Appendix 2

Module Description

Module Details	
Module Code:	CMT218
Module Name:	Data Visualisation
School:	Computer Science & Informatics
Module Tutor:	Dr Martin Chorley
Credits:	20
Level:	7
Module Language:	English

Outline Description of Module

The aim of this module is to give students an understanding of the processes and tools required to create interactive visualisations and explanations of data.
The module will allow students to critically appreciate correct visualisations, and to identify biased or manipulated interpretations.
It will cover the practical skills required to create visualisations using tools such as Python and JavaScript, while also examining the theory of design required.

On successful completion of the Module a student should be able to:

1. Describe and discuss the theory behind visualisation design
2. Critically analyse visualisations of data
3. Examine and explore data to find the best way it can be visually represented
4. Create static, animated and interactive visualisations of data
5. Critically reflect upon and discuss the merits and shortcomings of their own visualisation work

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. Students will be guided through learning activities appropriate to their module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- Use of appropriate tools for data analysis and visualisation.
- Critical analysis of visualisation.
  JavaScript and Python for data access, manipulation, statistical analysis and visualisation.

How the Module will be assessed

Summative assessment that counts towards the results of the module will be provided through a critical evaluation task covering Learning Outcomes 1 and 2, and a practical data analysis and visualisation task covering Learning Outcomes 3, 4 and 5.

Formative assessment opportunities that do not count towards the result of the module, but that will allow you to gain feedback on your work and your progress in the module, will be provided through online and in-person discussion of work.

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
CW	40	Visualisation Analysis		NA
CW	60	Data Analysis Visualisation Creation		NA

Syllabus Content

1. Visualisation theory
2. Visualisation history
3. Current trends in visualisation
4. Use of appropriate software tools and libraries for data analysis and visualisation
5. Python and JavaScript for data visualisation
6. Retrieving and storing data (JSON, csv) using JavaScript and Python
7. Visualisation development

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

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Appendix 2

Module Description

Module Details	
Module Code:	CMT309
Module Name:	Computational Data Science
School:	Computer Science & Informatics
Module Tutor:	Dr Oktay Karakus
Credits:	20
Level:	7 Masters
Module Language:	English

Outline Description of Module

This module introduces the foundations of computational data science, covering both theoretical underpinnings and the practical computational applications of core data science knowledge and skills.

You will learn how to extract, store and analyse both numeric and textual data using computational programming languages.

On successful completion of the Module a student should be able to:

1. Use the Python programming language to complete a range of programming tasks
2. Demonstrate familiarity with programming concepts and data structures
3. Use code to extract, store and analyse textual and numeric data
4. Carry out data analysis and statistical testing using code
5. Critically analyse and discuss methods of data collection, management and storage
6. Extract textual and numeric data from a range of sources, including online
7. Reflect upon the legal, ethical and social issues relating to data science and its applications

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. You will be guided through learning activities appropriate to your module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- Fundamental programming in Python
- Reading and writing common data formats
- Data analysis using appropriate libraries
- Understanding HTML document structure and the fundamentals of the web (HTTP, APIs, Security and Authentication)

How the Module will be assessed

Summative assessment that counts towards the results of this module will be provided through a series of programming exercises that cover Learning Outcomes 1, 2 and 3, and a portfolio of data science analysis and discussion that cover Learning Outcomes 4, 5 and 6.

Formative assessment opportunities that do not count towards the result of this module but that will allow you to gain feedback on your work and your progress in the module will be provided during practical exercises and tutorial sessions.

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
CW	30	Programming Exercises		NA
PCEX	70	Data Science portfolio		NA

Syllabus Content

- Computational & algorithmic thinking and developing basic algorithmic steps for coding.
- Basic programming in Python: Fundamental data types, program control structures, Object Oriented Programming and other basic language features.
- Data extraction and importing; analysis using common libraries (e.g. pandas, numpy, scipy)
- Data Visualisation (e.g. matplotlib, seaborn, plotly)
- Natural language processing using common libraries (e.g regex, nltk)
- Testing and documentation
- Data Science applications
- Legal issues relating to Data Science (GDPR)
- Social and Ethical issues relating to Data Science
- Descriptive statistics
- Hypothesis testing
- Regression analysis & prediction
- Estimation Theory & Bayesian Sampling
- Retrieving data from online sources (web scraping, APIs)

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

Appendix 2

Module Description

Module Details	
Module Code:	MAT021
Module Name:	Foundations of Operational Research and Analytics
School:	Mathematics
Module Tutor:	Dr Jonathan Thompson
Credits:	20
Level:	7 Masters
Module Language:	English

Outline Description of Module

This course will introduce you to a range of fundamental Operational Research (OR) techniques, both stochastic and deterministic in nature. You will gain experience in using commercial software packages to connect theoretical understanding with solving practical problems.

The module will introduce the concepts and applications of simulation including Monte Carlo, Discrete Event, System Dynamics, and Agent Based Simulation. You will be introduced to a range of simulation software covering the different approaches taught in the lectures, and you will learn about linear and integer programming, dynamic programming, scheduling, and heuristics.

On successful completion of the Module a student should be able to:

1. Know when it is appropriate to apply a range of fundamental OR techniques, based on an understanding of their theoretical underpinnings.
2. Construct both deterministic and stochastic models of real-life situations using simulation, mathematical programming and other optimisation techniques.
3. Use optimisation algorithms to solve practical problems.
4. Implement OR models and algorithms using different commercial computer packages.
5. Present findings and recommendations in a concise manner.

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. You will be guided through learning activities appropriate to your module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- O.R. and analytics: simulation of stochastic systems; formulation and solution of optimisation problems.
- Mathematical reasoning: understanding the theory and assumptions that underpin optimisation algorithms.
- Use of simulation and optimisation computer packages.
- Written communication skills.

How the Module will be assessed

Summative assessment that counts towards the results of the module will be provided through a class test covering Learning Outcomes 1 and 2, and a group simulation assignment covering Learning Outcomes 3, 4 and 5.

Formative assessment opportunities that do not count towards the result of this module but that will allow you to gain feedback on your work and your progress in the module will be provided during practical exercises and tutorial sessions.

Type of assessment (Please refer to key at the bottom of this document)	**% Contribution**	**Title**	**Duration/ word count (or equivalent)**	**Approx. date of Assessment**
CT	60	Foundations of Operational Research and Analytics	2 hrs	NA
CW	40	Group Simulation assignment		NA

Syllabus Content

1. Simulation. Concepts of the modelling approach, simulation approaches, static/dynamic, continuous/discrete. Monte Carlo, Discrete Event, System Dynamics.
2. Linear Programming. Model construction, standard and normal forms of LP problems, Simplex method, two-phase method, Big M method, primal and dual problems, pre-multiplication matrix, dual Simplex, duality theorem, sensitivity analysis, case studies.
3. Integer Programming. Branch and Bound, binary variables, problem formulation, some types of IP problems.
4. Dynamic Programming. Terminology, practical examples, stochastic dynamic programming.
5. Scheduling. Scheduling models, constraints, rules, Moore's algorithm, Johnson's algorithm.
6. Heuristics. Design of heuristics, complexity, greedy algorithms, local search, genetic algorithms.

Types of Assessment

Assessment Type code	**Full Name**	**Assessment Type code**	**Full Name**
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

Appendix 2

Module Description

Module Details	
Module Code:	MAT022
Module Name:	Foundations of Statistics and Data Science
School:	Mathematics
Module Tutor:	Dr Panqiu Xia
Credits:	20
Level:	7 Masters
Module Language:	English

Outline Description of Module

This module will introduce a range of fundamental statistical ideas. The broad aim of the module is to provide you with
1. an understanding of the mathematical ideas that underpin some fundamental statistical methods;
2. proficiency in performing practical data analysis using statistical software;
3. the ability to communicate the results of data analysis by clearly explaining the steps you have followed in your analysis.

On successful completion of the Module a student should be able to:

1. Formulate problems involving uncertainty within the framework of probability theory.
2. Understand the conditions under which various statistical methods can be applied.
3. Summarise a data set using descriptive statistics.
4. Calculate confidence intervals and perform hypothesis tests.
5. Identify the sources of variation in data.
6. Fit linear models to data and evaluate the accuracy of these models.
7. Perform variable selection and dimension reduction.
8. Write technical reports to communicate the results of data analysis procedures.

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. You will be guided through learning activities appropriate to your module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- Mathematical reasoning
- Practical data analysis
- The use of statistical computer packages
- Written communication skills.

How the Module will be assessed

Summative assessment that counts towards the results of this module will be provided through a class test covering learning outcomes 1, 2 and 3 and a group work assignment covering Learning Outcomes 4, 5, 6, 7 and 8.

Formative assessment opportunities that do not count towards the result of this module but that will allow you to gain feedback on your work and your progress in the module will be provided during practical exercises and tutorial sessions.

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
CT	60	Foundations of Statistics and Data Science	2 hours	XXX
CW	40	Group analysis assignment		

Syllabus Content

1. Elementary probability
2. Descriptive statistics
3. Estimation
4. Hypothesis testing
5. Categorical data
6. Correlation
7. Analysis of variance
8. Regression
9. Principal components analysis
10. Non-parametric methods

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

Appendix 2

Module Description

Module Details	
Module Code:	MAT025
Module Name:	AI Essentials
School:	Mathematics
Module Tutor:	Prof Gavin Shaddick
Credits:	20
Level:	7
Module Language:	English

Outline Description of Module

This module will introduce you to a range of inter-related topics that will be important in applying AI to solve real-life problems. These include (i) an introduction to the concepts behind AI models; (ii) the importance and value of data; and (iii) the use of AI tools to gain insight from data and support decision making. You will learn the fundamental concepts that underpin AI models and understand the differences and similarities between a range of modelling approaches and terminologies, including machine learning, stochastic and statistical models, data fusion, neural networks, large language models, numerical models and uncertainty quantification. You will learn about different types of data and how different data collection mechanisms can lead to biases, errors and uncertainties that might affect how robust results are for decision making. You will gain and understanding of important AI techniques, including for example prediction and segmentation experience through applying them to real-life examples and datasets using widely available AI tools.

On successful completion of the Module a student should be able to:

1. Systematically understand the underlying principles of AI models and the differences between different types of mathematical/computational models
2. Appreciate different forms of data generation and choose appropriate AI models to use on data
3. Assess the principles of bias and how this is linked to the data generation mechanism
4. Use AI tools to perform exploratory data analysis
5. Implement predictive models using AI tools.
6. Use AI tools to perform segmentation on data

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. You will be guided through learning activities appropriate to your module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- The ability to perform prediction and segmentation using AI tools
- Exploratory data analysis
- Understanding the difference between different modelling approaches
- Understanding the effects that different data generation mechanisms can have on inference and decision making

How the Module will be assessed

A blend of assessment types which may include coursework and portfolio assessments, class tests, and/or formal examinations. Will include report writing as well as analysis of data. CW1 will cover LO1, LO2, LO3, LO4 and CW2 will cover LO1, LO2, LO3, LO5, LO6

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
CW	40	Data Analysis: Prediction and evaluation		NA
CW	60	Data Analysis: Segmentation		NA

Syllabus Content

- What is an AI model?
- Different types of models: AI models, numerical models, stochastic models, machine learning; differences, similarities, and examples
- Model evaluation: errors, cross validation
- Sources of data
- Biases and uncertainties
- Data Integration
- Introduction to AI tools
- Predictive AI
- Segmentation

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

Module Description

Module Details	
Module Code:	MAT026
Module Name:	AI in Practice
School:	Mathematics
Module Tutor:	Prof Vince Price
Credits:	20
Level:	7
Module Language:	English

Outline Description of Module

This module aims to develop the skills required for using AI in practice. You will gain an understanding of the wider opportunities and challenges associated with using AI in practical settings, including an understanding of ethics, data governance and decision making.

You will be introduced to the important aspects of how to develop your own original consulting/research analyses and how to communicate them effectively. You will gain the key skills required for employment in this field, including team building and presentational skills. You will develop the skills required to stay up-to-date with and communicate your subject knowledge and succeed in the professional and academic environment.

You will learn about the importance of data pipelines, workflows and version control, the practice of tracking and managing changes to code and data. You will understand the principles for undertaking independent research and analyses and the ability to effectively communicate and present your work and conclusions in a form that is appropriate to different audiences.

On successful completion of the Module a student should be able to:

1. Critically evaluate the opportunities associated with the use of AI in different settings, and discuss the challenges including ethics, governance and privacy
2. Appreciate the role of knowledge discovery, writing and presenting in research and consulting;
3. Develop literature search and reading skills, allowing you to distil key concepts from the literature and other sources of information;
4. Summarise and explain scientific concepts;
5. Understand the importance of version control and workflow.

How the Module will be delivered

Modules will be delivered through a blend of teaching styles. You will be guided through learning activities appropriate to your module, which may include:

• on-line resources that you work through at your own pace (e.g. videos, web resources, e-books, quizzes)

• on-line interactive sessions to work with other students and staff (e.g. discussions, live streaming of presentations, live-coding, team meetings)

• face to face/in-person group sessions (e.g lectures, practicals, help classes, tutorials, feedback sessions)

Skills that will be practised and developed

- Understanding the opportunities associated with the use of AI across different sectors
- Understanding issues related to ethics, governance and privacy
- Be able to perform knowledge discovery, including from papers, reports and through sourcing data from different sources
- Performing literature searches and distil key concepts from the literature and other sources of information;
- Summarising and explain scientific concepts;
- Work collaboratively to understand and use AI concepts and techniques
- Use of version control software and developing data pipelines and workflows

How the Module will be assessed

A blend of assessment types which may include coursework and portfolio assessments, class tests, and/or formal examinations. Will include report writing and analysis of data. CW1 will assess LO1, LO2 and LO3. CW2 will assess LO4 and LO5.

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
PR	40	Group work: case study including research, analysis and presentation		NA
CW	60	Knowledge discovery: sourcing data, workflows, analysis and communication		NA

Syllabus Content

- AI in Society
- Data governance and ethics.
- Fairness in data collection and analysis with case studies
- Knowledge discovery and sources of information
- Critical reviews
- Interpretation and decision making
- Literature reviews
- Communication of complex ideas to different audiences, including different modes of presentation
- Workflows and data pipelines
- Version control

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
CW	Written Assessment	PCEX	Practical-Based Assessment
DIS	Dissertation	PJ	Project
EXAU	Exam - Autumn Semester	PL	Placements
EXOA	Exam online – Autumn semester	PO	Portfolio
EXOR	Exam online – Re-sit period	PR	Presentation
EXOS	Exam online – Spring semester	PSA	Practical Skills Assessment
EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		

Appendix 2

Module Description

Module Details	
Module Code:	MAT027
Module Name:	AI + Statistical Analytics Project
School:	Mathematics
Module Tutor:	Prof Paul Harper
Credits:	60
Level:	7
Module Language:	English

Outline Description of Module

In this module, you will work on a research problem in the application of AI and Statistical Analytics. You will apply your understanding of the underlying concepts of AI and Statistical Analytics together with the methods and tools that you have learned to a problem in an applied field. The module aims to build on the knowledge and skills you have acquired in the taught modules of the programme to allow you to investigate an area of particular interest to you. It aims to give you experience of many aspects of research work, including problem formulation, literature review, planning, tool development, experimentation, analysis, interpretation and presentation of results.

The project will require understanding of the area of application, a critical review of possible approaches, choice and implementation of appropriate methodology, an extended piece of analysis and a clear and concise write up of the background, data, methodology, results and conclusions.

This is an independent project, supervised by an expert from the relevant area, and culminates in writing a dissertation, describing your research and its results. Research topics can be selected from across the breadth of the application of AI and Statistics.

On successful completion of the Module a student should be able to:

1. Demonstrate knowledge of a research topic of relevance to the use of AI and Statistical Analytics, acquired through a deep and self-motivated exploration of that topic.
2. Design and follow systematically the phases of research project development.
3. Apply sophisticated and appropriate analysis and development techniques at each stage of a project.
4. Show familiarity with the background and context of a new application area.
5. Apply methods and tools learnt in the context of other fields to the application in question
6. Produce full documentation as appropriate to the system and research.

How the Module will be delivered

Scheduled Learning and Teaching Activities
Guided Independent Study

Skills that will be practised and developed

- Gaining familiarity with the background and context of a new application area;
- Applying methods and tools learnt in the context of other fields to the application in question;
- Producing full documentation as appropriate to the system and research
- Conduct independent study, including library and web-based research;
- Plan an extended project and manage time effectively;
- Present work to a non-specialist audience.

How the Module will be assessed

Coursework – Mid-Point Presentation
Coursework – Final Presentation
Coursework – Dissertation

Type of assessment	% Contribution	Title	Duration/ word count (or equivalent)	Approx. date of Assessment
CW	10	Mid-Point Presentation		NA
CW	20	Final Presentation		NA
CW	70	Dissertation		

Syllabus Content

- Developing a research idea
- Performing a literature review
- Sourcing data
- Dissertation
- Presentation

Types of Assessment

Assessment Type code	Full Name	Assessment Type code	Full Name
CT	Class Test	FW	Field Work
CTAU	Autumn Semester Class Test	LB	Laboratory Work
CTSP	Spring Semester Class Test	OA	Oral/Aural Assessment
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EXPG	Exam - Postgraduate	RP	Report
EXRE	Exam - Re-sit Period	SM	Seminar
EXSP	Exam - Spring Semester	ST	Study
EXSU	Exam - Summer		