Programme Regulations
2019–2020

Data Science
MSc
PGDip
PGCert

Data Science and Financial Technology
MSc
PGDip

Data Science and Artificial Intelligence
MSc
PGDip

Important document – please read
This document contains important information that governs your registration, assessment and programme of study.
Contents

Important information regarding the Programme Regulations .......................................................... 2
1 Structure of the programmes .................................................................................................................. 3
2 Registration ........................................................................................................................................ 5
3 Recognition of prior learning and credit transfer .............................................................................. 6
4 Assessment for the programme ........................................................................................................... 6
5 Transfer of Registration ....................................................................................................................... 9
6 Scheme of award .................................................................................................................................. 10

Appendix A – Structure of the programmes ......................................................................................... 13
   MSc Data Science ................................................................................................................................. 13
   Postgraduate Diploma in Data Science ................................................................................................ 13
   Postgraduate Certificate in Data Science ............................................................................................. 14
   MSc Data Science and Financial Technology ...................................................................................... 15
   Postgraduate Diploma in Data Science and Financial Technology .................................................... 15
   MSc Data Science and Artificial Intelligence ....................................................................................... 16
   Postgraduate Diploma in Data Science and Artificial Intelligence ..................................................... 17

Appendix B – Module Outlines .............................................................................................................. 18

Appendix B – Assessment Criteria ...................................................................................................... 27
Important information regarding the Programme Regulations

About this document

Last revised 05 August 2019

As a student registered with the University of London you are governed by the current General Regulations and Programme Regulations associated with your programme of study. These Programme Regulations are designed and developed by the Goldsmiths, which is responsible for the academic direction of the programme, in collaboration with the University of London. Further information about how to use the Programme Regulations and Programme Handbook can be found in the Student Guide.

In addition to Programme Regulations you will have to abide by the General Regulations. These regulations apply to all students registered for a programme of study with the University of London and provide the rules governing registration and assessment on all programmes; they also indicate what you may expect on completion of your programme of study and how you may pursue a complaint, should that be necessary. Programme Regulations should be read in conjunction with the General Regulations.

The relevant General Regulations and the Programme Regulations relating to your registration with us are for the current year and not the year in which you initially registered. On all matters where the regulations are to be interpreted, or are silent, our decision will be final.

Further information about your programme of study is outlined in the Programme Specification which is available on the relevant Courses page of the website. The Programme Specification gives a broad overview of the structure and content of the programme as well as the learning outcomes students will achieve as they progress.

To note

Throughout the Regulations, ‘we’ ‘us’ and ‘our’ mean the University of London; ‘you’ and ‘your’ mean the student, or where applicable, all students.

For the programmes offered under these regulations you should note the following terminology:

Module: Individual units of a programme are called modules. Each module is a self-contained, formally structured learning experience with a coherent and explicit set of learning outcomes and assessment criteria.

Core module: Core modules are central to the teaching and learning on the programme and often introduce concepts and ideas that appear in the optional modules. Core modules must be passed and cannot be compensated.

Compulsory module: Compulsory modules introduce concepts and ideas that appear in optional modules. Students must take these modules as part of their studies. They are subject to the rules for compensation.

Optional module: Optional modules are designed to extend the concepts and ideas introduced in core and compulsory modules and to introduce other relevant concepts and techniques. Students may select their optional modules from a list. They are subject to the rules for compensation.

Significant changes made to the programme regulations 2019-2020:

This programme is being offered for the first time in 2019-2020.
1 Structure of the programmes

Qualifications

1.1

The following qualifications are offered under these regulations:

- Master of Science in Data Science
- Postgraduate Diploma in Data Science
- Postgraduate Certificate in Data Science
- Master of Science in Data Science and Financial Technology
- Postgraduate Diploma in Data Science and Financial Technology
- Master of Science in Data Science and Artificial Intelligence
- Postgraduate Diploma in Data Science and Artificial Intelligence

Award structures

For further information on the modules for each programme, see Appendix A.

Data Science

1.2

For the award of MSc in Data Science you must complete:

- four core modules (60 credits total)
- two compulsory modules (30 credits total)
- four optional modules (60 credits total)
- a Final Project (30 credits total)

1.3

For the award of a Postgraduate Diploma in Data Science you must complete:

- four core modules (60 credits total)
- two compulsory modules (30 credits total)
- two optional modules (30 credits total)

1.4

For the award of a Postgraduate Certificate in Data Science you must complete:

- two core modules chosen from a list (30 credits total)
- any two other modules (either further core or optional modules) (30 credits total)

Data Science and Financial Technology

1.5

For the award of MSc in Data Science and Financial Technology you must complete:

- four core modules (60 credits total)
• three compulsory modules (45 credits total)
• three optional modules (45 credits total)
• a Final Project (30 credits total)

1.6
For the award of **Postgraduate Diploma in Data Science and Financial Technology**, you must complete:

• four core modules (60 credits total)
• three compulsory modules (45 credits total)
• one optional module (15 credits total)

**Data Science and Artificial Intelligence**

1.7
For the award of **MSc in Data Science and Artificial Intelligence**, you must complete:

• four core modules (60 credits total)
• three compulsory modules (30 credits total)
• three optional modules (60 credits total)
• a Final Project (30 credits total)

1.8
For the award of **Postgraduate Diploma in Data Science and Artificial Intelligence**, you must complete:

• four core modules (60 credits total)
• three compulsory modules (30 credits total)
• one optional module (30 credits total)

1.9
The maximum number of modules you can register for at any one time is six 15 credit modules, or four 15 credit modules and the 30 credit Final Project.

Over a 22 week session, a 15 credit module will typically require five to seven hours of work/effort per week, and a 30 credit module will typically require ten to 15 hours of work/effort per week.

**Intermediate qualifications**

1.10
If you are registered on the **Postgraduate Diploma or MSc in Data Science**, you can apply for a Postgraduate Certificate or a Postgraduate Diploma in Data Science as an intermediate qualification, providing you have successfully completed the required modules.

1.11
If you are registered on the **Postgraduate Diploma or the MSc for either of the specialisms**, you can request a Postgraduate Certificate in Data Science or a Postgraduate Diploma relating to your
specialism as an intermediate qualification, providing you have successfully completed the required modules.

See Appendix A for the award structures.

1.12

If you satisfy the necessary requirements and wish to receive a Postgraduate Diploma or Postgraduate Certificate as an intermediate qualification, you must apply to be granted those qualifications. A Postgraduate Diploma or Postgraduate Certificate will not be awarded automatically as an intermediate qualification.

1.13

If you do not apply for the Postgraduate Diploma or the Postgraduate Certificate as an intermediate qualification at, or prior to, your final examination entry for the programme you have registered for, you will not be awarded these qualifications at a later date.

2 Registration

Full details of the Entrance Requirements for the programme are listed on the requirements tab of the website

Effective date of registration

2.1

Your effective date of registration will be either:

- 1 October if you first register before the September registration deadline
- 1 April if you first register before the March registration deadline

Date of first examinations

2.2

If your date of registration is:

- 1 October, you will take your first examinations in March of the following year
- 1 April, you will take your first examination in September of the same year

Period of registration

The minimum and maximum periods of registration to complete the programme are given in the Programme Specification.

2.3

If you progress from the Postgraduate Certificate or Postgraduate Diploma to the Postgraduate Diploma or MSc respectively, your maximum period of registration will continue from the date you initially registered under these regulations.

2.4

If you transfer between the Data Science programmes and a specialism, you will not be granted a new period of registration, it will continue from the date you initially registered under these regulations.
Programme Regulations 2019-2020 Data Science (MSc/PGDip/PGCert); Data Science and Financial Technology (MSc/PGDip) and Data Science and Artificial Intelligence (MSc/PGDip)

Order in which to take the modules

2.5

For all programmes, you can attempt the modules in any order, subject to module availability.

Whilst you can attempt modules in any order, you are advised to have attempted the assessments for all other modules before registering for the Final Project.

We recommend that you select Data programming in Python and Mathematics and statistics for data science in your first set of modules.

Progression within the programme

2.6

Upon successful completion of the Postgraduate Certificate or a Postgraduate Diploma offered under these regulations you may progress to a Postgraduate Diploma or a related MSc programme respectively.

You will only be considered for progression to the related Postgraduate Diploma or MSc respectively once your final result has been ratified by the exam board and released to you. This may affect your module selection and session start date.

3 Recognition of prior learning and credit transfer

The rules for recognition of prior learning are described in the General Regulations.

3.1

If you are registered for an MSc programme, you may apply for recognition of prior learning (RPL) mapped against modules up to a total of 120 UK credits.

3.2

Recognition of prior learning will not be considered for the Final Project.

3.3

If you are registered for a Postgraduate Diploma programme, you may apply for recognition of prior learning mapped against modules up to a total of 60 UK credits.

3.4

If you are registered for the Postgraduate Certificate in Data Science, you may apply for recognition of prior learning mapped against modules up to a total of 30 UK credits.

4 Assessment for the programme

4.1

All modules are assessed by coursework elements (30%) and a written examination element (70%) except for the Final Project. The grade awarded for each module will be based on all the elements of assessment.

4.2

The pass mark for any element of assessment is 50%.
4.3
You will be required to pass each element of the assessment in order to pass a module overall, subject to the application of the rules for compensation.

4.4
All modules include elements of formative assessment. Any marks obtained in these elements will not contribute towards your final module mark.

Rules for compensation

4.5
We will allow compensation for an assessment element within optional and compulsory modules if both:

- the mark awarded for the assessment element is between 45%-49% and
- the mark for the other assessment element is sufficient to produce an overall combined weighted pass mark for the module.

4.6
We will not allow compensation for an assessment element within core modules or the Final Project.

Summary table of assessment

4.7

<table>
<thead>
<tr>
<th>Module</th>
<th>Element of assessment</th>
<th>Element weighting</th>
<th>To pass the module you must get:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core modules</td>
<td>Coursework</td>
<td>30%</td>
<td>A mark of at least 50% in both elements of assessment (compensation not permitted)</td>
</tr>
<tr>
<td></td>
<td>Written examination</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Optional and compulsory modules</td>
<td>Coursework</td>
<td>30%</td>
<td>A mark of at least 50% in both elements of assessment</td>
</tr>
<tr>
<td></td>
<td>Written examination</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Final Project</td>
<td>Coursework</td>
<td>70%</td>
<td>A mark of at least 50% in both elements (compensation not permitted)</td>
</tr>
<tr>
<td></td>
<td>Written examination</td>
<td>30%</td>
<td></td>
</tr>
</tbody>
</table>

Taking assessments

Please refer to the rules on assessment and assessment offences in the General Regulations.

4.8
When you register for a module, you must take the assessments at the first available opportunity.
Written examinations take place on two occasions each year in September and March.

**Deferring an assessment**

The deadlines and process for deferring a written examination are given on the VLE.

If you defer taking a written examination you have to pay a module continuation fee when you register for the session in which you wish to take the examination. You do not have to register for the next available session; there are two sessions each year and you have five years to complete your studies.

You can defer taking the written examination element of a module if you notify us by the deadline. You may only defer once per module.

If you do not notify us of your deferral and do not attend the written examination you will be given a mark of zero for the assessment element and it will count as an attempt at the written examination.

If you defer the written examination, the mark for the coursework element of the module will be carried forward if it is 50% or more.

If you defer the written examination and your mark for the coursework element is below 50%, the rules for compensation will not apply and you must resit the coursework element.

**Deadlines for items of assessment and submission guidance**

See the VLE for full details of all the assessment points, deadlines and submission guidance.

All assessments must be submitted by the prescribed deadlines.

For coursework and project items, you should not exceed the maximum word limits. Five marks will be deducted if the word count is up to 10% more than the maximum word limit. If the word count exceeds the maximum word limit by more than 10%, you will receive a mark of zero for your work.

The content within the main body of text comprises the overall word count, including in-text citations, references, quotes, heading and sub-headings. The cover page, reference list and any appendices do not count towards the overall word count.

**Number of attempts permitted at an element of assessment**

If you register to resit one or more elements of assessment for a module, you will be required to pay a module continuation fee. You do not have to take the assessment at the next available session; there are two sessions each year and you have five years to complete your studies.

The maximum number of attempts permitted for an element of coursework, written examination, or project report is two.
4.17
You will not be permitted to resit any element which you have passed.

4.18
If you fail a core module or the Final Project at the second attempt your registration on the
programme will cease.

4.19
If you fail a compulsory module at the second attempt, and your mark cannot be compensated, your
registration on the programme will cease.

4.20
If you fail an optional module at the second attempt, you may register for an alternative module,
where possible.

Swapping a module

4.21
You will be permitted to swap an optional module for an alternative, where available, on a maximum
of two occasions provided you are within your maximum period of registration. If you do so:
- you must withdraw from your current module
- you will have two attempts to pass the new module(s)
- your mark for the new module will be used for the purposes of classification.

4.22
You will not be permitted to swap any module which you have passed.

Students are permitted to withdraw from a module within 14 days of the module start date with
no financial penalty. You will not be permitted to register for an alternative however, until the
next session.

If you choose to withdraw from a module later than 14 days after module start date you will need
to pay a new module fee should you decide to swap for an available alternative.

5 Transfer of Registration

Transfer between programmes offered under these regulations

5.1
All requests to transfer between programmes offered under these regulations will be considered by
the Programme Director on a case-by-case basis.

5.2
You may apply to transfer between equivalent programmes offered under these regulations
provided that
- you have selected, or are still able to select, the core and compulsory modules on the
  programme to which you wish to transfer;
- you are still within your maximum period of registration AND
you are not yet eligible for the award on which you are currently registered

5.3

If you transfer between degree programmes we will credit you with any modules that you have already passed and any RPL that we previously awarded you provided they form part of the structure of your new programme.

5.4

If you have been awarded credit for a module, we will not allow you to resit it upon transfer.

5.5

Any failed attempts made will be carried forward and will be counted towards the number of attempts permitted at the same modules following transfer.

5.6

If you are permitted to transfer between MSc programmes offered under these regulations, all modules studied will be displayed on your final transcript when you receive your award. This includes modules which are discarded upon transfer.

6 Scheme of award

Mark scheme

6.1

The following mark scheme is used for the MSc, Postgraduate Diploma and Postgraduate Certificate:

<table>
<thead>
<tr>
<th>Mark range</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>70% and over</td>
<td>Distinction</td>
</tr>
<tr>
<td>60% – 69%</td>
<td>Merit</td>
</tr>
<tr>
<td>50% – 59%</td>
<td>Pass</td>
</tr>
<tr>
<td>0% – 49%</td>
<td>Fail</td>
</tr>
</tbody>
</table>

6.2

To be granted the award with Distinction, your mean average mark for modules must be 70% or above.

6.3

To be granted the award with Merit, your mean average mark for modules must be between 60% and 69%.

6.4

To be granted the award with Pass, your mean average mark for modules must be between 50% and 59%.
Weighting of the assessments

6.5
The overall mark for modules is calculated by weighting the marks achieved for the coursework element and the written examination element in a ratio of 30:70.

6.6
The overall mark for the Final Project is calculated by weighting the marks achieved for the coursework element and the examination element in a ratio of 70:30.

Date of award

6.7
The date of your award will correspond to the year that the requirements for the award were satisfied.

Award requirements

6.8
To be awarded an MSc, you must

- achieve a mark of at least 50% in each of the modules. The mark may be achieved through the application of the rules for compensation, where appropriate.

6.9
To be awarded a Postgraduate Diploma, you must

- achieve a mark of at least 50% in each of the modules. The mark may be achieved through the application of the rules for compensation, where appropriate.

6.10
To be awarded the Postgraduate Certificate in Data Science, you must

- achieve a mark of at least 50% in each of the modules. The mark may be achieved through the application of the rules for compensation, where appropriate.

Exit qualifications

6.11
If you are registered on an MSc or Postgraduate Diploma programme and are unable to complete your programme of study, an exit qualification (i.e. a Postgraduate Certificate or Postgraduate Diploma) may be granted for the successful completion of 60 or 120 credit respectively.

6.12
All exit qualifications are granted at the discretion of the exam board.

6.13
If you are registered on a specialist MSc programme and cannot complete your programme of study, you may be awarded a Postgraduate Diploma in line with your named specialism, only where you have completed the modules listed in Appendix A. Where you have not completed the modules listed but have obtained enough credits, you will be awarded a Postgraduate Diploma in Data Science.
6.14

If you complete 60 credits, you may only be awarded a Postgraduate Certificate in Data Science.

6.15

The exit qualification will be with effect from the year in which you satisfied the requirements for that award.

6.16

If you accept a Postgraduate Certificate or Postgraduate Diploma offered as an exit qualification under these regulations we will not permit you to register or re-register for the related MSc at a later date.
Appendix A – Structure of the programmes

MSc Data Science

For the award of an **MSc in Data Science** you must complete:

**Four** core modules (60 credits total):

- Big data analysis [DSM010]
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]

+ **Two** compulsory modules (30 credits total):

- Data visualisation [DSM050]
- Data science research topics [DSM060]

+ **Four** optional modules chosen from the below list (60 credits total):

- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]
- Artificial intelligence [DSM100]
- R for data science [DSM110]
- Financial data modelling [DSM120]
- Natural language processing [DSM140]
- Neural networks [DSM150]
- Social networks and graph analysis [DSM160]

+ A final project in data science [DSM500] (30 credits total)

Postgraduate Diploma in Data Science

For the award of a **Postgraduate Diploma in Data Science** you must complete:

**Four** core modules (60 credits total):

- Big data analysis [DSM010]
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]
Programme Regulations 2019-2020 Data Science (MSc/PGDip/PGCert); Data Science and Financial Technology (MSc/PGDip) and Data Science and Artificial Intelligence (MSc/PGDip)

**Two compulsory modules (30 credits total):**
- Data visualisation [DSM050]
- Data science research topics [DSM060]

**Two optional modules chosen from the below list (30 credits total):**
- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]
- Artificial intelligence [DSM100]
- R for data science [DSM110]
- Financial data modelling [DSM120]
- Natural language processing [DSM140]
- Neural networks [DSM150]
- Social networks and graph analysis [DSM160]

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**Postgraduate Certificate in Data Science**

For the award of a **Postgraduate Certificate in Data Science** you must complete:

**Two core modules chosen from the below list (30 credits total):**
- Big data analysis [DSM010]
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]

**Two other modules chosen from the below list (30 credits total):**
- Data visualisation [DSM050]
- Data science research topics [DSM060]
- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]
- Artificial intelligence [DSM100]
- R for data science [DSM110]
- Financial data modelling [DSM120]
- Natural language processing [DSM140]
- Neural networks [DSM150]
MSc Data Science and Financial Technology

For the award of an **MSc in Data Science and Financial Technology** you must complete:

**Four** core modules (60 credits total):
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]
- Financial data modelling [DSM120]

+ **Three** compulsory modules (45 credits total):
  - Big data analysis [DSM010]
  - Blockchain programming [DSM070]
  - Mathematics of financial markets [DSM080]

+ **Three** optional modules chosen from the below list (45 credits total):
  - Data science research topics [DSM060]
  - Data visualisation [DSM050]
  - Artificial intelligence [DSM100]
  - R for data science [DSM110]
  - Natural language processing [DSM140]
  - Neural networks [DSM150]
  - Social networks and graph analysis [DSM160]

+ A final project in data science and financial technologies [DSM500] (30 credits total)

**Postgraduate Diploma in Data Science and Financial Technology**

For the award of a **Postgraduate Diploma in Data Science and Financial Technology** you must complete:

**Four** core modules (60 credits total):
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]
Programme Regulations 2019-2020 Data Science (MSc/PGDip/PGCert); Data Science and Financial Technology (MSc/PGDip) and Data Science and Artificial Intelligence (MSc/PGDip)

- Financial data modelling [DSM120]

Three compulsory modules (45 credits total):
- Big data analysis [DSM010]
- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]

One optional module chosen from the below list (15 credits total):
- Data science research topics [DSM060]
- Data visualisation [DSM050]
- Artificial intelligence [DSM100]
- R for data science [DSM110]
- Natural language processing [DSM140]
- Neural networks [DSM150]
- Social networks and graph analysis [DSM160]

MSc Data Science and Artificial Intelligence

For the award of an MSc in Data Science and Artificial Intelligence you must complete:

Four core modules (60 credits total):
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]
- Artificial intelligence [DSM100]

Three compulsory modules (45 credits total):
- Big data analysis [DSM010]
- Data science research topics [DSM060]
- Neural networks [DSM150]

Three optional modules chosen from the list below (45 credits total):
- Data visualisation [DSM050]
- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]
Programme Regulations 2019-2020 Data Science (MSc/PGDip/PGCert); Data Science and Financial Technology (MSc/PGDip) and Data Science and Artificial Intelligence (MSc/PGDip)

- R for data science [DSM110]
- Financial data modelling [DSM120]
- Natural language processing [DSM140]
- Social networks and graph analysis [DSM160]

A final project in data science and artificial intelligence [DSM500] (30 credits total)

Postgraduate Diploma in Data Science and Artificial Intelligence

For the award of a **Postgraduate Diploma in Data Science and Artificial Intelligence** you must complete:

**Four** core modules (60 credits total):
- Data programming in Python [DSM020]
- Mathematics and statistics for data science [DSM030]
- Machine learning [DSM040]
- Artificial intelligence [DSM100]

**Three** compulsory modules (45 credits total):
- Big data analysis [DSM010]
- Data science research topics [DSM060]
- Neural networks [DSM150]

**One** optional module chosen from the list below (15 credits total):
- Data visualisation [DSM050]
- Blockchain programming [DSM070]
- Mathematics of financial markets [DSM080]
- R for data science [DSM110]
- Financial data modelling [DSM120]
- Natural language processing [DSM140]
- Social networks and graph analysis [DSM160]
Appendix B – Module Outlines

Topics covered in each module may be revised to ensure currency and relevance. Students will be advised of any changes in advance of their study. See module descriptors under the Structure tab on the website for further information and any updates.

Big data analysis [DSM010]

This module covers the topic of Big Data which is a key element of contemporary applications of Data Science. It provides practical skills related to working with Big Data computing resources as well as the conceptual context of how Big Data relates to methods and technologies in statistics and computing. The module is complementary to Machine Learning and other modules.

By taking this module, you will gain an in-depth understanding of the technology and methods used for Big Data analysis and how they relate to concepts in statistics and computing more generally. The technologies will include distributed file systems, SQL and NoSQL databases. You will learn what the key challenges are in Big Data analysis, how they relate to privacy and security and how these are addressed with current technologies. You will work in Python, a modern language widely used in Big Data analysis. You will use querying to extract data, then design data processing and analysis pipelines to analyse the data. You will learn how to apply these techniques to data in business and scientific applications.

Topics covered in this module:

- Introduction to Big Data
- Big Data in context: statistical methods and computing technologies
- Data privacy and security
- Environment for Big Data Programming
- Distributed File systems & MapReduce
- SQL and NoSQL Databases
- Big Data Pipelines
- Examples of Big Data Applications
- Cluster, Grid & Cloud Computing
- Optimisation Techniques

Data programming in python [DSM020]

This module will provide you with the programming skills necessary to carry out the programming tasks in the rest of the programme.

This module aims to provide you with the programming skills you will need to carry out the programming tasks you will encounter in the other modules in this programme. You will learn about general programming techniques such as variables, functions and control flow. You will learn how to work with different types of data structures such as arrays and dictionaries. You will develop data processing pipelines, which allow you to convert raw data into data that you can analyse. You will apply mathematical and statistical procedures to data. You will learn how to plot graphs of various types. You will also familiarise yourself with an industry standard data science programming environment which you can use throughout the programme.

Topics covered in this module:

- Setting up your programming environment
• Variables, control flow and functions
• Data structures
• Data plotting
• Reading and writing data on the filesystem
• Retrieving data from the web
• Retrieving data from databases using query languages
• Cleaning data
• Restructuring data
• Version control systems

**Mathematics and statistics for data science [DSM030]**

A strong grasp of mathematics and statistics is key to the correct interpretation of the results of data analysis. This module aims to provide you with a deep understanding of the aspects of mathematical and statistical analyses which are key to correctly interpreting and developing the results of the data analyses you will carry out elsewhere in the programme.

This module aims to cover the key mathematical and statistical concepts and techniques you will need to interpret the results you might generate through data analysis. The areas covered include probability theory, likelihood, common distributions, confidence intervals, hypothesis tests, parametric and non-parametric tests.

Topics covered in this module:

• Differential Calculus
• Linear Algebra 1: Matrices, algebra of matrices and inverses
• Linear Algebra 2: Special Matrices, decompositions and Eigen theory
• Sample data and Measures of Dispersion and Central Tendency
• Probability Theory
• Probability Distributions
• Statistical Significance and Tests of Hypothesis
• Analysis of Variance
• Correlation and Regression
• Classification

**Machine learning [DSM040]**

Machine Learning covers a wide range of techniques that data scientists should be aware of, and able to use. This module aims to provide you with deep theoretical and practical knowledge of these techniques.

This module provides a broad view of Machine Learning and statistical pattern recognition. You will learn several techniques, including supervised learning (e.g. generative and discriminative learning, parametric and non-parametric learning), unsupervised learning (e.g. clustering), and theoretical aspects of Machine Learning (e.g. bias, variance). The module will also focus on recent applications of Machine Learning to areas of interest to data scientists.

Topics covered in this module:

• Introduction to Machine Learning
• Exploring Data
• Cleaning and Preparing Data
• Getting Started with Supervised Learning
Programme Regulations 2019-2020 Data Science (MSc/PGDip/PGCert); Data Science and Financial Technology (MSc/PGDip) and Data Science and Artificial Intelligence (MSc/PGDip)

- Improving Model Performance
- Machine Learning Algorithms
- Unsupervised Learning
- Working with Time-series Data
- Dynamic Modelling
- Further Applications of Machine Learning

Data visualisation [DSM050]

This module will equip you with data visualisation skills which you can use to generate compelling, interactive representations of data. Effectively presenting data in a manner in which it can be easily interpreted is a useful skill for a data scientist, especially when working with non-specialists. The module is complementary to other modules in the programme.

This module aims to equip you with a data visualisation skillset. By taking this module, you will be able to gain access to a wide range of data sources, and then to transform this data into compelling visualisations and plots. You will learn how to convert a data source into a visual story, wherein you will reveal and present the structure of the data. You will also learn how to publish your data visualisations on the web, such that your work is available to others. You will use a range of data visualisation tools, including interactive and animated graphing libraries.

Topics covered in this module:

- Introduction to data visualisation.
- Data visualisation tools
- Quantitative relationships, variables and types.
- Descriptive statistics 1: Univariate analysis.
- Descriptive statistics 2: Multivariate analysis.
- Time-series data.
- Geographical data.
- Groups and hierarchies.
- Connections and networks.
- Large and high-dimensional data.

Data science research topics [DSM060]

This module will develop your awareness and abilities regarding the practice of professional data scientists. It will also expose you to a range of active research topics in Data Science, both in industry and academia. This will help you develop your Final Project ideas.

The module introduces you to research topics related to Data Science, for example: modern applications of Machine Learning, Data Mining, Computational Statistics, Computational Social Sciences, Cognitive computing, Business analytics and its applications.

In particular, you will have an opportunity to learn from Data Science and Computing industry professionals and academics whose mono-disciplinary or interdisciplinary research in areas of Computer Science, Sociology, Psychology, Bioinformatics, Biomedical Statistics and other disciplines is based or involves data analysis. The module will guide your work in exploring a research theme of interest, as a preliminary phase preparing you for the Final Project.

The module will also expose you to learning techniques of conducting research and writing scientific reports. Moreover, you will be taught approaches for devising and optimising your strategies adapted to your skills in seeking and securing an employment, whether in research or the industry.
sector. The module will also expose you to a discussion of the ethical and legal issues related to the area of Data Science and its applications.

- Research methods.
- Analytics Storytelling for Impact
- Academic writing.
- Analyzing and Visualizing Data.
- Ethics and Law in Data and Analytics.
- Final Project ideas.

Data Science research topics in industry and academia; indicative topics (see more examples of the topics above):

- Artificial Intelligence.
- Text Mining.
- Business data analytics and its applications.
- Data data-driven synthetic chemistry.
- Data mining

**Blockchain programming [DSM070]**

Blockchain is the technology that underpins Bitcoin and other cryptocurrencies. Blockchain promises to become a dominant technology in financial and other transactions, whether cryptocurrencies thrive or die. This module will give you a practical and theoretical knowledge of: how blockchains work, security issues with blockchains, where blockchains come from, how to analyse competing notions for blockchains (i.e. proof of stake vs proof of work; and bitcoin vs ethereum), what applications there are on the horizon.

This is both a practical and a theoretical module. It is practical in the sense that by running through the exercises you will have designed and implemented your own blockchain by the end. It is theoretical in the sense that you will have learned the theory behind security issues and the claims for competitive paths to blockchain issues. Your implementation is meant to reflect your thinking on the theoretical issues.

Topics covered in this module:

- Historical intro
- Cryptographic preliminaries
- Merkel trees and blockchains
- Blockchains and Verification
- Proof of stake and proof of work
- Block propagation and difficulty adjustment
- Transactions in Bitcoins and Ethereum
- Lightning and off-chain transactions
- Types of Attack
- Forks, and sizes and frequencies of blockchains

**Mathematics of financial markets [DSM080]**

This module will provide you with a foundational knowledge of modern financial instruments. Such knowledge is crucial for people working in financial technology, who will have to create and understand software tools for optimising investment behaviour.
This module will give you the mathematical and qualitative tools to analyse modern financial markets, helping you develop strategies for market participants. It will introduce you to a range of derivatives and market behaviour. We take a distinctly mathematical and computational approach, leading you to understand how financial markets work well enough to analyse, evaluate and implement investment decisions involving financial instruments.

Topics covered in this module:
1. Introduction to Markets
2. Futures Markets
3. Hedging Strategies 1
4. Hedging Strategies 2
5. Interest rates
6. Determination of futures and forwards prices
7. Mechanics of financial markets
8. Stock Options
9. Trading Strategies 1
10. Trading Strategies 2

Artificial intelligence [DSM100]

Through this module you will learn a wide range of Artificial Intelligence techniques. The module complements the Machine Learning module by focusing on Artificial Intelligence related topics it does not cover, such as symbolic representations, modeling, task learning and game playing. Through this module, you will widen and deepen your knowledge of Artificial Intelligence techniques, which should provide you with an additional set of methods with which you can address Data Science problems.

This module is focused on Artificial Intelligence techniques. You will understand the historical development of Artificial Intelligence including search, vision and planning. You will be familiar with the foundations of agent-based approach to software design, decision making and problem solving including under uncertainty. You will have an opportunity to apply Artificial Intelligence techniques.

Topics covered in this module:
- Historical overview of Artificial Intelligence
- Intelligent agents and environments
- Problem solving
- Knowledge representation, ontologies
- Automated reasoning
- Uncertain knowledge and reasoning under uncertainty
- Decision making
- Games and optimal decisions in games
- Planning algorithms
- Robotics

R for data science [DSM110]

This module will provide you with a wide range of applied data analysis techniques in R. With its strong focus on practical application of the techniques, and learning by doing, you will gain confidence in your ability to select appropriate techniques for attacking a wide variety of data sources. This module is complimentary to other modules in the programme.

Topics covered in this module:
- Data sources: quantitative and qualitative
Financial data modelling [DSM120]

Through this module you will learn nonlinear models and corresponding learning algorithms used in financial data mining of time series, a key contemporary application area for data scientists. The focus of the module is applications of Data Science techniques to real-world financial data. You will have an opportunity to further master and apply Data Science skills you gained in other modules of the programme to financial data.

This module aims to provide you with the ability to analyse financial, time series data using Machine Learning techniques. Analysis of financial data is an exciting application area for Data Science. You will study linear, non-linear and density models of sequential data, using Neural Networks. You will use gradient descent techniques and apply Kalman filters to enable proper dynamic treatments. You will investigate the concepts of overfitting, generalisation and performance evaluation. You will see several practical applications of Neural Networks and extended Kalman filters from the FinTech area of Financial Data Analytics. These include value-at-risk estimation, option pricing, portfolio estimation and automated, algorithmic trading.

Topics covered in this module:

- Introduction to Financial Data Modelling
- Financial time series models
- Learning algorithms for financial data models
- Density modelling with financial data
- Performance estimation of nonlinear models
- Extended Kalman filtering of nonlinear models
- Value-at-Risk estimation
- Portfolio selection and estimation
- Automated algorithmic trading
- Introduction to FinTech

Natural language processing [DSM140]

Machine processing of natural language is a key target for the application of Data Science techniques. It has a range of specialised techniques that are being developed in a large and growing research field of Natural Language Processing (NLP). By taking this module you will gain a solid grasp and practical experience of those techniques.

This module is intended to provide you with a grounding in both rule-based and statistical approaches to NLP, and combines theoretical study with hands-on work employing widely used software packages. The module focuses on text processing, and does not deal with speech or multi-modal communication.

Topics covered in this module:
• History of NLP and its applications
• Language processing and Python
• Curated corpora and raw data sources
• Corpus readers, stemmers and taggers
• Classification tasks: e.g. gender identification, sentiment analysis, joint/sequence classification
• Classification methods: decision trees, Naïve Bayes, MaxEnt
• Information extraction: chunking and NER (Named Entity Recognition)
• Formal grammars and parsing
• Grammars and parsing: probabilistic parsing, feature-based grammars
• Ethical and social issues around NLP

**Neural networks [DSM150]**

Neural Networks are widely used techniques for modelling and classifying data. They are used in industry for data analysis applications such as image classification, speech analysis and regression tasks. This module will provide you with specialised theoretical and practical knowledge of a range of Neural Network architectures that are appropriate for data oriented tasks. This module is complementary to the Machine Learning and Artificial Intelligence modules in the programme, focusing on the area of neural computation.

This module introduces the theory and practice of neural computation. It offers the principles of neuro-computing with Neural Networks widely used for addressing real-world problems such as regression, pattern recognition and time-series prediction.

Topics covered in this module:

- Introduction to Connectionist Learning
- Implementing Learning Algorithms for Single-Layer Perceptrons
- Multilayer Perceptrons: On-line and Batch Backpropagation Algorithms
- Radial-Basis Function Networks
- Neural Network Tuning: The Bias/Variance Dilemma
- Overfitting Avoidance
- Unsupervised Learning with Self-Organizing Kohonen Networks
- Deep Learning
- Hopfield Type Recurrent Neural Networks
- Applications of Neural Networks

**Social networks and graph analysis [DSM160]**

The analysis of graph-based data, a key example of which is social network data, is an important theoretical application area for Data Science, with considerable engagement from industry. This module aims to familiarise you with this conceptually and technically challenging area.

By taking this module, you will have an opportunity to master the theory and practice of graph analysis and social data analysis. You will be shown how to gather datasets from public social networking platforms. You will learn how to convert social network data into graph representations and then apply typical algorithms to analyse the structure of the graph. You will visualise graphs and assess data flow and influence between nodes in the graph.

Topics covered in this module:

- Directed and undirected graphs
- Paths, including Hamiltonian and Eulerian paths
- Distance and shortest path
- Complexity theory
- The PageRank algorithm
- Directed acyclic graphs
- Retrieving social network data
- Generating graphs from social network data
- Betweenness centrality in social networks
- Visualisation of networks

**Assessment**

All modules (except for the Final Project) are assessed by the following:

1. **Coursework (30% weighting overall)**

   There are two items of coursework for each module. Each contributes to the final assessment mark as follows:

   - Coursework item 1 25% (deadline – normally week 6 or 7 – see VLE for date)
   - Coursework item 2 5% (deadline – normally week 13 or 14 – see VLE for date)

2. **Examination (70% weighting)**

   The final piece of assessment for each module will be through an unseen written examination of 3 hours duration. The examination will comprise three sections with a mix of qualitative and quantitative questions.

   The deadlines provided are indicative and subject to change. You should always refer to the VLE for the most up to date information.
Final project [DSM500]

Overview

In this module you will undertake a substantial independent research project that will allow you to demonstrate a wide range of skills: project planning, management, research, and written presentation. You will integrate the knowledge gained throughout the programme and use skills acquired in other modules in the implementation of your Final Project. The work will consist of a combination of research and highly applicative elements in various proportions. For your project work you can make use of methodologies from various components of Data Science as instruments of research.

Topics covered in this module:

- Project planning and management
- Project-associated risk management
- Project-specific research methodology and methods
- Aims and objectives of your project
- Project-specific literature review
- Project-specific ethical and legal issues
- Project-specific data gathering
- Project-specific data analysis
- Evaluation of research results
- Project-specific academic writing.

Assessment

1. Coursework (70% weighting)

The project will be submitted as a sequence of deliverables. These will include, but not be limited to:

- Project proposal
- Preliminary project report
- Weekly progress logs, including source code versioning logs where appropriate
- Final Project report, including source code and data sets where appropriate
- Project presentation and demonstration where appropriate

2. Examination (30% weighting)

The project will also be assessed through an unseen, written examination of 3 hours, based on general questions about data science projects and specific questions about the project undertaken by the student.
Appendix B – Assessment Criteria

This is an indicative description of expectations at each grade level. Overall grades comprise qualitative and quantitative elements. The setting of questions, tasks and requirements and the accompanying marking scheme should take account of the criteria below.

**Distinction (80+%)**

An answer falling into the mark range 80+% demonstrates:

- very significant ability to evaluate critically existing methodologies and suggest new approaches to current research or professional practice;
- very high levels of creativity, originality and independent thought;
- very significant ability to plan, organise and execute independently a research project, coursework assignment or examination question;
- very significant ability to evaluate literature and theory critically and make informed judgements;
- very significant ability to analyse data critically;
- outstanding levels of accuracy, technical competence, organisation and expression.

**Distinction (70-79%)**

An answer falling into the mark range 70 to 79% demonstrates:

- a capacity to develop a sophisticated and intelligent argument;
- clear evidence of wide and relevant reading, referencing and an engagement with the conceptual issues;
- original thinking and a willingness to take risks;
- a significant ability to plan, organise and execute independently a research project, coursework assignment or examination question;
- rigorous use and a sophisticated understanding of relevant source materials, balancing appropriately between factual detail and key theoretical issues. Materials are evaluated directly and their assumptions and arguments challenged and/or appraised;
- significant ability to analyse data critically;
- correct referencing.

**Merit (60 to 69%)**

An answer falling into the mark range 60 to 69% demonstrates:

- a detailed understanding of the major factual and/or theoretical issues and directly engages with the relevant literature on the topic;
- strong evidence of critical insight and thinking;
- a capacity to develop a focused and clear argument and articulate clearly and convincingly a sustained train of logical thought;
- an ability to plan, organise and independently execute a research project, coursework assignment or examination question;
• an ability to analyse data critically;
• clear evidence of planning and appropriate choice of sources and methodology with correct referencing.

Pass (50 to 59%)
An answer falling into the mark range 50 to 59% demonstrates:
• a reasonable understanding of the major factual and/or theoretical issues involved;
• evidence of some knowledge of the literature with correct referencing;
• examples of a clear train of thought or argument;
• an ability to plan, organise and independently execute a research project, coursework assignment or examination question;
• how to introduce and appropriately conclude a text.

Fail (40 to 49%)
Fails to meet the minimum requirements of the assessment criteria. An answer falling into the mark range 40 to 49% demonstrates:
• some awareness and understanding of the literature and of factual or theoretical issues, but with little development and/or irrelevant/unrelated material or arguments included;
• a limited ability to present a clear and coherent argument;
• a limited ability to plan, organise and execute a research project, coursework assignment or examination question;
• a limited ability to analyse data;
• incomplete referencing.

Fail (20 to 39%)
Fails to meet the minimum requirements of the assessment criteria. An answer falling into the mark range 20 to 39% demonstrates:
• clear conceptual or factual errors or misunderstandings;
• only fragmentary evidence of critical thought or data analysis;
• very limited ability to plan, organise and execute a research project, coursework assignment or answer an examination question;
• fails to develop a coherent argument that relates to the research project or assignment or fails to answer the question or to develop an argument that relates to the question set;
• a lack of engagement with the relevant literature or fails to demonstrate a knowledge of the key issues;
• incomplete referencing.

Fail (0 to 19%)
Fails to meet the minimum requirements of the assessment criteria. An answer falling into the mark range 0 to 19% demonstrates:
• little or no knowledge or understanding;
• little or no knowledge of the relevant literature;
• no demonstrable ability to plan, organise and execute a research project, coursework assignment or examination question;
• no evidence of critical thought or data analysis;
• short answers and incoherent argument;
• major errors in referencing.