

DEPARTMENT OF COMPUTER SCIENCE
Student Handbook 2019-20 / Appendix B / Postgraduate Taught
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CSMS MSc Computer Science

Students follow either Full-Time Pathway of one year duration, or Part-Time Pathway of minimum of two years and maximum of six years duration.

Full-time pathway

The programme is divided into three, equally weighted semesters. The first two, which are run concurrently with the normal undergraduate semesters, comprise taught modules, weighted at 15 credit points each, to a total of 60 credits per semester. An extended research based project, culminating in a dissertation, is undertaken full time over the summer period. This counts for a further 60 credits, making a total of 180.

At least 90 credits of the 120 taught credits available in the first two semesters must comprise level '7' modules. The remaining 30 may include selected level 6 modules, taken from the Department's 3rd year module list, with the proviso that a graduates of the University of Liverpool cannot elect to take a level 3 module if they have already taken that module as part of their undergraduate study. The modules available in the MSc in Computer Science programme are as follows ('•' indicates a required module):

Module Code	Module Title	Credit Value	Level	Co-requisite	Pre-requisites	Pre-requisite for
Semester 1						
COMP516	Research Methods in Computer Science (•)	15	7	-	First degree in Computer Science or closely related subject	COMP524 COMP525 COMP702
COMP517	Object-Oriented Software Development (•)	15	7	-		COMP524 COMP525 COMP526 COMP527
COMP518	Database and Information Systems (•)	15	7	-		
COMP519	Web Programming (•)	15	7	-		
Semester 2						
<i>Plus options totalling 60 credits from the following ten modules provided pre-requisites are satisfied</i>						
COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	Technologies for E-Commerce	15	6	-	-	-
COMP318	Advanced Web technologies	15	6	-	-	-
COMP524	Safety and Dependability	15	7	-	COMP516 COMP517	-
COMP525	Reasoning about Action and Change	15	7	-	COMP518 COMP519	-
COMP526	Applied Algorithmics	15	7	-	COMP516	-

COMP527	Data Mining and Visualisation	15	7	-	COMP516	-
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
COMP575	Computational Intelligence	15	7	-	-	-
ENVS456	Web Mapping and Analysis	15	7	-	-	-
Summer						
COMP702	MSc Project (●)	60	7	-	Taught part of MSc	-

Part-Time Pathway

From the set of taught modules available for full-time pathway students select modules totalling 120 credit points over period of minimum of two years and maximum of 6 years. The particular choice of modules over the years and semesters may be arbitrary provided the pre-requisites are satisfied. The further 60 credit points come from COMP702 (MSc Final Project) which is undertaken over the summer semester after all 120 credit points of taught modules are collected.

The same conditions as for full-time mode should be satisfied: at least 90 credits must comprise level '7' modules and COMP516, COMP517, COMP518, COMP519 and COMP702 are required modules.

Note: for the part-time pathway the department cannot guarantee availability of modules for the whole duration of the programme. If a module becomes unavailable then it will be substituted by an alternative module in accordance with a modified programme specification or by approval of the appropriate Director of Studies.

Part-time Semester 1, Year 1

Part-time Semester 1, Year 2

Part-time Semester 2, Year 1

Part-time Semester 2, Year 2

Year 1 part-time						
Module Code	Module Title	Credit Value	Level	Co-requisite	Pre-requisites	Pre-requisite for
Semester 1						
COMP517	Object-Oriented Software Development (●)	15	7	-		COMP524 COMP525 COMP526 COMP527
COMP518	Database and Information Systems (●)	15	7	-		
Semester 2						
<i>Plus options totalling 30 credits from the following ten modules provided pre-requisites are satisfied</i>						
COMP524	Safety and Dependability	15	7	-	COMP516 COMP517 COMP518 COMP519	-
COMP525	Reasoning about Action and Change	15	7	-	COMP516 COMP517 COMP518 COMP519	-

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Unfortunately no timetabling availability can be guaranteed for the following optional modules:

COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	Technologies for E-Commerce	15	6	-	-	-
COMP318	Advanced Web technologies	15	6	-	-	-
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
ENVS456	Web Mapping and Analysis	15	7	-	-	-

Year 2 part-time						
Module Code	Module Title	Credit Value	Level	Co-requisite	Pre-requisites	Pre-requisite for
Semester 1						
COMP516	Research Methods in Computer Science (●)	15	7	-	First degree in Computer Science or closely related subject	COMP524 COMP525 COMP702
COMP519	Web Programming (●)	15	7	-		
Semester 2						
<i>Plus options totalling 30 credits from the following ten modules provided pre-requisites are satisfied</i>						
COMP526	Applied Algorithmics	15	7	-	COMP516	-
COMP527	Data Mining and Visualisation	15	7	-	COMP516	-
COMP575	Computational Intelligence	15	7	-	-	-
Unfortunately no timetabling availability can be guaranteed for the following optional modules:						
COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	Technologies for E-Commerce	15	6	-	-	-
COMP318	Advanced Web technologies	15	6	-	-	-
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
ENVS456	Web Mapping and Analysis	15	7	-	-	-
Summer						
COMP702	MSc Project (●)	60	7	-	Taught part of MSc	-

CSAD MSc Advanced Computer Science

CSAI MSc Advanced Computer Science with a Year in Industry

Students follow either Full-Time Pathway of one year duration, or Part-Time Pathway of minimum of two years and maximum of six years duration.

Full-time pathway (CSAD/CSAI)

The programme is divided into three, equally weighted semesters. The first two, which are run concurrently with the normal undergraduate semesters, comprise taught modules to a total of 60 credits per semester. An extended research based project, culminating in a dissertation, is undertaken full time over the summer period. This counts for a further 60 credits, making a total of 180.

At least 90 credits of the 120 taught credits available in the first two semesters must comprise level '7' modules. The remaining 30 may include selected level 6 modules, taken from the Department's 3rd year module list, with the proviso that a graduates of the University of Liverpool cannot elect to take a level 6 module if they have already taken that module as part of their undergraduate study. The modules available in the MSc in Advanced Computer Science programme are as follows ('•' indicates a required module)

Module Code	Module Title	Credit Value	Level	Co-requisites	Pre-requisites	Pre-requisite for
Semester 1						
COMP516	Research Methods in Computer Science (•)	15	7	-	First degree in Computer Science or closely related subject	COMP524 COMP525 COMP702
<i>Options totalling 45 credits from the following seven modules provided pre-requisites are satisfied (Note that ELEC415 and ELEC319 must be taken as a pair)</i>						
COMP521	Knowledge Representation	15	7	-	First degree in Computer Science or closely related subject	-
COMP522	Privacy and Security	15	7	-		-
COMP523	Advanced Algorithmic Techniques	15	7	-		-
COMP528	Multicore and Multi-Processor Programming	15	7	-		-

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COMP557	Optimisation	15	7			
COMP305	Biocomputation	15	6	-	-	-
ELEC319	Image Processing	7.5	7	ELEC415	Mathematics: complex numbers and algebra, Laplace transforms, matrix algebra, Fourier series, partial differentiation, probability, Engineering: time and frequency domain response, concept fo filtering.	-
ENVS563	Geographical Information Systems	15	7	1	-	-

**Semester
2**

Plus options totalling 60 credits from the following eleven modules provided pre-requisites are satisfied (Note that ELEC415 and ELEC319 must be taken as a pair)

COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	COMP524	7.5	6	ELEC319	Understanding communication principles to level 6. Basic understanding of calculus, matrices and probabilities	-
COMP318	Advanced Web Technologies	15	6	-	-	-
COMP524	Safety and Dependability	15	7	-	COMP516	COMP516
COMP525	Reasoning about Action and Change	15	7	-	COMP516	-
COMP526	Applied Algorithmics	15	7	-	COMP516	COMP516
COMP527	Data Mining and Visualisation	15	7	-	COMP516	COMP516
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
COMP559	Computational Auctions and Mechanism Design	15	7		COMP523 COMP557	

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COMP575	Computational Intelligence	15	7	-	Basic knowledge of UG mathematics	-
ELEC415	Information Theory and Coding	7.5	7	-		-
ENVS456	Web Mapping and Analysis	15	7	-	-	-
Summer						
CSAD only						
COMP702	MSc Project (•)	60	7	-	Taught part of MSc	-
CSAI only						
COMP598	MSc Placement Experience (•)	60	7	-	Successful completion of first	-
COMP599	MSc Industrial Project (•)	60	7	-	year taught modules	-

Part-Time Pathway (CSAD only)

From the set of taught modules available for full-time pathway students select modules totalling 120 credit points over period of minimum of two years and maximum of six years. The particular choice of modules over the years and semesters may be arbitrary provided the pre-requisites and conditions specified for full-time mode are satisfied. The further 60 credit points come from COMP702 (MSc Final Project) which is undertaken over the summer semester after all 120 credit points of taught modules are collected.

Note: for the part-time pathway the department cannot guarantee availability of modules for the whole duration of the programme. If a module becomes unavailable then it will be substituted by an alternative module in accordance with a modified programme specification or by approval of the appropriate Director of Studies.

Part-time Semester 1, Year 1

Part-time Semester 1, Year 2

Part-time Semester 2, Year 1

Part-time Semester 2, Year 2

Year 1 part-time						
Module Code	Module Title	Credit Value	Level	Co-requisites	Pre-requisites	Pre-requisite for
Semester 1						
COMP516	Research Methods in Computer Science (•)	15	7	-	First degree in Computer Science or closely related subject	COMP524 COMP525 COMP702
<i>Options totalling 15 or 30 credits from the following provided pre-requisites are satisfied (60 credits needed for the year)</i>						
COMP521	Knowledge Representation	15	7	-	First degree in Computer Science or closely related subject	-
COMP522	Privacy and Security	15	7	-		-
Unfortunately no timetabling availability can be guaranteed for the following optional modules (Note that ELEC415 and ELEC319 must be taken as a pair):						

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COMP557	Optimisation	15	7			
COMP305	Biocomputation	15	6	-	-	-
ELEC319	Image Processing	7.5	7	ELEC415	Mathematics: complex numbers and algebra, Laplace transforms, matrix algebra, Fourier series, partial differentiation, probability, Engineering: time and frequency domain response, concept for filtering.	-
ENVS563	Geographical Information Systems	15	7	1	-	-

Semester 2

Plus options totalling 15 to 30 credits from the following modules provided pre-requisites are satisfied (60 credits needed for the year)

COMP524	Safety and Dependability	15	7	-	COMP516	COMP516
COMP525	Reasoning about Action and Change	15	7	-	COMP516	-

Unfortunately no timetabling availability can be guaranteed for the following optional modules (Note that ELEC415 and ELEC319 must be taken as a pair):

COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	COMP524	7.5	6	ELEC319	Understanding communication principles to level 6. Basic understanding of calculus, matrices and probabilities	-
COMP318	Advanced Web Technologies	15	6	-	-	-
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
COMP559	Computational Auctions and Mechanism Design	15	7		COMP523 COMP557	
ELEC415	Information Theory and Coding	7.5	7	-		-
ENVS456	Web Mapping and Analysis	15	7	-	-	-

Year 2 part-time

Module Code	Module Title	Credit Value	Level	Co-requisites	Pre-requisites	Pre-requisite for
Semester 1						
<i>Options totalling 30 credits from the following modules provided pre-requisites are satisfied (60 credits needed for the year)</i>						
COMP523	Advanced Algorithmic Techniques	15	7	-	First degree in Computer Science or closely related subject	-
COMP528	Multicore and Multi- Processor Programming	15	7	-	First degree in Computer Science or closely related subject	-

Unfortunately no timetabling availability can be guaranteed for the following optional modules (Note that ELEC415 and ELEC319 must be taken as a pair):

COMP557	Optimisation	15	7			
COMP305	Biocomputation	15	6	-	-	-
ELEC319	Image Processing	7.5	7	ELEC415	Mathematics: complex numbers and algebra, Laplace transforms, matrix algebra, Fourier series, partial differentiation, probability, Engineering: time and frequency domain response, concept for filtering.	-
ENVS563	Geographical Information Systems	15	7	1	-	-

Semester 2

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Plus options totalling 30 credits from the following modules provided pre-requisites are satisfied (60 credits needed for the year)

COMP526	Applied Algorithmics	15	7	-	COMP516	COMP516
COMP527	Data Mining and Visualisation	15	7	-	COMP516	COMP516
COMP575	Computational Intelligence	15	7	-	Basic knowledge of UG mathematics	-

Unfortunately no timetabling availability can be guaranteed for the following optional modules (Note that ELEC415 and ELEC319 must be taken as a pair):

COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	COMP524	7.5	6	ELEC319	Understanding communication principles to level 6. Basic understanding of calculus, matrices and probabilities	-
COMP318	Advanced Web Technologies	15	6	-	-	-
COMP532	Machine Learning and BioInspired Optimisation	15	7	-	-	-
COMP559	Computational Auctions and Mechanism Design	15	7	-	COMP523 COMP557	-
ELEC415	Information Theory and Coding	7.5	7	-	-	-
ENVS456	Web Mapping and Analysis	15	7	-	-	-

Summer

CSAD only

COMP702	MSc Project (•)	60	7	-	Taught part of MSc	-
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CSAI only

COMP598	MSc Placement Experience (•)	60	7	-	Successful completion of first year taught modules	-
COMP599	MSc Industrial Project (•)	60	7	-		-

CSCI MSc Advanced Computer Science with Internet Economics (Pathway A: with first degree in Computer Science, Pathway B: with first degree in Economics)

CSCN MSc Advanced Computer Science with Internet Economics with a Year in Industry (Pathway A: with first degree in Computer Science, Pathway B: with first degree in Economics)

Pathway A: Computer Science entrants

Students with a first degree in Computer Science (or a related subject) are expected to pursue the following programme of study (•) indicates a required module):

Module Code	Module Title	Credit Value	Level	Corequisites	Prerequisites	Prerequisite for
Semester 1						
COMP516	Research Methods in Computer Science (•)	15	7	-	First degree in Computer Science or closely related subject	COMP702 COMP524 COMP525
COMP557	Optimisation (•)	15	7	-	-	-
ECON915	Microeconomic Theory (•)	15	7	-	First degree in Economics or equivalent field ²	-
<i>Students who have not previously taken COMP323 (or an equivalent) as part of their undergraduate programme take</i>						
COMP323	Introduction to Computational Game Theory (•)	15	7	-	COMP109 or equivalent mathematical module	-
<i>Students who have taken COMP323 (or an equivalent) as part of their undergraduate programme take</i>						
COMP523	Advanced Algorithmic Techniques (•)	15	7	-	-	-
Semester 2						
COMP526	Applied Algorithmics (•)	15	7	-	COMP516	-
COMP559	Computational Auctions and Mechanism Design (•)	15	7	-	COMP516 COMP323/523 COMP557 ECON915	-
<i>Plus options totalling 30 credits from the following four modules provided pre-requisites are satisfied</i>						
COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	Technologies for E-Commerce	15	6	-	-	-
COMP524	Safety and Dependability	15	7	-	-	-
COMP527	Data Mining and Visualisation	15	7	-	-	-
COMP575	Computational Intelligence	15	7	-	Basic knowledge of UG mathematics	-
Summer						
CSCI only						

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COMP702	MSc Project (•)	60	7	-	Taught part of MSc	-
CSCN only						
COMP598	MSc Placement Experience (•)	60	7	-	Successful completion of first year taught modules	-
COMP599	MSc Industrial Project (•)	60	7	-		-

Note 1: Students can choose at most one optional module at level 6. Students who took COMP323 as part of their undergraduate programme, replace COMP323 by COMP523.

Note 2: ECON915 normally has a prerequisite of an Economics undergraduate degree. It has been agreed with the Management School that a Computer Science degree will be considered to be equivalent for students on the MSc Advanced Computer Science with Internet Economics.

Pathway B: Economics entrants

Students with a first degree in Economics (or a related subject) are expected to pursue the following programme of study (• indicates a required module):

Module Code	Module Title	Credit Value	Level	Corequisites	Prerequisites	Prerequisite for
Semester 1						
COMP323	Introduction to Computational Game Theory (•)	15	6	-	-	-
COMP516	Research Methods in Computer Science (•)	15	7	-	First degree in suitable subject	COMP702 COMP524 COMP525
COMP517	Object-Oriented Software Development (•)	15	7	-	First degree in suitable subject other than Computer Science	COMP524 COMP525 COMP526 COMP527
COMP557	Optimisation (•)	15	7	-	-	-
Semester 2						
COMP526	Applied Algorithmics (•)	15	7	-	COMP516	-
COMP559	Computational Auctions and Mechanism Design (•)	15	7	-	COMP516 COMP323 COMP557	-
<i>Plus options totalling 30 credits from the following four modules provided pre-requisites are satisfied (at most one module at level 6 can be taken)</i>						
COMP310	Multi-Agent Systems	15	6	-	-	-
COMP315	Technologies for E-Commerce	15	6	-	-	-
COMP524	Safety and Dependability	15	7	-	COMP516 COMP517	-
COMP527	Data Mining and Visualisation	15	7	-	COMP516	-
COMP575	Computational Intelligence	15	7	-	Basic knowledge of UG mathematics	-

Summer						
CSCI only						
COMP702	MSc Project (•)	60	7	-	Taught part of MSc	-
CSCN only						
COMP598	MSc Placement Experience (•)	60	7	-	Successful completion of first year taught modules	-
COMP599	MSc Industrial Project (•)	60	7	-		-

CMBD MSc Big Data and High Performance Computing

CMBI MSc Big Data and High Performance Computing with a Year in Industry

The programme is divided into three, equally weighted semesters. The first two, which are run concurrently with the normal undergraduate semesters, comprise taught modules to a total of 60 credits per semester. An extended research based project, culminating in a dissertation, is undertaken full time over the summer period. This counts for a further 60 credits, making a total of 180.

The modules available in the MSc in Big Data and HPC programme are as follows (●) indicates a required module.

Module Code	Module Title	Credit Value	Level	Co-requisites	Pre-requisites	Pre-requisite for
Semester 1						
COMP516	Research Methods in Computer Science (●)	15	7	-	First degree in Computer Science or closely related subject	COMP702 COMP524 COMP525
COMP528	Multi-core and Multi-processor Programming (●)	15	7	-		-
COMP529	Big Data Analysis (●)	15	7	-		COMP702
COMP557	Optimisation (●)	15	7	-		-
Semester 2						
COMP526	Applied Algorithmics (●)	15	7	-	-	-
COMP527	Data Mining and Visualisation (●)	15	7	-	-	-
COMP530	Big Data Group Project (●)	15	7	-	COMP528 COMP529	-
<i>Plus options totalling 15 credits from the following four modules</i>						
COMP524	Safety and Dependability	15	7	-	-	-
COMP525	Reasoning about Action and Change	15	7	-	-	-
COMP532	Machine Learning and Bioinspired Optimisation	15	7	-	-	-
COMP559	Computational Auctions and Mechanism Design	15	7	-	-	-
COMP575	Computational Intelligence	15	7	-	-	-
Summer						
CMBD only						
COMP702	MSc Project (●)	60	7	-	Taught part of MSc	-

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CMBI only						
COMP598	MSc Placement Experience (•)	60	7	-	Successful completion	-
COMP599	MSc Industrial Project (•)	60	7	-	of first year taught modules	-

Summary Information on Modules

Module Descriptions – Semester 1

COMP516 Research Methods in Computer Science

This module includes various "high order transferable skills" such as: searching for information on the WWW and libraries, reading and understanding research papers, writing papers (including referencing), a review of professional ethics and legal issues, problem solving, and the development and conduct of research programmes. There are 30 lectures and 10 hours of practical work.

COMP517 Object Oriented Software Development

This module provides a comprehensive review of object oriented software development using the Java programming language. The module is designed to equip students without a computer science (or related) first degree with the appropriate software development capabilities required for the second semester research based modules and when they go on to seek employment within the IT industry. There are 22 lectures and 22 tutorials.

COMP518 Database and Information Systems

This module provides a comprehensive review of database and information system techniques. The module is intended for MSc students who do not have a computer science (or related) first degree to provide those students with the appropriate information systems capabilities required for the second semester research based modules, their final individual project and when they go on to seek employment within the IT industry. There are 22 lectures and 22 tutorials.

COMP519 Web Programming

This module covers topics such as: distributed systems, WWW and HTML, Applets and the WWW, introduction to Java script, programming in Perl, CGI scripting and protocols. The module is intended for MSc students who do not have a computer Science (or related first degree) to provide those students with the appropriate WWW programming capabilities that they may require to complete their individual project and when they go on to seek employment. There are 26 lectures and 18 tutorials.

COMP521 Knowledge Representation

This module covers topics such as introduction to knowledge representation (KR) and logic for KR, introduction to modal and description logics, applications of modal logic, and handling uncertain information through probability and decision theory. There are 30 lectures and 10 tutorials.

COMP522 Privacy and Security

This module covers topics such as: identification and authentication, monitoring, protocols, attacks and defences, legal and ethical issues and future directions. There are 30 lectures and 10 tutorials.

COMP523 Advanced Algorithmic Techniques

This module covers topics such as: the study of algorithmic problems and techniques on the boundary of current research, dealing with non-standard computational models, graph algorithms,

randomised algorithms, on-line algorithms, string algorithms and elements of probabilistic and number theory. There are 30 lectures and 10 tutorials.

COMP528 Multi-Core and Multi-Processing Programming

This module covers theoretical and practical aspects of parallel programming for multi-core architectures with the main focus on hands-on programming experience with latest multi-core and multi-processor platforms. The module was developed in collaboration with STFC Hartree Centre for High-Performance Computing and High-Performance Computing Services of University of Liverpool, whose facilities will be used in the practical sessions of the module. There are 24 lectures and 12 practicals.

COMP529 Big Data Analysis

This module provides an initial overview of the middleware used to provide solutions to Big Data and how to use this middleware to analyse data. There are 36 lectures and 12 tutorials.

COMP557 Optimisation

This module provides a foundation for modelling various continuous and discrete optimisation problems, related to real-world production and economics motivated applications which also involve big data. The tools and paradigms for the design and analysis of algorithms for such optimisation problems are introduced. Topics include linear programming, local search, algorithms and their complexity, algorithms for hard optimisation problems. Additionally, existing commercial optimisation software is introduced that allows to treat such problems. There are 30 lectures and 10 tutorials.

COMP305 Biocomputation
(FHEQ Level 6 module)

This module aims to introduce students to some of the established work in the field of neural computation; to highlight some contemporary issues within the domain of neural computation with regard to biologically-motivated computing particularly in relation to multidisciplinary research; to equip students with a broad overview of the field of evolutionary computation, placing it in a historical and scientific context; to emphasise the need to keep up-to-date in developing areas of science and technology and provide some skills necessary to achieve this; and to enable students to make reasoned decisions about the engineering of evolutionary ("selectionist") systems. There are 30 lectures and 10 seminars.

COMP323 Introduction to Computational Game Theory
(FHEQ Level 6 module)

This module aims to introduce students to the main subareas of algorithmic game theory, which is a novel academic field in the intersection of economics and computer science. This provides mathematical tools and models used for the analysis and implementation of existing Internet systems, mostly related to electronic commerce applications where emphasis is put on their algorithmic side. The module covers an introduction to basic economic game theory and applications like Google's sponsored search auctions, combinatorial auctions, Internet recommendation systems, mechanism design, price of anarchy. There are 30 lectures and 5 tutorials.

ECON915 Microeconomic Theory

This module, offered by the Management School, introduces students to the fundamental aspects of decision making under uncertainty, allowing for the presence of risk. It covers mostly microeconomic models related to non-cooperative game theory, which will serve as the economics related background for the students. Specific topics include the theory of production, choice under uncertainty, credit markets. There are 24 lectures and a series of seminars.

ELEC319 Image Processing

(7.5 credit module (level 6) offered as a pair with ELEC415 and taught by the Department of Electrical Engineering and Electronics)

This module covers the fundamentals of how images are generated, represented, compressed and processed to extract features of interest.

ENVS456 Web Mapping and Analysis

This module is taught by the School of Environmental Sciences. It has two main aims. First, it seeks to provide hands-on experience and training in the design and generation of web-based mapping and geographical information tools. Second, it seeks to provide hands-on experience and training in the use of software to access, analyse and visualise web-based geographical information. There are 10 lectures and 10 two hour practicals.

Module Descriptions – Semester 2

COMP524 Safety and Dependability

This module covers topics such as: safety critical systems, security, trusted systems, dependability and reliability, formal requirements engineering, design and development techniques and verification techniques. There are 22 lectures and 20 hours of practical work.

COMP525 Reasoning about Action and Change

This module covers topics such as: temporal logic, dynamic logic, alternating-time temporal logic, dynamic epistemic logics and belief revision. There are 30 lectures and 10 hours of practical work.

COMP526 Applied Algorithmics

This module covers topics such as: the study of problems with strong algorithmic components, specialised data structures, engineering of algorithms data structures with applications to large data sets, data compression and network algorithms. There are 30 lectures and 10 hours of practical work.

COMP527 Data Mining and Visualisation

This module provides an in-depth, systematic and critical understanding of some of the current research issues at the forefront of the academic research domain of data mining. There are 30 lectures and 10 tutorials.

COMP530 Big Data Group Project

This module aims at providing experience in working and collaborating in a software development team in the context of HPC and Big Data. Students will work largely autonomously in small teams to produce a HPC solution to a Big Data problem. The project and expected outcomes will be prescribed. Introductory lectures will outline details of the project framework, the available projects, and the key high-level skills required for group working. There are 6 lectures and 8 tutorials.

COMP532 Machine Learning and BioInspired Optimisation

In this module we focus on learning agents that interact with an initially unknown world. Since the world is dynamic this module will put strong emphasis on learning to deal with sequential data unlike many other machine learning courses. This module will cover the following topics: Introduction to parallel problem solving from nature/overview, Reinforcement Learning/Multi-Agent Reinforcement Learning/Replicator Dynamics, Swarm Intelligence: Ant System, Ant Colony Optimization/Bee System/Swarm Robotics, Deep Learning: Restricted Boltzman Machines/Auto-Encoder Networks/Deep Belief Networks, Immune Systems and DNA computing. Lecture slides and reading material will be made available to the students.

COMP575 Computational Intelligence

This module is divided into two parts: (i) Neural Networks and (ii) Evolutionary Computation and Fuzzy Systems. The Neural Network material covered includes the structure of such networks, the learning process (supervised and unsupervised) and applications. Part 2 covers evolutionary methods and optimisation, evolutionary optimisation and genetic algorithms, evolutionary programming, particle swarm intelligence, applications and fuzzy logic systems. This module consists of 24 lectures and 12 tutorials.

COMP559 Algorithmic Game Theory

This module presents an in-depth understanding of the research area of mechanism design which is widely present in the form of dedicated auction protocols used in existing electronic commerce systems. Such systems are implemented and used over the Internet, for instance various banking systems, or many kinds of Internet auctions. The emphasis is put on the algorithmic aspects of these systems where part of the input data (such as customers' preferences) are private data of selfish agents (customers) and the goal of the protocol, called a mechanism, is to efficiently elicit this information from the agents There are 30 lectures and 10 tutorials.

COMP310 Multi-Agent Systems
(FHEQ Level 6 module)

A multi-agent system is one composed of multiple interacting software components known as agents, which are typically capable of co-operating to solve problems that are beyond the abilities of any individual member. Multi-agent systems are important primarily because they have been found to have very wide applicability, in areas as diverse as industrial process control and electronic commerce. This module will begin by introducing the student to the notion of an agent, and will lead them to an understanding of what an agent is, how they can be constructed, and how agents can be made to co-operate effectively with one another to solve problems. The practical component of the module will be based on some of the many Java agent frameworks currently available (e.g. the Java-based based "Jack" programming language). There are 30 lectures.

COMP315 Technologies for E-Commerce
(FHEQ Level 6 module)

With the explosion in the use of the internet, there is an increasing interest in e-commerce: the use of the Internet as a means of exchanging goods and services for money. This has, in turn, led to a whole host of new problems for which software solutions are required. This module introduces students to some of these, in particular those which relate to security, privacy and cryptography. There are 30 lectures.

COMP318 Advanced Web Technologies
(FHEQ Level 6 module)

This module aims to provide students with guidelines, concepts and models for designing and evaluating applications utilising advanced web technologies. The module will also introduce students to Artificial Intelligence and Semantic Web techniques that can be applied to the application of advanced web technologies and the notion of semantic web applications intended to be used by software. There are 30 lectures and 10 hours of practical work.

ELEC415 Information Theory and Coding

(7.5 credit module offered as a pair with ELEC319 and taught by the Department of Electrical Engineering and Electronics)

This module aims to introduce students to the techniques used in source coding and error correcting codes, including the use of information as a measure. Topics covered include: Source coding (measuring information entropy of a zero memory source, variable-length codes, buffer management, vector coding and Shannon's noiseless coding theorem); channels (binary symmetric channels, equivocation, channel capacity, continuous channels, and the Shannon-Hartley law); and block codes (ideas of n-tuples, Hamming distance, least distance decoding, possibility of error-free messages, the Hamming bound, linear codes, generator and parity-check matrices, algebraic codes, cyclic codes, output error rates and coding gain). There are 12 lectures and 6 problem classes.

ENVS563 Geographical Information Systems
(taught by the School of Environmental Sciences)

This module introduces students to the fundamentals of Geographical Information Systems (GIS). It will enable students to develop both (i) theoretical knowledge of GIS and (ii) a practical ability to apply GIS in the handling and analysis of spatial data. The module aims to develop an understanding of how and why GIS may be useful in geography, planning and other disciplines. There are 11 lectures and 24 practicals.

NOTE: No more than two FHEQ Level 6 modules may be included in any individual student's programme over the two semesters. Also graduates of the University of Liverpool cannot elect to take a level three module if they have already passed that module as part of their undergraduate study.

Summer Project

COMP702 MSc Project (60 credits)

The MSc project is undertaken over the summer period, starting immediately after the announcement of the examination results, and leads to the submission of a written dissertation in September, when the programme finishes. This will investigate some real application of computing with the object of producing an agreed deliverable, in addition to the dissertation. The project work is usually associated with material covered in the taught research modules making up the programme. Alternatively, students can propose their own projects, or undertake projects based on the needs of local industries, provided that the proposal meets with the academic criteria for an MSc (level M) project.

Members of staff within the Department will manage the project, and students will be required to give regular progress reports and presentations on their work. This is extremely valuable experience, as such presentations are likely to be required in a future career.

Further details of project management, together with details of the projects on offer, will be provided closer to the project start date. There will also be information available on-line nearer the time.

Year in Industry Modules

COMP598 MSc Placement Experience **(FHEQ Level 7 module)**

The placement experience module will be assessed in terms of a portfolio containing a number of documents as articulated in the COMP598 module specification. For the project module the assessment comprises: (i) an interim report (35% in January), (ii) an oral presentation (15% in May), and (iii) a final report (50% in May).

COMP599 MSc Industrial Project **(FHEQ Level 7 module)**

This module is focused on doing an industrial research project and it will be chosen by the student by the end of semester 2 in Year One. In situations where a student is not able to find a placement by the end of semester 2, or fails to complete the industrial placement, the student will be able to transfer to the standard version of the programme and commence a new project at the University.