)structured data
- Text mining pipeline
- Text mining and Bag-of-Words with R
- Introduction to natural language processing with Python
- NLP and Deep Learning

3rd year - first semester (B3S1)

Dimensionality Reduction and Clustering Algorithms

Duration : 30 hours (2 ECTS)

- K-means
- Hierarchical Clustering
- Principal Component Analysis (PCA)
- Describing a clustering project
- Describing a PCA

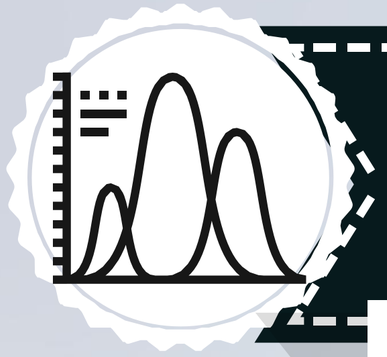
3rd year - first semester (B3S1)

Cloud Computing & Machine Learning

Duration : 30 hours (2 ECTS)

- Amazon Web Service
- Microsoft Azure
- Distributed storage system
- Multi-core operating system
- Security in the cloud
- Implementing a Machine Learning project in the cloud

4th year - first semester (B4S1)



NoSQL Databases

Duration : 30 hours (3 ECTS)

- Introduction to NoSQL
- MongoDB
- Cassandra
- Neo4j

4th year - first semester (B4S1)

Language Theory

Duration : 30 hours (2 ECTS)

- Languages and grammars
- Regular languages and grammars
- Left quotients and systems of language equations
- Contextual languages and Turing machine
- Universal problems and Turing machine

4th year - first semester (B4S1)

Advanced Deep Learning

Duration : 30 hours (3 ECTS)

- Convolutional neural networks
- Recurrent Neural Networks
- Choice of hyperparameters
- Tensorflow, Keras, Pytorch

4th year - first semester (B4S1)

Advanced Data Visualization

Duration : 30 hours (3 ECTS)

- Interactive Data Visualization
- Plotly
- Leaflet
- Shiny-based apps
- Elasticsearch-Kibana
- Short project :
  - Data visualization challenge

4th year - first semester (B4S1)

Business Intelligence

Duration : 30 hours (2 ECTS)

- Applications of Data Science for Business intelligence
- Data analytics and data warehouse
- Data visualization and BI
- Introduction to data lakes

4th year - first semester (B4S1)

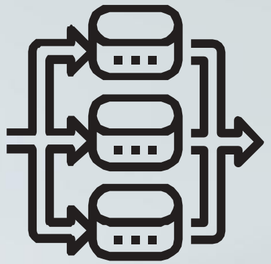
Advanced Data Mining

Duration : 60 hours (5 ECTS)

- Exploration of datasets
- Correlation mining
- Association-rule mining
  - Market Basket Analysis
- Tree-based Models
- Project on a dataset
  - Report design

4th year - first semester (B4S1)

Parallel & Distributed Processing

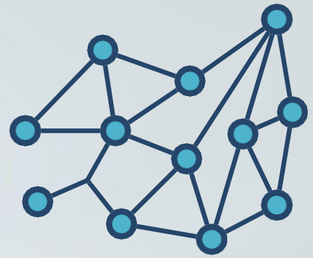


Duration : 30 hours (3 ECTS)

- Classification of parallel computers
- Different kinds of parallelism
- MPI programming and data partitionning
- Parallelization of fundamental algorithms
- N-body simulation

4th year - first semester (B4S1)

Complexity, Decidability & Graph Theory



Duration : 30 hours (3 ECTS)

- Turing machine
- Formal languages
- Decidability, undecidable problems, Halting problems
- Complexity classes, P and NP classes, NP-complete problems
- Algorithms Prim, Kruskal, Dijkstra, Bellma,-Ford

4th year - first semester (B4S1)

Constraint Programming & Optimization

Duration : 60 hours (5 ECTS)

- Aggregation methods
- Non-aggregated methods
- Methods based on Pareto
- Resolution by metaheuritics
- Constraint satisfaction problem
- Consistency algorithms
- Coloration and planning problem resolutions

4th year - second semester (B4S2)

Introduction to Complex Dynamical Systems

Duration : 30 hours (2 ECTS)

- Introduction to nonlinear dynamical systems
- Numerical appraoch and simulations of complex systems
- Numerical algorithms
- Applications in different fields

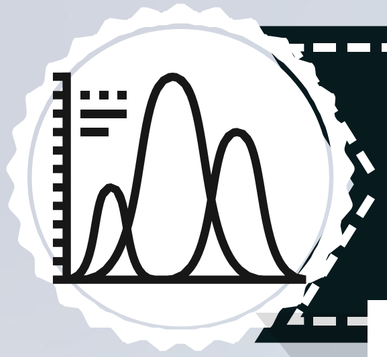
4th year - second semester (B4S2)

Big Data Management

Duration : 60 hours (5 ECTS)

- Concepts of Big Data
- Big Data Visualization
- MapReduce
- Combiners, partition functions
- Hadoop ecosystem
- Google GFS
- Apache Spark
- Managing real time Big Data

4th year - second semester (B4S2)



Introduction to Scala

Duration : 30 hours (2 ECTS)

- Scala Programming
- Apache Spark
- Functional Programming
- Recursion
- Data Parallelism
- Streams
- Array Programming

4th year - second semester (B4S2)

Project

Duration : 45 hours (2 ECTS)

- Problem solving in various domains
- Deepen or learn new concepts
- Work in teams
- Have a systematic approach to problems
- Work of companies issues during the third or the fourth year

Every semester

The tools of design

- Adobe Illustrator
- Unity
- Adobe Premiere
- Project featuring the different softwares

Once a year

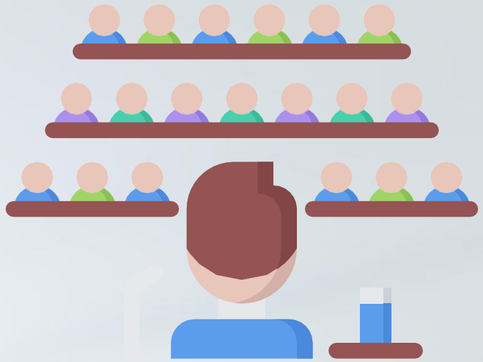
Contemporary Issues Module

Duration : 30 hours (1,5 ECTS)

- Short-term (1 week) project
- Various possibilities :
  - Develop an app
  - Analyze a dataset
- Specific training: Introduction to Design Thinking Method, UX/UI, graphic facilitation

Every semester

Enlightenment Sessions



Duration : 22 hours

- Conferences and debates on subjects related to
  - Data Science
  - Environmental issues
  - Societal issues

Every semester

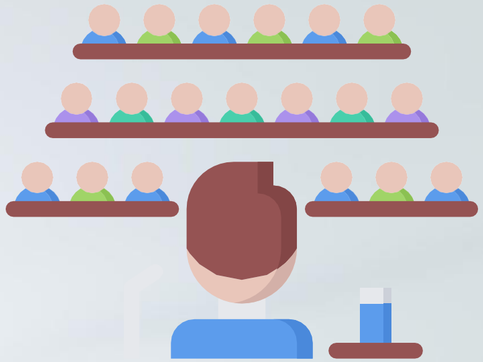
Humanities and social sciences

Duration : 15 hours

- Sociololy
- Ethnology
- Anthropology
- Semiology
- Digital Sociology
- Ecology

Every semester

French as a Foreign Language



Training adapted to students' level :

- Written and oral comprehension
- Written and oral presentation

Every semester