Department of Computer Science and Information Systems

MSc in Data Science
Programme Arrangements
2019–2020

Version of September 29, 2019
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1 General Information

1.1 Contacts

Programme Director: Dr Alessandro Provetti, ale@dcs.bbk.ac.uk

Programme Administrators: Kat Miao Yu, Stacey Hine, pg@dcs.bbk.ac.uk

Admissions Tutors coordinator: Dr Carsten Fuhs, carsten@dcs.bbk.ac.uk

Projects Tutor: Dr Oded Lachish, oded@dcs.bbk.ac.uk

Disability Officer: Dr Oded Lachish, oded@dcs.bbk.ac.uk

1.2 Web presence

Detailed and updated information about the programme is available from the Moodle Virtual Learning Environment

moodle.bbk.ac.uk

is used to provide detailed information and post announcements about each module on which you are enrolled.

- intranet page (for enrolled students):
  https://moodle.bbk.ac.uk/course/view.php?id=15780

- Legacy departmental internet page:
  http://www.dcs.bbk.ac.uk/study/postgraduate/msc-data-science/

It is your responsibility to familiarise yourself with the contents of both of this booklet as well as the programme’s web site, and to consult the web site on a regular basis, since additional information will be posted there during the year. You should also read your College email on a regular basis.
2 Student Support

Every student is allocated a personal tutor in the first weeks of the programme. The personal tutor is someone students can contact to discuss any problems of a non-academic nature. These may relate to special needs or personal problems that may affect the student’s academic performance. The Department also has a disability officer whom students can contact.

Academic problems should first be addressed to the lecturer concerned. If the problem is not resolved or it does not relate to a specific module, then the Programme Director should be contacted.

For more general information about Birkbeck, student services and regulations have a look at

https://www.bbk.ac.uk/student-services.

It is expected that students familiarise themselves with these pages so that they are aware of the services and regulations.

The School of Business, Economics and Informatics has Learning Co-ordinators. Their role is to support students in their studies. They can offer help and support on a variety of topics ranging from writing skills to basic maths. See

http://www.bbk.ac.uk/business/current-students/learning-co-ordinators

for details.
3 Important Dates

Lectures will commence in the week starting on Monday 30 September 2019. The teaching (i.e., not including exams and project) covers two terms of eleven weeks each (autumn and spring term). The summer term is given over to revision (including revision lectures), exams, and the project.


Please refer to

http://www.bbk.ac.uk/about-us/term-dates

for the College holiday closing times.

Students should attend lectures during term time as shown in the timetables in Section 4.3. If students are unable to attend lectures, they should arrange with lecturers or fellow-students to obtain copies of any material distributed in class.

Any student who decides to withdraw from the programme should inform the Programme Administrator(s). Students who simply stop turning up for lectures without formally withdrawing from the programme will still be held liable for fees. It is especially important for international students that they inform the department about any absence.
4 Syllabus

4.1 Introductory Talks

The programme will kick off with introductory talks to new students in the days around the start of the first term. The dates, times and venues of these will be made available through the personalised agenda on My Birkbeck. They are also mentioned at

http://www.bbk.ac.uk/events/?tag=7.

The talks will include a hands-on introduction to the departmental computer systems and short presentations by representatives of the Birkbeck library and the disability office.

Background material

On the course web site enrolled students will find three notes, in PDF format, to be used for pre-course preparation. The three notes will refresh students on Python programming, Mathematics and Probability & Statistics, respectively.

4.2 List of Modules

We give a general overview of the content of the programme here; detailed description of the individual modules is in the next section.

4.2.1 Compulsory Modules

• Fundamentals of Computing — FoC (15 credits)
• Principles of Programming I — PoP I (15 credits)
• Big Data Analytics using R — BDA (15 credits)
• Computer Systems — CS (15 credits)
• Programming with Data — PwD (15 credits)
• Data Science Techniques and Applications — DSTA (15 credits)
• MSc Data Science Project (60 credits)
4.2.2 Optional Modules

To complete MSc Data Science requirements each student is required to select and take two optional modules. The following list of available optional/elective modules can only be indicative as actual availability may vary on a year-by-year basis. Please consult the web page of each module for the updated contents and times.

Optional module availability is subject to timetabling constraints and student demand. In the event that an optional module is over-subscribed, available places will be allocated on a first-come, first-served basis determined by the date you return your module choice form to the Programme Administrator.

- Advances in Data Management — ADM (15 credits)
- Applied Machine Learning — AML (15 credits)
- Cloud Computing — CC (15 credits)
- Information and Network Security — INS (15 credits)
- Information Systems — IS (15 credits)
- Machine Learning — ML (15 credits)
- Natural Language Processing and Information Retrieval — NLP (15 credits)
- Principles of Programming II — PoP II (15 credits)
- Semantic Technologies — ST (15 credits)

Additionally, a 15-credit, level 7 module offered by the Advanced Computing Technologies MSc (MSc-ACT) programme may be considered. For a detailed description of these modules and the timetable, see the following web page:

http://www.dcs.bbk.ac.uk/courses/mscact/

Please note that the modules above run on a different timetable, so you can only take these modules if you are able to fit them into your schedule. If you are interested in taking a module from the MSc-ACT programme as an option, please discuss this with your Programme Director.
Suggested dependencies between modules

The following directed graph illustrates the suggested dependencies between the content of one module and the subsequent modules offered by this program. Compulsive modules are written in roman font, elective modules are *in italics*. Again, please notice that due to timetable and lab availability constraints not all combinations are possible.

4.3 Timetables

The teaching venues will be available on the personal calendar on MyBirkbeck. A general timetable for the week ahead is available at departmental level:

http://www.dcs.bbk.ac.uk/study/

For an overview of the teaching venue locations, please refer to

http://www.bbk.ac.uk/mybirkbeck/guides/help/class-information/
Below is the indicative timetable for the modules. Note that occasionally there might be changes (e.g., swapping of lectures between modules, or additional tutoring sessions). Also, actual start/end times might vary. Please contact regularly the web pages of the modules for up-to-date information. Week 6 of each term is normally considered reading week, with no classes taking place. In what follows compulsory modules are in **boldface**; all other activities are optional.

**Part-time Students, Year 1**

In their first year, part-time Data Science students take five compulsory modules as in the following preliminary timetable.

<table>
<thead>
<tr>
<th>Term 1 (Autumn)</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>PoP I</td>
<td>PoP I</td>
</tr>
<tr>
<td>Tue.</td>
<td>BDA</td>
<td>BDA</td>
</tr>
<tr>
<td>Wed.</td>
<td>FoC</td>
<td>(FoC tutorial)</td>
</tr>
<tr>
<td>Thu.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term 2 (Spring)</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tue.</td>
<td>PwD</td>
<td>PwD</td>
</tr>
<tr>
<td>Wed.</td>
<td>FoC</td>
<td>(FoC tutorial)</td>
</tr>
<tr>
<td>Thu.</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Part-time Students, Year 2**

In their second year, part-time Data Science students take *Data Science Techniques and Applications (DSTA)*, and two optional modules, as in the following preliminary
timetable.

<table>
<thead>
<tr>
<th>Term 1</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>INS</td>
<td>INS</td>
</tr>
<tr>
<td></td>
<td>ST</td>
<td>ST</td>
</tr>
<tr>
<td>Tue.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thu.</td>
<td>AML</td>
<td>AML</td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please notice that on Friday Week 3 (TBC) there will be a Project briefing event.

<table>
<thead>
<tr>
<th>Term 2</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>ADM</td>
<td>ADM</td>
</tr>
<tr>
<td></td>
<td>PoP II</td>
<td>PoP II</td>
</tr>
<tr>
<td>Tue.</td>
<td>NLP</td>
<td>NLP</td>
</tr>
<tr>
<td>Wed.</td>
<td>DSTA</td>
<td>DSTA</td>
</tr>
<tr>
<td>Thu.</td>
<td>ML</td>
<td>ML</td>
</tr>
<tr>
<td>Fri.</td>
<td>CC</td>
<td>CC</td>
</tr>
</tbody>
</table>

Please notice that due to timetabling constraints the two-terms module Information Systems (IS) is available only in day-time version: Thursday from 15:30 to 17:00.

**Full-time Students**

In their first term, full-time students take PoP I in the first five weeks of the term, then PwD in weeks 7 to 11, with week 6 normally serving as the reading week\(^1\).

\(^1\)In the current organization of studies the reading week is at the discretion of the instructor. Please check individual models for the current arrangements.
The preliminary timetables are as follows.

<table>
<thead>
<tr>
<th>Term 1: weeks 1–5</th>
<th>13:30–15:00</th>
<th>15:30–17:00</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>PoP I</td>
<td>PoP I</td>
<td>INS ST</td>
<td>INS ST</td>
</tr>
<tr>
<td>Tue.</td>
<td>BDA</td>
<td>BDA</td>
<td></td>
<td>(FoC tutorial)</td>
</tr>
<tr>
<td>Wed. (weeks 1-5)</td>
<td>PoP I</td>
<td>PoP I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thu.</td>
<td></td>
<td></td>
<td>FoC AML</td>
<td>AML</td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please notice that FoC tutorials are discretionary and normally run on alternate weeks.

Please also notice that on Friday Week 3 (TBC) there will be a Project briefing event.

<table>
<thead>
<tr>
<th>Term 1: weeks 7–11 (Autumn)</th>
<th>13:30–15:00</th>
<th>15:30–17:00</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>PwD</td>
<td>PwD</td>
<td>INS ST</td>
<td>INS ST</td>
</tr>
<tr>
<td>Tue.</td>
<td>BDA</td>
<td>BDA</td>
<td></td>
<td>(FoC tutorial)</td>
</tr>
<tr>
<td>Wed.</td>
<td>PwD</td>
<td>PwD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thu.</td>
<td></td>
<td></td>
<td>FoC AML</td>
<td>AML</td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term 2: w. 1–5, 7–11 (Spring)</th>
<th>13:30–15:00</th>
<th>15:30–17:00</th>
<th>18:00–19:20</th>
<th>19:40–21:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon.</td>
<td>(ADM labs)</td>
<td>(ADM labs)</td>
<td>ADM PoP II</td>
<td>ADM PoP II</td>
</tr>
<tr>
<td>Tue.</td>
<td></td>
<td></td>
<td>NLP</td>
<td>NLP (FoC tutorial)</td>
</tr>
<tr>
<td>Wed.</td>
<td>CS</td>
<td>CS</td>
<td>DSTA</td>
<td>DSTA</td>
</tr>
<tr>
<td>Thu.</td>
<td>FoC</td>
<td>IS</td>
<td>ML</td>
<td>ML</td>
</tr>
<tr>
<td>Fri.</td>
<td></td>
<td></td>
<td>CC</td>
<td>CC</td>
</tr>
</tbody>
</table>
Please notice that FoC tutorials are discretionary and may run on alternate weeks.
Module Descriptions

5.1 Fundamentals of Computing (FoC)

Teaching Staff

Michael Zakharyaschev (module coordinator), Trevor Fenner

Aims

Discrete mathematics, mathematical logic, and the related fundamental areas of data structures and algorithms lie at the heart of any modern study of Computer Science. Any understanding of how computers operate and how to use them effectively and efficiently, in terms of either their hardware or software, inevitably involves numerous mathematical concepts.

Syllabus

- Digital logic. Arithmetic for computers.
- Elements of set theory.
- Finite state machines (automata). Nondeterministic automata.
- Regular languages.
- Context-free languages and pushdown automata.
- Data structures: representations and operations.
- Lists, stacks, queues and dequesues.
- Trees, forests, binary trees.
- Tree traversal and other operations; binary search trees.
- Organisation of disk storage; methods of file organisation; B-trees.
- Design and analysis of algorithms. Sorting and searching.

Prerequisites

Students taking this module must be also be currently taking (or have previously taken) a suitable programming module (Principles of Programming, or Introduction to Software Development). With the permission of the Programme Director, other students may take this module if they have equivalent appropriate programming experience.
Assessment

By 3-hour written examination and coursework exercises, weighting 80% and 20% respectively.

Reading


Online material

http://www.dcs.bbk.ac.uk/~michael/foc/foc.html
http://www.dcs.bbk.ac.uk/~trevor/FoC/focTF2018.html
5.2 Principles of Programming I (PoP I)

Teaching Staff
Vladislav Ryzhikov, Hubie Chen

Online material
On Moodle.

Aims, Outline and Learning Outcomes
To provide the student with a comprehensive grounding in programming. This module introduces programming concepts and techniques, as well as elementary software development principles. Both for absolute beginners and for those with prior programming experience, the module introduces the fundamentals of programming, including: variables and assignment, primitive and complex types, methods, control structures, collections, iteration, recursion, as well as classes and objects in object-oriented programming. The module also introduces basic software development issues such as design, testing, debugging.

On successful completion of this module a student will be expected to be able to:

- Demonstrate knowledge of fundamental imperative programming concepts such as variables and assignment, conditional statements, loops and methods.
- Code an application in a suitable programming language, from a detailed software specification.
- Evidence knowledge of basic concepts and principles of object-orientation such as objects and classes, encapsulation, object state, coupling, cohesion and modularity.
- Show awareness of basic principles of software design and development including appropriate naming of variables and classes, code layout, testing, debugging, and code version control.

Syllabus
- Core imperative programming ideas: sequence, iteration, assignment, and variables
- Data types
• Collection Data Structures: Arrays, List, Sets, Dictionaries
• Functions
• Version Control
• Automated testing and test-driven development (TDD)
• Object-oriented programming: Encapsulation, Inheritance, Polymorphism
• Functional programming features of Python
• Dynamic data structures: Linked lists, Queues, and Stacks
• Recursion
• Exception handling

Prerequisites
A pass in the relevant admissions test.

Assessment
By examination (80%) and programming coursework (20%). The examination is split into two parts; 1) 40% via an online programming exam, and 2) 40% via a written exam.

Reading
A set of course notes will be provided but the following text covers similar topics:

5.3 Big Data Analytics Using R (BDA)

Teaching Staff
Tingting Han

Online material
http://moodle.bbk.ac.uk

Aims
This module covers the principle concepts and techniques of data analytics and how to apply them to large-scale data sets. Students develop the core skills and expertise needed by data scientists, including the use of techniques such as linear regression, classification and clustering. The module will show you how to use the popular and powerful data analysis language and environment R to solve practical problems based on use cases extracted from real domains.

Syllabus

- Introduction to big data analytics: big data overview, data pre-processing, concepts of supervised and unsupervised learning.
- Basic statistics: mean, median, standard deviation, variance, correlation, covariance.
- Linear regression: simple linear regression, introduction to multiple linear regression.
- Classification: logistic regression, decision trees, SVM.
- Ensemble methods: bagging, random forests, boosting.
- Evaluation and validation: cross-validation, assessing the statistical significance of data mining results.
- Selection of advanced topics such as: scalable machine learning, big data related techniques, mining stream data, social networks.
- Tools: R.

Prerequisites
Experience with a modern programming language.
Assessment

By 3-hour written examination and practical coursework, weighting 80% and 20% respectively.

Reading

5.4 Computer Systems (CS)

Teaching Staff

Szabolcs Mikulás

Aims

To learn the basics of computer architecture and organisation, and the role and mechanism of operating systems.

Syllabus

- Introduction: Computer architecture (CA) and Operating system (OS) overview
- Processors
- Processes and threads
- Concurrency
- Memory management
- I/O and file systems
- Protection and security
- Distributed and parallel processing

Prerequisites

MSc IT students who wish to enrol to this module are expected to pass the test for the short course.

Assessment

By 2-hour written examination and coursework, weighting 90% and 10%, respectively.

Reading

Textbook:


Recommended reading:


Online material

http://www.dcs.bbk.ac.uk/~szabolcs/compsys.html
5.5 Programming with Data (PwD)

Teaching Staff
Alessandro Provetti and Stelios Sotiradis

Online material
http://www.moodle.bbk.ac.uk/

Aims
This module builds on the core module “PoP I” to further students’ ability to program data analytics in Python. During the course, we will introduce algorithmic techniques for data analysis and some basic Python modules. A summary but complete view of available algorithmic techniques will be given, and we will examine randomization, approximation, scalability and intractability. Moreover, it introduces the Relational Data Model and the SQL language for managing and querying databases. Finally, students will study and discuss the Ethics of Computing and Data Mining.

Syllabus
- the main algorithmic techniques, in Python
- Randomness
- Optimization
- Montecarlo methods (if time allows)
- Scalability and intractability
- the Ethical issues with Computing, Data collection and storage.
- The Relational Data Model; the SQL language for data manipulation/querying
- in-memory databases and No-SQL data repositories

Prerequisites
The ability to program in Python (such as obtained by having taken the module Principles of Programming I, or as approved by the module leader).

Assessment
By a 2-hour written examination and courseworks, weighting 80% and 20% (aggregated), respectively.
Reading

- J. Grus, Data Science from Scratch – First principles with Python (2nd ed.). O’Reilly, 2019.
- Materials on SQL, made available from the site.
5.6  Data Science Techniques and Applications (DSTA)

Teaching Staff
Alessandro Provetti

Online material
http://moodle.bbk.ac.uk/

Aims
This module has been designed as the final module for MSc Data Science students. It presents to them a set of topics in data analytics, focusing on a range of applied data analysis techniques to convert information into knowledge. In particular, the “complex network” model of data organization is studied in some depth.

Syllabus
This module is designed for a minimal overlapping with the Machine Learning/Applied Machine learning modules, which are available as electives for MSc Data Science students.

- introduction to the module; Data Science as 9 computational problems;
- refresh some concepts of Statistics, Linear Algebra and Information theory;
- the geometric view of data, the curse of dimensionality, spectral and decomposition techniques;
- traditional Data Mining techniques such as Dimensionality reduction, e.g., PCA, SVD, SVMs; some kernelization;
- lab experience with Python modules for Data Analytics such as NumPy, Pandas and Scikit-learn;
- from data to graphs, and their relevant properties;
- centrality measures; communities (if time allows).

Prerequisites
The ability to program in Python, SQL and a basic knowledge of statistics normally obtained by taking the PoP I, PwD and BDA modules or as approved by the module leader.


**Assessment**

By a 2-hour written examination and courseworks, weighting 80% and 20% (aggregated), respectively.

**Reading**

The needed study materials may be made available electronically during the term.

6 Elective Modules Descriptions

6.1 Applied Machine Learning (AML)

Teaching Staff
Paul Yoo

Online material
http://moodle.bbk.ac.uk/

Aims
This module covers the fundamental concepts and techniques of applied machine learning using Python and how to use the existing tools to analyse data. Students develop the hands-on and practical skills needed for applied machine learning including the use of existing Python libraries and tools (e.g. Scikit-Learn and TensorFlow) and the use of the techniques needed to analyse data (e.g. pre-processing, feature selection and classification). The module will use Python the most popular machine learning language to solve practical problems based on use cases extracted from real domains such as financial forecasting and computer vision.

Syllabus
- Introduction to Python for machine learning
- Preparing data
- Feature selection for machine learning
- Evaluation and resampling
- Rule-based algorithms: decision tree and random forest
- Regression-based algorithms: logistic regression and neural networks
- Large-scale machine learning using TensorFlow
- Real-life case studies (e.g. financial forecasting and computer vision)

Prerequisites
No specific module is pre- or co-requisite but knowledge of mathematical concepts and basic python will be assumed.
Assessment

By 2-hour written examination and practical coursework, weighting 70% and 30%, respectively.

Reading


• Students will also be directed to papers available online and other Web resources on the subject.
6.2 Cloud Computing (CC)

Teaching Staff
Stelios Sotiradis

Online material
http://www.dcs.bbk.ac.uk/~stelios/cc/

Aims and Outline
The Cloud Computing module aims to introduce back-end Cloud Computing techniques for deploying applications, processing Big Data and developing scalable systems. The module focuses on (a) the theoretical aspects of Distributed Systems and Cloud Computing, and (b) the practical aspects by using Python to develop and deploy cloud-based applications.

Students will understand the emerging area of Cloud Computing and how it relates to traditional models of computing, while at the same time gaining competence in developing cloud-based services and applications. The students will also be introduced to Big Data processing systems and applications.

Syllabus

- Introduction to Cloud Computing and Virtualisation
- Cloud services and Cloud software engineering
- Parallel Computing and Distributed Systems
- Cloud data storage systems
- Deploying and using Cloud storage systems
- Introduction to Container systems
- Introduction to Big Data systems
- Introduction to Hadoop MapReduce framework
- Developing Hadoop Map Reduce applications
- Introduction to Internet of Things and Service-Oriented Architectures

Each class will include a laboratory session (that usually takes half the time) with practical exercises and tutorial sessions to provide hands-on experience of cloud application development and deployment. Students will have the opportunity to develop RESTful web services using Python and access virtualised Linux servers. The students will be introduced into various distributed computing systems and technologies such as APIs, NoSQL systems, container systems, Hadoop MapReduce, Amazon WS, as well as other systems and platforms.
Prerequisites

Very good knowledge of programming with Python.

MSc students who did not have much experience in software development before joining their respective postgraduate programmes should have already taken the Principles of Programming I (POP1) module.

Coursework

One programming assignment with report.

Assessment

By 2-hour written examination and practical coursework, weighting 80% and 20%, respectively.

Reading

- Extensive use is made of other relevant book chapters and research papers that are distributed in class or provided online.
6.3 Information and Network Security (INS)

Teaching Staff
Igor Razgon

Aims
Information security is about protecting information (and information systems) against unauthorised access and tampering. Avoiding security breaches has a high priority for organisations storing and handling confidential data.

The main aim of this module is to provide broad coverage of the field of information security. This course covers the technical as well as the management side of security in information systems. Despite being an essential part of security, technical methods such as cryptography are not enough to guarantee a high level of security. They have to be embedded into a wider context in order to make them more effective. Users of technology have to understand the underlying principles and follow certain policies to avoid security breaches. This module introduces the fundamental approaches to security engineering and includes a detailed look at some important applications.

Syllabus
- Overview of Information Security
- Access Control Matrix Model
- Security Policies
- Social Engineering
- Basic Cryptography
- Identity Management
- Access Control Mechanisms
- Confinement
- Assurance and Trust
- Network Intruders and Intrusion Detection
- Firewalls and Malicious Software
- Cryptographic Protocol Concepts
- Authentication
- Key Exchange
- Economics of Information Security
Assessment

Two-hour written examination (80%) and practical coursework (20%).

Reading


Online material

https://moodle.bbk.ac.uk/
6.4 Information Systems (IS)

Teaching Staff

Brian Gannon

Aims

The primary aim of the module is to describe enterprise information systems (EIS) and to set out the considerations and approaches used to implement (deploy) these systems in the business enterprise. This covers predominantly the Systems Development Life Cycle (SDLC) and the various methodologies used to formalise it, including waterfall and agile approaches, with particular emphasis on the Scrum method. In the course of this module students are introduced to a range of topics relevant to EIS deployment and the SDLC, including object-orientation, the Unified Process and Universal Modelling Language (UML), enterprise architecture and technical architecture.

Alongside describing the SDLC, students will be introduced to practical aspects associated with a career as an IS professional, and social and organisational aspects of enterprise computing. This will include topics such as Intellectual Property, Digital Surveillance, Data Privacy and Ethical issues in computing.

Outline

The module describes approaches, processes, methodologies and techniques commonly used for large-scale information systems development. It covers the systems development life cycle (SDLC), including project initiation, analysis, design and implementation, addressing key aspects and techniques at each stage. Project methodologies are described, with an emphasis on the Scrum methodology. The module also incorporates insights into professional and legal issues associated with EIS development.

Syllabus

- Introduction to Enterprise Information Systems (EIS)
- SDLC, IS project methodologies and the Unified Process
- Unified Process – Planning & Analysis
- Scrum I – Process, Roles, Activities & Ceremonies
- Scrum II – Artefacts & Concepts
• Enterprise Architecture & Technical Architecture;
• EIS Implementation and Operation;
• GDPR, Freedom of Information & Intellectual Property Rights, Contracts & Business Planning, and

Assessment
By a 2-hour unseen written examination and in-class tests, weighting 80% and 20% respectively.

Recommended Reading
Multiple sources including various academic papers. Also, various textbooks including:

• Essential SCRUM, Rubin, Addison Wesley, NJ 2013.
• Systems Analysis and Design with UML, Tegarden, Dennis, & Wixom, 5th edition, Wiley.

Online Material
https://moodle.bbk.ac.uk/
6.5 Machine Learning (ML)

Teaching Staff
George Magoulas

Online material
http://moodle.bbk.ac.uk/

Aims
The module covers computational algorithms for intelligent information management, decision making and complex problem solving. It provides an introduction to machine learning methods such as neural networks, fuzzy logic, fuzzy clustering, natural computing, and covers basic concepts of feature selection and generalisation.

Syllabus

• Learning from data
• Feature selection and generalisation
• Supervised learning, unsupervised learning and clustering
• Fuzzy logic and fuzzy clustering
• Deep networks: architectures and learning algorithms
• Natural computing: genetic algorithms, evolutionary algorithms, swarm intelligence
• Advanced learning and evolution schemes

Prerequisites
No specific module is pre- or co-requisite but knowledge of mathematical concepts (algebraic concepts, vector, matrix, function and graph, gradient, trigonometry concepts, statistical concepts and the notion of probability), and data structures and algorithms, as taught in a typical undergraduate degree in computer science or engineering, is essential.

Assessment
By 2-hour written examination and practical coursework, weighting 80% and 20%, respectively.
Reading

- S. Theodoridis, K. Koutroumbas, Pattern Recognition, Academic Press.
- Students will be directed to papers available online and other Web resources on the subject.
6.6 Natural Language Processing and Information Retrieval (NLP)

Teaching Staff
Dell Zhang

Online material
http://www.dcs.bbk.ac.uk/~dell/teaching/ir/

Aims and Outline
The aim of this module is to introduce modern NLP & IR concepts and techniques, from basic text indexing to advanced text analysis. Both theoretical and practical aspects of NLP & IR systems will be presented and the most recent issues in the field of NLP & IR will be discussed. This will give students an insight into how modern search engines work and are developed.

Due to the explosive growth of digital information in recent years, modern Natural Language Processing (NLP) and Information Retrieval (IR) systems such as search engines have become more and more important in almost everyone’s work and life (e.g. see the phenomenal rise of Google). NLP & IR research and development are one of the hottest research areas in academia as well as industry. This module will convey the basic principles of modern NLP & IR systems to students.

Syllabus

- Boolean Retrieval
- The Term Vocabulary and Postings Lists
- Regular Expressions and Text Normalization
- Dictionaries and Tolerant Retrieval
- Edit Distance
- Index Compression
- Scoring, Term Weighting and the Vector Space Model
- Evaluation in Information Retrieval
- Probabilistic Information Retrieval
- Language Models for Information Retrieval
- Language Modeling with N-Grams
- Spelling Correction and the Noisy Channel
• Text Classification, Naive Bayes, and Sentiment Analysis
• Vector Space Classification
• Logistic Regression
• Matrix Decompositions and Latent Semantic Indexing
• Vector Semantics
• Neural Nets and Neural Language Models
• Sequence Processing with Recurrent Networks

Assessment

By 2-hour written examination and practical coursework, weighting 80% and 20%, respectively.

Reading

• Dan Jurafsky and James H. Martin, *Speech and Language Processing*, 3rd ed draft.
  [https://web.stanford.edu/~jurafsky/slp3/](https://web.stanford.edu/~jurafsky/slp3/)
6.7 Principles of Programming II (PoP II)

Teaching Staff
Hubie Chen

Online material
On Moodle.

Aims and Learning Outcomes
This module covers object-oriented programming using the Java programming language, including the use of subclasses, modules, and library classes to create well-organised programs. A further aim is to enhance student’s understanding of making appropriate choices on the selection of algorithms, their implementation together with the required data structures (e.g. arrays, lists, trees, graphs, depth-and breadth-first search algorithms).

This module further develops the techniques described in the “Principles of Programming I” module. This module discusses issues specifically related to developing programs for large programming projects and for modern computer hardware architectures.

On successful completion of this module a student will be expected to be able to:

- Explain and exploit subclasses, inheritance and interfaces to produce modular, well-organised code.
- To utilise the relevant features of a programming language.
- Implement simple algorithms and data structures, both in sequential and parallel environments.
- Show knowledge of basic concepts and principles of object-orientation such as objects and classes, encapsulation, object state, coupling, cohesion and modularity.

Syllabus
- Data types in Java
- Control flow in Java
- Transition to Object-Oriented Programming, including types, classes, inheritance, etc.
- Static typing and reference types
- Local I/O
- Exception handling
- Generics
- Multithreaded programming
- Style
- Further test driven development
- Programming in teams

**Prerequisites**

Principles of Programming I module.

**Assessment**

This module is assessed by

- Two-hour unseen examination – online or paper (80%)
- Programming assignments and group work (20%)

**Reading**

Materials will be provided by the instructor; the following text is recommended as a reference:

6.8 Semantic Technologies (ST)

Teaching Staff
Michael Zakharyaschev

Online material
https://moodle.bbk.ac.uk/mod/page/view.php?id=595902

Aims

Semantic Technologies provide easier ways to find, share, reuse and combine information. Prominent examples include Google’s Knowledge Graph, Wikipedia’s knowledge base sister Wikidata, numerous artificial intelligence projects from Alexa to Siri, and the healthcare ontology SNOMED CT. Various companies are exploring the use of their own enterprise knowledge graphs for improving internal knowledge management with the help of tools such as the graph database management system Neo4j, virtual knowledge graph engine Ontop, and the enterprise knowledge graph platform Stardog.

Semantic Technologies are a cross-cutting topic in computer science that involves aspects of data management, publication (exchange formats, data integration), knowledge organisation (ontologies), and advanced analytics (expressive query languages). This module gives an introduction to Semantic Technologies for data analysis, knowledge representation, and data management.

The aims of this module are to

– introduce the theoretical foundations of Semantic Technologies and Knowledge Graphs, including the W3C standard languages RDF/S, SPARQL, the Web Ontology Language OWL;

– provide the students with practical skills of modelling data using knowledge graphs, querying knowledge graphs, and building ontologies;

– overview the current applications of Semantic Technologies in Wikidata, health care, media management, and industry;

– demonstrate standard reasoning algorithms for classification of concepts in ontologies.

Syllabus

• Introduction to the module: Knowledge Graphs, Semantic Web, Linked Data, Wikidata; ontologies and their applications. Practical work: building ontologies with the Protege editor.
• Is XML a semantic technology? The tree model of XML documents, XML Schema, JSON. Querying XML documents with XPath. Practical work: (1) querying XML using an online XPath tool; (2) building a pizza ontology.
• SPARQL Query Language. Practical work: querying Knowledge Graphs using SPARQL; setting up and querying Apache Jena triplestore.
• Virtual Knowledge Graphs, ontology-based data access (OBDA). Practical work: ontology-based access to the IMDB database using Ontop.
• The OWL 2 Web Ontology Language. Practical work: understanding the OWL 2 language using Protege.
• Ontology engineering. OWL ontologies in life sciences and industry. Practical work: designing a travel agent’s ontology.
• Reasoning with OWL. Introduction to formal semantics. Practical work: using the reasoner in Protege.
• Introduction to Description Logic and reasoning algorithms. Practical work: applying the reasoning algorithm.

Prerequisites

None

Assessment

By 2-hour written examination and coursework exercises, weighting 80% and 20% respectively.

Reading


6.9 Advances in Data Management (ADM)

Teaching Staff
Alex Poulovassilis, Richard Brownlow (2019/20)

Online material
http://moodle.bbk.ac.uk/

Aims
To study advanced aspects of database management and recent advances in data management technologies in three major directions: performance, distribution of data, and heterogeneity of data.

The module examines the technologies underlying modern database management systems. It studies advanced aspects of query processing, transaction management, distributed data management, and recent developments in web data, big data and alternative database architectures.

Syllabus
- Review of the fundamental principles of modern database management systems, relational databases and SQL.
- Query processing and query optimisation.
- Transaction management: ACID properties, concurrency control, recovery.
- Beyond records and objects: stored procedures and functions, triggers, semantic technologies.
- Distributed databases: data fragmentation and replication, distributed query processing, distributed transaction management.
- Heterogeneous data integration.
- XML data management.
- Linked Data.
- Parallel databases.
- NoSQL/NewSQL stores.
- Graph databases.

Prerequisites
A first module in Database Systems (e.g. as taught in a typical UK undergraduate degree in computer science) or the Birkbeck module “Data and Knowledge Management”. Knowledge of computer programming.
Assessment

By 2-hour written examination and coursework, with weighting 90% and 10%, respectively.

Reading

- Research papers will be distributed to students; students will also be directed to Web resources on the subject.
7 MSc Project

Aims
In the MSc project students will be able to demonstrate their skills in organising and completing a task that goes beyond a typical coursework assignment. This includes planning and executing a major piece of programming work or an experimental campaign appropriate to the MSc programme and presenting existing approaches in the problem area (placing the student’s own approach in the wider technical and conceptual context).

The MSc project will offer students the opportunity to:

- develop a systematic understanding and critical awareness of an agreed problem relevant to Data Science, as described in a project proposal form;
- plan and execute a major piece of programming work appropriate to the MSc programme;
- critically present existing approaches in the problem area, place their own approach in the wider area and evaluate their contribution, and
- gain experience in communicating complex ideas and concepts to others by writing a comprehensive, self-contained report.

The rules regarding the administration of graduation projects are described in the general brief given by the Projects tutor. For the slides of the Project tutor’s presentation, the the proposal form, the learning objectives and example of successful past projects please consult the Moodle page for the MSc Project module (Moodle access is for enrolled students).

Syllabus
The main part of the module will be done by the students on their own (supported by the supervisor). There is a small taught part of the module in which the students are acquainted with

- how to formulate the objectives/aims of an MSc project
- how to write a project proposal
- how to organise and plan the project
- how to research literature
- how to write a project report.
The taught part is normally scheduled on Friday of Week 3 of the Autumn term. In 2019-20 a new system for the assignment of supervisors will be phased in on the Moodle platform. In general, students are encouraged to come up with their own ideas for projects and discuss them with the lecturer who seems the most appropriate for the topic.

Assessment

Written project proposal (of about 2000-3000 words) and written project report (of about 10,000 words), weighting 20% and 80%, respectively.

Reading

- As recommended by the supervisor.

Ethical Implications

All activities carried out by Birkbeck staff and students that involve one or more of:

- intervention or interaction with human participants;
- the collection and/or study of data derived from human participants;
- a potential impact on animals or the environment;

requires ethical consideration and approval.
For details see

http://www.bbk.ac.uk/committees/research-integrity/GuidelinesonResearchwithEthicalImplications.pdf
8 Administration and Assessment

For detailed College rules and regulations see

http://www.bbk.ac.uk/registry/policies

and, in particular,


Below we summarise the most relevant rules for the MSc Computer/Data Science.

8.1 Requirements for the Award of the MSc

Each taught module (all modules except the project) is assessed by a written exam and, in most cases, by additional coursework. The project module is assessed by the project proposal document (20%) and the project report (80%).

For each module, a Pass requires at least 50% of the available marks (computed according to the corresponding weights of the parts of the assessment). Up to 30 credits of the taught modules (excluding the project) with a mark between 40% and 49% can be compensated (assuming that the total weighted average mark of the taught modules is at least 50%) on the MSc and on the PGDip (note that College regulations do not allow compensation on PGCert). Additionally, there is a 60-credit project module.

To gain an award, the following is required:

• Postgraduate Certificate (PGCert): pass four 15-credits modules: PoP I, PwD and two further modules between BDA, CS and FoC.

• Postgraduate Diploma (PGDip): pass all compulsory taught modules and optional taught modules for a total of 120 credits.

• Master of Science (MSc): the requirements for PGDip plus pass the project module (60 credits).

The final grade is computed by taking the weighted average (according to the credits) of the module assessment marks. The following has to be satisfied:

• Pass requires at least a 50% weighted average pass mark.

• Merit requires at least a 60% weighted average pass mark.

• Distinction requires at least a 70% weighted average pass mark.
8.2 Announcement of Results
The Examination Board normally meets in July to consider the results of the written exams and coursework, and in November to consider the results of the projects and to award degrees.

After the meeting of the exam board, your results and grades will be officially confirmed by the College through My Birkbeck.

Students who have not paid their fees will not get any information about their examination results.

8.3 Choosing the Optional Modules
At the beginning of the relevant term you will receive a form (or a link to an online form) from the Programme Administrator(s) on which you need to indicate your choice of optional modules. You should indicate your preferences by the specified deadline so that your chosen module can be listed among the modules for which you wanted to be assessed that year.

Optional module availability is subject to timetabling constraints and demand. In the event that an optional module is over-subscribed, available places will be allocated on a first-come, first-served basis determined by the date on which you return your module choice form to the Programme Administrator(s).

8.4 Examinations
Please consult the departmental Computer Science and Information Systems Moodle page (for enrolled students).

8.5 Coursework
A number of modules require students to submit coursework as part of the assessment. Please consult the web page of the relevant module or contact the teaching staff of the module for particular details.

Submitted coursework must always be the students’ own work, except where explicitly noted. Students are required to confirm in writing that each item of coursework submitted is indeed their own work.

The Department and College have strict guidelines and penalties associated with plagiarism, and routinely submit students’ work to plagiarism detection services. More details are given in the section “Assessment Offences and Plagiarism” of this booklet.

College policy dictates how Departments will treat work that is due for assessment but is submitted after the published deadline. Any work that is submitted for
formal assessment after the published deadline but before the cut-off date (normally ten working days after the deadline) is given two marks: a capped mark of 50% for postgraduate students, assuming it is of a pass standard, and the “real” mark that would have been awarded if the work had not been late. If the work is not of a pass standard a single mark is given.

If you submit work that is to be considered for assessment late, then you should submit a mitigating circumstances form, see below, and provide written documentation, medical or otherwise, to explain why the work was submitted late. The case will then be considered by the appropriate sub-board or delegated panel of the Board of Examiners. If no case is made then the capped mark will stand. If the case is made and accepted then the examination board may allow the “real” mark to stand.

The College policy about the provision of feedback on assessment is as follows.

http://www.bbk.ac.uk/mybirkbeck/services/rules/Feedback-on-Assessment.pdf

Unlike other disciplines, feedback on Computer/Data science coursework/tests is often given in the form of model answers/solutions (e.g., program code), rather than textual comments.

8.6 Projects
Please consult the relative Moodle pages (for enrolled students).

8.7 Mitigating Circumstances and Deferral
A Mitigating Circumstances claim should be submitted if valid detrimental circumstances result in:

- the late or non-submission of assessment;
- non-attendance of examination;
- poor performance in assessment.

If a student feels their circumstances warrant consideration by the Board of Examiners, they should submit a Mitigating Circumstances Claim Form to the Programme Administrator (within 2 weeks of the assessment deadline or examination). The form can be downloaded from:

http://www.bbk.ac.uk/registry/policies/documents/mitigating-circumstances-form.docx
In the form, students should state whether the circumstances relate to non-attendance at an examination or late submission of an assignment and should include supporting evidence (e.g. a medical certificate giving the nature and duration of any illness). Students should be aware that discussing their claim with a member of staff does not constitute a submission of a claim of mitigating circumstances.

For a claim to be accepted a student must produce independent documentary evidence to show that the circumstances:

- have detrimentally affected their performance/submission/attendance in assessment or will do so;
- were unforeseen;
- were out of their control and could not have been prevented;
- relate directly to the timing of the assessment affected.

In exceptional cases, students may be permitted to defer the written exams to the next examination period and/or the project to the following year. They must apply by filling in a Mitigating Circumstances Claim Form. Students have to do this before May 1st for exams and by September 1st for the project.

A student who defers an element of assessment normally has to enter for that element at the next available opportunity; usually no further deferrals are permitted. Simply not turning up for an exam or failing to submit a coursework or project, without permission to defer, will be considered to be the same as failing it, in the sense that it will count as one of the two attempts that you are permitted to make at passing that element.

### 8.8 Retake and Reassessment

The college regulation for Retake and Reassessment have been changed and will be phased in the 2019-20 year. In general One reassessment, and only one, is allowed for each element. You may be reassessed in a failed coursework, written exam or the project if your marks for that module are below 50%.

Students who fail an assessment and are awarded a reassessment opportunity have their reassessment mark subject to a cap of 50% for the reassessed element. The cap does not apply to a retake of a whole module and to students with accepted mitigating circumstances.

Reassessment for exams takes place in August/September, while coursework reassessment is usually done the following year, in line with the normal coursework submission deadlines for modules. For students who do not take the summer reassessment exam (perhaps because of accepted mitigating circumstances) and
where the syllabus for the next year has changed, we set a paper that is suitable for resit candidates, providing alternative questions where necessary. Note, however, that we do this only for candidates from the previous year, not from further in the past.

Also note that part-time students need to accumulate at least 45 credits (out of the available 75) in their first year in order to progress into the second year.

8.9 Re-enrolment

Repeat students, i.e., students who have to retake some modules (and are not taking any new modules) will be charged pro-rata based on the number of credits they retake.

Assessment only students, i.e. those students who

- are being reassessed for coursework and/or examinations only
- have deferred their examinations and are not taking any new modules
- have deferred the project and do not require supervision (resubmitting only)

do not have to pay fees. While deferred students are classed as assessment only, they are allowed to attend lectures for revision purposes. They should formally seek the permission of module tutors to ensure classes are not oversubscribed.

Dissertation only students, i.e. students who retake the project with supervision, pay one third of full fees. Note that

- a student who has to resubmit the dissertation with supervision and be reassessed for examination or coursework will be progressed as dissertation only
- a student who has to resubmit the dissertation and also repeat modules will be progressed as repeat and fees are based pro-rata on the number of credits.

8.10 Assessment Offences and Plagiarism

See

http://www.bbk.ac.uk/student-services/exams/assessment-offences

for the College Policy on Assessment Offences.

One particular assessment offence is plagiarism that is defined as
“[...] copying a whole or substantial parts of a paper from a source text (e.g., a web site, journal article, book or encyclopedia), without proper acknowledgement; paraphrasing of another’s piece of work closely, with minor changes but with the essential meaning, form and/or progression of ideas maintained; piecing together sections of the work of others into a new whole; procuring a paper from a company or essay bank (including Internet sites); submitting another student’s work, with or without that student’s knowledge; submitting a paper written by someone else (e.g., a peer or relative), and passing it off as one’s own; representing a piece of joint or group work as one’s own.”

Also,

“[a] student who knowingly assists another student to plagiarise (for example by willingly giving them their own work to copy from) is committing an examination offence.”

The College considers plagiarism a serious offence, and as such it warrants disciplinary action. This is particularly important in assessed pieces of work where plagiarism goes so far as to dishonestly claim credit for ideas that have been taken by someone else.

The College also provides learning support for exams and assessments, please see

http://www.bbk.ac.uk/student-services/learning-development

and guidelines on plagiarism

http://www.bbk.ac.uk/student-services/exams/plagiarism-guidelines
9 Student Services

The College provides various services to students, see:

http://www.bbk.ac.uk/student-services

In particular, there are the Counselling Service, the Disability and Dyslexia Service, and the Mental Health Service. They provide specialist support to students.

9.1 Counselling Service

The Counselling Service

http://www.bbk.ac.uk/student-services/counselling-service

provides assistance to students who are experiencing emotional difficulties which may be impacting upon their studies or overall experience at Birkbeck.

9.2 Mental Health Service

Many students experience mental health difficulties at some point in their time at university. Whether you have a formally diagnosed psychiatric condition or other form of mental health difficulty such as anxiety or depression, we encourage you to seek support in your studies. Birkbeck’s Mental Health Service

http://www.bbk.ac.uk/student-services/mental-health-advisory-service

is a first point of contact for students experiencing mental health issues at any stage during their studies.

9.3 Disability and Dyslexia Service

At Birkbeck we welcome students with disabilities. We aim to provide all of our students with a study environment that enables them to participate fully in our courses.

The Disability and Dyslexia Service:

http://www.bbk.ac.uk/student-services/disability-service

can provide advice and support to students with conditions that impact their ability to study, such as:

- specific learning difficulties (dyslexia, dyspraxia, dyscalculia, AD(H)D)
• sensory impairments (blind/partially sighted, deaf/hearing impaired)
• mobility conditions (including RSI, arthritis, neck back and knee conditions etc.)
• medical conditions (e.g. HIV, CFS, diabetes, cancer, chest and respiratory conditions etc.)
• autism-spectrum conditions (autism or Asperger’s syndrome)

They can provide support during your studies including

• Your Study Support Plan
• The Disabled Students’ Allowance
• Access to Learning Fund
• Charities and trusts
• Dyslexia screening test
• Government benefits
• Personal emergency evacuation plans
• Pager alert system
• Rest Room
• Toilet facilities
• Car parking
• Disability and Dyslexia Support in the Library and IT Services
10 The Business Engagement Team

The School of Business, Economics and Informatics has a dedicated Business Engagement team to provide you with extra support. The team delivers the following initiatives to support you in your career aspirations:

10.1 Mentoring Pathways

Mentoring Pathways pairs successful applicants with industry professionals for individual advice and guidance. There are a number of places available for final year undergraduates and postgraduate students. We have partnerships with a number of key organisations and work alongside Birkbeck alumni who provide mentors. Applications open in the autumn. Please email mentoring@bbk.ac.uk or visit http://www.bbk.ac.uk/business/business-services/mentoring-external for more information.

10.2 Enterprise Pathways

Whether you are setting out in your journey as an entrepreneur or have already established a thriving business, we offer various pathways to support you. These include a non-credit bearing module with workshops once a month throughout the academic year, access to digital resources, enterprise boot camps and inspirational talks to help you to develop your ideas and network with other students. Please email enterprise@bbk.ac.uk or visit www.bbk.ac.uk/enterprise.

10.3 Keeping in Touch

You can also follow BEI on social media for information and conversations:

- Twitter: @BirkbeckBEI
- Facebook, Google+ and LinkedIn: Search ‘BirkbeckBEI’

Please visit our website www.bbk.ac.uk/business/business-services for more resources and information.
11 Career Development

Most students are interested in developing their careers, either within their current field of work or in a completely new direction. The Careers Group, University of London

http://www.thecareersgroup.co.uk/

offers great expertise and experience in working with students and graduates of all ages and at all stages of career development.

The Careers and Employability Service

http://www.bbk.ac.uk/careers/careers-service

is our in-house service for enhancing career development and employability throughout your time at Birkbeck, from enrolment through to graduation.

There is also Birkbeck Talent, a professional recruitment service aimed exclusively at assisting Birkbeck students to find work whilst studying and after graduation. They work with top employers in and outside London to offer innovative internships, prestigious job vacancies and exciting graduate opportunities. To find out more please visit

http://www.bbk.ac.uk/student-services/birkbeck-talent-service