

## 1 Introduction

The bachelor degree in Data Science contains 30 ECTS elective courses and the master degree contains 30 ECTS elective specialization and 30 ECTS elective courses. These notes lists courses that can be used for the elective parts of the study. First is a list of courses suitable as electives on the third year of the bachelor study, followed by a few recommendations. Next follows a description of the master study followed by a list of elective courses suitable for the master study.

The lists below are structured according to the department offering the course. This reflects that the Data Science education is a cooperation between department of mathematics, department of computer science, department of economics and business economics, and department of electro and computer technology.

These notes will be updated half-yearly. Remember also (mandatory) to update your study contract when (or better: before) you sign up for courses.

## 2 Electives on third year of bachelor study

The following list states the most relevant courses, but you can also choose courses outside this list subject to the approval from the head of the degree programme. Those courses marked with an *M* are master courses that are suited also as courses on third year of the bachelor study.

Quick overview: Autumn		ECTS
Math/stat/ mathecon	<a href="#">Multivariate Statistical Analysis</a>	10
	<a href="#">Statistical Models</a> (note: part of package)	10
	<a href="#">Monte Carlo simulation</a> (M) (note: can be part of package)	10
	<a href="#">Graph Theory 1</a> (M)	10
Computer science	<a href="#">Software Engineering and Architecture</a>	10
	<a href="#">Human-Computer Interaction</a>	10
Economics	<a href="#">Principles of Economics</a>	10
	<a href="#">Investment and Finance</a> (note: part of package)	10
Electro and comtech	<a href="#">Signals and Systems</a>	5
	<a href="#">Digital Signal Processing</a>	5

Quick overview: Spring		ECTS
Math/stat/ mathecon	<a href="#">Mathematical Analysis 2</a>	10
	<a href="#">Modelling, Simulation and Analysis</a> (M)	10
	<a href="#">Metaheuristics for Combinatorial Optimization</a> (M)	10
Computer science	<a href="#">Computability and Logic</a>	10
	<a href="#">Programming Languages</a>	10
Economics	<a href="#">Microeconomics I</a>	10
Electro and comtech	<a href="#">Digital Signal Processing</a>	5
	<a href="#">Digital Image Processing 1</a>	5
	<a href="#">Discrete-time Signal Processing</a>	5

### 3 Recommendations for choice of electives for bachelor study

In order to have more skills in programming and organizing larger programming projects the course [Software Engineering and Architecture](#) is recommended.

To enhance your skills in statistical modelling and analysis either choose the course [Multivariate Statistical Analysis](#) or the course [Statistical Models](#).

To acquire some background in economics or to start the specialization package *Finance and FinTech* on the master study choose the course [Principles of Economics](#) or [Investment and Finance](#) in the autumn, or the course [Microeconomics I](#) in the spring.

To prepare for the specialization package *Signal Processing* on the master study choose the courses [Digital Signal Processing](#) and [Digital Image Processing 1](#).

Other popular choices are [Human-Computer Interaction](#) and [Monte Carlo simulation](#) in the autumn

### 4 Master degree

The master study is composed of 30 ECTS compulsory courses, a 30 ECTS specialization package, 30 ECTS elective courses and a 30 ECTS thesis. The student must choose one out of four specialization packages (it is allowed to start 10 ECTS of a specialization package on the bachelor study). (As of now the specialization package *Signal Processing* is 25 ECTS, implying an extra 5 ECTS electives.)

#### 4.1 Compulsory courses on the master study

- Advanced Statistical Learning (10 ECTS, autumn)  
<https://kursuskatalog.au.dk/en?search=advanced%20statistical%20learning&department=13>
- Large Scale Optimization (10 ECTS, spring) <https://kursuskatalog.au.dk/en?department=13&page=1&search=large%20scale%20optimization>
- Data Visualization (10 ECTS, autumn)  
<https://kursuskatalog.au.dk/en?search=data%20visualization&department=15>

## 4.2 Specialization packages on the master study

Quick overview		ECTS
Computational Statistics	Statistical Models	10
	Statistical inference for high dimensional data	10
	Reinforcement learning	10
Data-Intensive Systems	Algorithms, Incentives, and Data	10
	Data Mining	10
	Advanced Data Management and Analysis	10
Finance and FinTech	Investment and Finance	10
	Financial intermediation	10
	Quantitative Financial Economics	10
Signal Processing	Stochastic signal processing	5
	Computer Vision	10
	Advanced Signal Processing	10
Business Intelligence	Business Intelligence	5
	Business Forecasting	5
	Customer Analytics	10
	Artificial Intelligence and Business	5
	Generative AI with LLMs	5

## 4.3 Alternative courses in packages

The courses listed below can replace any of the courses above in the respective specializations without prior approval from the head of the degree programme.

Alternative courses		ECTS
Computational Statistics	Monte Carlo simulation	10
	Topological Data Analysis (odd numbered years)	10
Data-Intensive Systems	Cluster Analysis	10
	Randomized Algorithms	10

## 5 Elective courses on the master study

Upon choosing a specialization package the courses on the three remaining specialization packages can be chosen as elective courses. The courses on the specialization packages as well as the alternative courses listed above are not repeated in the list below with other elective courses. However, master courses that are listed under elective courses on the third year of the bachelor study are repeated. It is possible to choose courses outside the list here subject to the approval from the head of the degree programme.

Quick overview: Autumn		ECTS
Math/stat/ mathecon	<a href="#">Applied Optimization: Location Planning</a> (even numbered years)	10
	<a href="#">Multiple Criteria Optimization</a> (odd numbered years)	10
	<a href="#">Theory of Measure and Integration</a>	10
	<a href="#">Graph Theory 2</a> (even numbered years)	10
Computer science		
Economics	<a href="#">Time Series Econometrics</a>	10
	<a href="#">Microeconometrics</a>	10
	<a href="#">Digital Business Development</a>	10
Electro and comtech		

Quick overview: Spring		ECTS
Math/stat/ mathecon	<a href="#">Sampling</a> (even numbered years)	5
	<a href="#">Modelling, Simulation and Analysis</a>	10
	<a href="#">Metaheuristics for Combinatorial Optimization</a>	10
Computer science		
Economics	<a href="#">Business Data Analysis</a>	10
Electro and comtech	<a href="#">Information Theory: From Communication to Learning</a>	5
	<a href="#">Applied Innovation in Engineering</a>	5

## 6 Electives on third year of bachelor study: details

In the list below *A* stands for *autumn* and *S* for *spring*. On clicking on the letter you are redirected to the list with a *quick overview*.

### 6.1 Mathematics/statistics/mathematical economics

**A** Multivariate Statistical Analysis, 10 ECTS

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Multivariate%20Statistical%20Analysis>

Extends the statistical tool box from the course Mathematical Statistics to the multidimensional case. (Prerequisites are fulfilled through the courses Introduction to mathematics and optimization, Introduction to probability theory and statistics, and Mathematical Statistics)

**A** Statistical Models (10 ECTS)

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Statistical%20Models>

**A** Monte Carlo simulation, 10 ECTS (master degree course)

<https://kursuskatalog.au.dk/en?search=monte%20carlo%20simulation&department=13>

General introduction to solving a variety of problems via simulation.

- A** Graph Theory 1, 10 ECTS, (odd numbered years, master degree course)  
<https://kursuskatalog.au.dk/en?department=13&search=Graph%20Theory%201>  
 Graph theory is a mathematical subject of importance to many computer science and mathematical economics problems. (Prerequisites are fulfilled through the course Introduction to mathematics and optimization)
- S** Mathematical Analysis 2, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Mathematical%20Analysis%202>  
 A follow up course on your basic knowledge in mathematics. (Prerequisites are fulfilled through the course Introduction to mathematics and optimization, Numerical linear algebra)
- S** Modelling, Simulation and Analysis, 10 ECTS, (odd numbered years, master degree course)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Modelling%20%20Simulation%20and%20Analysis>  
 The aim of this course is to give an understanding of how we can build computer simulation models of a system and analyze simulation results to reveal important information. (Prerequisites are fulfilled through the courses Introduction to Probability Theory and Statistics and Mathematical Statistics) In the course description it states: "Notes: The report can be accepted as a bachelor project". This statement is only relevant for students in mathematical economy, and not relevant for datascience students.
- S** Metaheuristics for Combinatorial Optimization, 10 ECTS, (even numbered years, master degree course)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Metaheuristics%20for%20Combinatorial%20Optimization&year=2022-2023-2024>  
 In this course you learn how to solve decision problems with a finite number of useful solutions. (Prerequisites are fulfilled through the courses Introduction to mathematics and optimization and Modelling and solving optimization problems)

## 6.2 Computer science

- A** Software Engineering and Architecture, 10 ECTS  
<https://kursuskatalog.au.dk/en?search=Software%20Engineering%20and%20Architecture&department=15>  
 Theories, methods and techniques in modern software construction. (Prerequisites are fulfilled through the course Introduction to programming with scientific applications)
- A** Human-Computer Interaction, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=15&page=1&search=Human-Computer%20Interaction>  
 Gain knowledge in and learn methods for analyzing and designing user interfaces. (Prerequisites are fulfilled through the course Introduction to programming with scientific applications)

S Computability and Logic, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=15&page=1&search=Computability%20and%20Logic>

Basic subjects in computability and Logic. (Prerequisites are fulfilled through the course Introduction to programming with scientific applications and the course Algorithms and data structures)

S Programming Languages, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=15&page=1&search=Programming%20Languages>

Learn the basic principles in programming languages. (Prerequisites are fulfilled through the course Introduction to programming with scientific applications)

### 6.3 Economics

A Principles of Economics, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=46&page=1&search=Principles%20of%20Economics>

A Investment and Finance, 10 ECTS  
<https://kursuskatalog.au.dk/en?search=Investment%20and%20Finance&department=13>

Obtain a profound understanding of and insight into basic investment and financial theory. This course is part of a specialization package, but can be taken as an elective in your bachelor program in case you do not plan for the package. (Prerequisites are fulfilled through the course Introduction to mathematics and optimization, Numerical linear algebra and Causal Inference)

S Microeconomics I, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Microeconomics%20I>

Learn about aspects of economic theory. (Prerequisites are fulfilled through the course Introduction to mathematics and optimization, Numerical linear algebra and Causal Inference)

If you want a background course for the specialization package *FinTech* you can either choose Microeconomics I (giving a background on basic economical theories) in the spring or Principles of Economics in the autumn.

### 6.4 Electro and computer technology

A Signals and Systems, 5 ECTS  
<https://kursuskatalog.au.dk/en?department=128&page=1&search=Signals%20and%20Systems>

Learn how to describe a signal in mathematical terms and how to perform mathematical operations on signals.

A S Digital Signal Processing, 5 ECTS  
[https://kursuskatalog.au.dk/en?department=128&page=1&search=SW3DSB-01%](https://kursuskatalog.au.dk/en?department=128&page=1&search=SW3DSB-01%20)

[20Digital%20Signal%20Processing](https://kursuskatalog.au.dk/en?department=128&page=1&search=Digital%20Signal%20Processing)

Learn how to analyze a digital signal og to extract useful information. (Note that you can not both take this course and the course *Discrete-time Signal Processing*.)

S Digital Image Processing 1, 5 ECTS

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Digital%20Image%20Processing%201>

Learn the basic techniques in the analysis of digital images. (This course requires knowledge corresponding to for example *Signals and systems* or *Digital Signal Processing* (which can be taken alongside))

S Discrete-time Signal Processing (5 ECTS, bachelor 4.semester, spring, Elektroteknologi)

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Discrete-time%20Signal%20Processing>

This is a more extensive course on discrete time signals and has as a prerequisite the course *Signals and systems*. (Note that you can not both take this course and the course *Digital Signal Processing*.)

In order to choose the specialization package *Signal Processing* on your master study you need background material as in the course *Signals and systems* (autumn) or as in the course *Digital Signal Processing* (autumn or spring).

## 7 Specialization packages on the master study: details

### 1. Computational Statistics

A Statistical Models (10 ECTS)

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Statistical%20Models>

S Statistical inference for high dimensional data (10 ECTS)

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Statistical%20inference%20for%20high%20dimensional%20data>

A Reinforcement learning (10 ECTS)

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Reinforcement%20Learning>

### 2. Data-Intensive Systems

A Algorithms, Incentives, and Data (10 ECTS)

<https://kursuskatalog.au.dk/en?department=15&page=1&search=Algorithms%20Incentives%20and%20Data>

S Data Mining (10 ECTS)

<https://kursuskatalog.au.dk/en?department=15&page=1&search=Data%20Mining>

A Advanced Data Management and Analysis (10 ECTS)

<https://kursuskatalog.au.dk/en?department=15&page=1&search=Advanced%20Data%20Management%20and%20Analysis>

### 3. Finance and FinTech

A Investment and Finance (10 ECTS)

<https://kursuskatalog.au.dk/en?department=13&page=1&search=Investment%20and%20Finance>

S Financial intermediation (10 ECTS)

<https://kursuskatalog.au.dk/en?search=Financial%20intermediation&department=46>

(This course can only be taken on your master study.)

A Quantitative Financial Economics (10 ECTS)

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Quantitative%20Financial%20Economics>

The course *Investment and Finance* must be taken prior to *Financial intermediation* and prior to or alongside *Quantitative Financial Economics*.

### 4. Signal Processing

A Stochastic signal processing (5 ECTS)

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Stochastic%20signal%20processing>

S Computer Vision (10 ECTS)

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Computer%20Vision>

A Advanced Signal Processing (10ECTS)

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Advanced%20Signal%20Processing>

In order to choose the specialization package *Signal Processing* you need background material as in the course *Signals and systems* (autumn) or as in the course *Digital Signal Processing* (autumn or spring).

### 5. Business Intelligence

A Business Intelligence (5 ECTS)

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Business%20Intelligence>

(This course can only be taken on your master study.)

A Business Forecasting (5 ECTS)

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Business%20Forecasting>

(This course can only be taken on your master study.)

S Customer Analytics (10 ECTS)

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Customer%20Analytics>

(This course can only be taken on your master study.)



- A Artificial Intelligence and Business (5 ECTS)  
<https://kursuskatalog.au.dk/en?department=46&page=1&search=Artificial%20Intelligence%20and%20Business>  
 (This course can only be taken on your master study. Not yet in course catalogue.)
- A Generative AI with LLMs (5 ECTS)  
<https://kursuskatalog.au.dk/en?department=46&page=1&search=Generative%20AI%20with%20LLMs>  
 (This course can only be taken on your master study. Not yet in course catalogue.)

## 8 Electives on the master study: details

### 8.1 Mathematics/statistics/mathematical economics

The list below does not include courses mentioned previously under electives on third year of bachelor study.

- A Monte Carlo simulation, 10 ECTS (master degree course)  
<https://kursuskatalog.au.dk/en?search=monte%20carlo%20simulation&department=13>  
 General introduction to solving a variety of problems via simulation.
- A Applied Optimization: Location Planning 10 ECTS (autumn, even numbered years)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Applied%20Optimization%20Location%20Planning&year=2022-2023-2024>  
 (This course requires knowledge on *duality in linear optimization* that you gain for example through the compulsory master course *Large Scale Optimization*)
- A Multiple Criteria Optimization, 10 ECTS (autumn, odd numbered years)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Multiple%20Criteria%20Optimization>  
 (This course requires knowledge on *duality in linear optimization* that you gain for example through the compulsory master course *Large Scale Optimization*)
- A Theory of Measure and Integration, 10 ECTS.  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Theory%20of%20Measure%20and%20Integration>  
 In order to follow this course you must have taken the course *Mathematical analysis 2*.
- A Graph Theory 2, 10 ECTS (autumn, even numbered years)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Graph%20Theory%202&year=2022-2023-2024>  
 (This course requires some knowledge from Graph theory 1 or, alternatively, that you study these subjects yourself at the start of the course)

- S Topological Data Analysis, 10 ECTS, (spring, odd numbered years)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Topological%20Data%20Analysis>
- S Sampling, 5 ECTS, (spring, even numbered years)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Sampling&year=2022-2023-2024>
- S Modelling, Simulation and Analysis, 10 ECTS, (odd numbered years, master degree course)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Modelling%20Simulation%20and%20Analysis>  
 The aim of this course is to give an understanding of how we can build computer simulation models of a system and analyze simulation results to reveal important information. (Prerequisites are fulfilled through the courses Introduction to Probability Theory and Statistics and Mathematical Statistics) In the course description it states: "Notes: The report can be accepted as a bachelor project". This statement is only relevant for students in mathematical economy, and not relevant for datascience students.
- S Metaheuristics for Combinatorial Optimization, 10 ECTS, (even numbered years, master degree course)  
<https://kursuskatalog.au.dk/en?department=13&page=1&search=Metaheuristics%20for%20Combinatorial%20Optimization&year=2022-2023-2024>  
 In this course you learn how to solve decision problems with a finite number of useful solutions. (Prerequisites are fulfilled through the courses Introduction to mathematics and optimization and Modelling and solving optimization problems)

## 8.2 Computer science

- S Cluster Analysis, 10ECTS  
<https://kursuskatalog.au.dk/en?department=15&page=1&search=Cluster%20Analysis>
- S Randomized algorithms, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=15&page=1&search=Randomized%20algorithms>

## 8.3 Economics

- A Time Series Econometrics, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=46&page=1&search=Time%20Series%20Econometrics>  
 (This course can only be taken on your master study. Builds on the course *Causal Inference*)
- A Microeconometrics, 10 ECTS  
<https://kursuskatalog.au.dk/en?department=46&page=1&search=Microeconometrics>  
 (This course can only be taken on your master study. Builds on the course *Causal Inference*)

A Digital Business Development, 10 ECTS

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Digital%20Business%20Development>

(This course can only be taken on your master study.) This course is suitable for students considering making a start-up.

S Business Data Analysis, 10 ECTS

<https://kursuskatalog.au.dk/en?department=46&page=1&search=Business%20Data%20Analysis>

(This course can only be taken on your master study. Builds on the course *Causal Inference*)

## 8.4 Electro and computer technology

S Information Theory: From Communication to Learning, 5 ECTS

<https://kursuskatalog.au.dk/en?department=128&page=1&search=Information%20Theory%3A%20From%20Communication%20to%20Learning>

The course builds on background knowledge in probability theory, statistics and linear algebra.

S Applied Innovation in Engineering, 5 ECTS

<https://kursuskatalog.au.dk/en?department=127&page=1&search=Applied%20Innovation%20in%20Engineering>

No prior knowledge of business or innovation is required in this course. Students in doubt about their qualifications should contact the course coordinator.