Institiúid Teicneolaíochta Chorcaí
Cork Institute of Technology

Book of Modules

CR_SCOBI_9 - Master of Science in Computational Biology

14 modules listed.

16:10 on Monday, 05 July 2021

Institiúid Teicneolaíochta Chorcaí
Cork Institute of Technology

APPROVED

Master of Science in Computational Biology

Awards
MSc

Programme Code:	CR_SCOBI_9	**Mode of Delivery:**	Part Time	**No. of Semesters:**	5
NFQ Level:	9				
Embedded Award:	No	**Programme Credits:**	90		
Valid From:	Semester 1 - 2021/22 (September 2021)				
Next Review Date:	April 2024				
Department:	BIOLOGICAL SCIENCES				
Programme Sponsor:	Brigid Lucey				
Educational Aim of Programme:	The programme aim is to provide a mechanism for students to acquire expert knowledge in cutting-edge areas of biological science, and develop computational skills which can be applied to the analysis, visualisation, and interpretation of large biological datasets with a specific focus on producing graduates that can bridge the gap between biology and computer science disciplines to solve complex biological problems.				

Programme Outcomes

Upon successful completion of this programme the graduate will be able to demonstrate... :

PO1	Knowledge - Breadth	
	(a)	Knowledge of: advanced theories and skills spanning biological and computer sciences; planning, managing and developing medium to large scale computational biology projects; utilising the most current design principles, methodologies and technologies.
PO2	Knowledge - Kind	
	(a)	That they can: critically understand and evaluate a wide range of current theories, technologies and application areas in computational biology; research solutions to complex problems; evaluate different approaches to problem solving.
PO3	Skill - Range	
	(a)	That they can: identify ill-defined research problems; apply computational, statistical, numerical, research and/or analytical skills to solve complex biological problems; manage ill-defined projects as part of a group or as an individual.
PO4	Skill - Selectivity	
	(a)	That they can: independently assess and select knowledge in novel and emerging biological science and computational technologies; research complex projects and use the research literature to propose new solutions; integrate various principles and approaches to successfully plan and implement a computational biology project; compare with existing solutions and select the most appropriate approach for a specified project.
PO5	Competence - Context	
	(a)	That they can: evaluate the risks associated with individual and team projects in biological sciences; identify strategic research areas where bioscience and computational projects can be developed and evaluate their commercial potential; undertake research, design and development of large-scale projects in new trending areas of biological sciences and computational biology.
PO6	Competence - Role	
	(a)	That they can: lead teams on medium to large scale computational biology projects; manage long-term individual and group projects; communicate effectively within a team environment; execute project plans; prepare plans, reporting documentation, conference papers, technical reports, presentations and posters; communicate project outcomes both formally and informally; communicate effectively with the biological sciences and computational biology community; perform research, innovate, solve problems and design new studies.
PO7	Competence - Learning to Learn	
	(a)	That they can: master the use of computational biology platforms and interrogation of public biological databases; investigate and solve ill-defined problems; evaluate their own performance and knowledge base; use available resources to redress knowledge gaps and succeed with long-term and large-scale individual and team projects; discuss and debate problems and solutions with their peers; investigate and evaluate proposed designs with their peers; compare and contrast design approaches adopted by their peers.
PO8	Competence - Insight	
	(a)	That they can: act in a manner consistent with the best interests of clients, colleagues and other stakeholders and the general public; draw conclusions from large-scale project work; critically evaluate modelling, design and experimental work, also in accordance with best practices, health and safety, ethics and GDPR regulations; relate experimental work to theoretical frameworks; adhere to highest ethical standards in execution of their work; adhere to all health and safety standards during the execution of their work.

Semester Schedules

Stage 1 / Semester 1

Mandatory								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
BIOT9011	Synthetic Biology (Approved)	Brigid Lucey	Expert	5.0	4.00	4.00	100.0	0.0
BIOT9012	Omics Technologies (Approved)	Brigid Lucey	Expert	5.0	0.00	0.00	100.0	0.0
COMP9087	Scien. Prog. for Biologists (Approved)	Sean McSweeney	Advanced	5.0	4.00	4.00	100.0	0.0

Stage 1 / Semester 2

Mandatory								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
BIOT9009	Bioinformatics (Approved)	Brigid Lucey	Expert	5.0	4.00	4.00	100.0	0.0
DATA9002	Distributed Data Management (Approved)	Sean McSweeney	Expert	5.0	4.00	4.00	100.0	0.0
COMP9086	Processing and Visualization (Approved)	Sean McSweeney	Expert	5.0	4.00	4.00	100.0	0.0

Stage 2 / Semester 1

Mandatory								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
COMP9011	Research Practice & Ethics (Approved)	Sean McSweeney	Expert	5.0	3.00	3.00	100.0	0.0
BIOT9008	Applied Genomics (Approved)	Brigid Lucey	Expert	5.0	4.00	4.00	100.0	0.0
COMP9085	Machine Learning in Biology (Approved)	Sean McSweeney	Expert	5.0	4.00	4.00	100.0	0.0

Stage 2 / Semester 2

Mandatory								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
BIOT9013	Structural Biology (Approved)	Brigid Lucey	Expert	5.0	0.00	0.00	100.0	0.0
STAT9008	Applied Statistics for Biology (Approved)	David Goulding	Advanced	5.0	4.00	4.00	100.0	0.0

Elective								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
COMP9067	Deep Learning (Approved)	Sean McSweeney	Expert	5.0	4.00	4.00	100.0	0.0
BIOT9010	Enzymes & Therapeutics (Approved)	Brigid Lucey	Expert	5.0	4.00	4.00	100.0	0.0

Stage 3 / Semester 1

Mandatory								
Mod Code	**Module Title**	**Co-ordinator**	**Level**	**Credits**	**FT Contact Hours**	**PT Contact Hours**	**Course Work**	**Formal Exam**
BIOT9003	Research Project (Approved)	Brigid Lucey	Expert	30.0	1.00	1.00	100.0	0.0

Note: The Research Project (BIOT9003) can be completed by the end of semester 4 of the MSc programme. The learner has the option of submitting by 31 August of that year or of extending the project to semester 5.

Title:	Synthetic Biology APPROVED
Long Title:	Molecular & Synthetic Biology

Module Code:	BIOT9011	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	Eamonn Culligan
Module Description:	This module provides detailed information on the processes involved in biological information flow in cells, how these processes are regulated and modern approaches for their exploitation for synthetic biology.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Demonstrate a detailed understanding of the key processes of cellular biological information flow; DNA replication, transcription and translation.
LO2	Appraise the different mechanisms of regulation of gene expression.
LO3	Critically evaluate current techniques used in synthetic biology.
LO4	Critically examine the diversity of biological parts for genetic circuit design.
LO5	Critically assess the applications of synthetic biology.
LO6	Demonstrate the ability to write a professional scientific report and communicate the content through an oral presentation.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Process of Biological Information Flow Genome organisation, DNA replication, transcription and translation.
Regulation of gene expression. Transcriptional, translational and post-translational control of gene expression. Promoters, operons, transcription factors, positive and negative regulation. Antisense RNAs, Riboswitches.
Synthetic biology tools and genetic circuits DNA synthesis, genetic engineering, cloning. Biological parts, genetic circuit design and assembly. Codon optimisation. De novo genome synthesis.
Applications of synthetic biology Examples of synthetic biology in bacteria, yeast, mammalian cells and viruses (phage). Inducible systems. Therapeutic applications in cancer therapy, infectious diseases, metabolic disorders, drug screening and discovery. Biosafety and biocontainment.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Multiple Choice Questions	MCQ exam on course material.	1,2	40.0	Week 5
Written Report	Written report on a current topic in synthetic biology.	3,4,5,6	40.0	Week 13
Presentation	Presentation based on written report.	3,4,5,6	20.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online Lectures	3.0	Every Week	3.00
Tutorial	Online Tutorial	1.0	Every Week	1.00
Independent & Directed Learning (Non-contact)	Review of course material and recommended resources	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online Lectures	3.0	Every Week	3.00
Tutorial	Online Tutorial	1.0	Every Week	1.00
Independent & Directed Learning (Non-contact)	Review of course material and recommended resources	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Christina Smolke, Sang Yup Lee, Jens Nielsen, Gregory Stephanopoulos 2018, *Synthetic Biology: Parts, Devices and Applications*, Vol. 8 Ed., Wiley-Blackwell [ISBN: 9783527330751]**

This module does not have any article/paper resources

Other Resources

- **Website: *BioBricks Foundation - Biotechnology in the Public Interest***
  https://biobricks.org/
- **Website: *International Genetically Engineered Machine (iGEM) Foundation***
  https://igem.org/
- **Website: *addgene***
  https://www.addgene.org/synthetic-biolog y/
- **Website: *PubMed***
  https://pubmed.ncbi.nlm.nih.gov/

Title:	Omics Technologies APPROVED
Long Title:	Omics Technologies

Module Code:	BIOT9012	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	ROY SLEATOR
Module Description:	A comprehensive overview of 'omics' technologies, specifically: Genomics/Metagenomics, Transcriptomics, Proteomics, Transcriptomics, & Metabolomics.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Critically analyze analyze the contribution of 'omics' technologies to modern molecular biology.
LO2	Critically assess the impact of Next Generation Sequencing on the field of Genomics
LO3	Interpret how gene array and RNA Seq technologies can be used to identify when and to what extent gene expression is altered.
LO4	Critically assess the techniques used to identify and analyze proteins.
LO5	Critically appraise how metabolic profiling can lead to a greater understanding of physiological processes.
LO6	Demonstrate the ability to write a professional scientific report and communicate the content through an oral presentation.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
'Omics' Technologies Overview An introduction to 'omics' technologies and their role in integrating information to give a systems view of biological processes.
Genomics and Metagenomics A comprehensive overview of large scale DNA sequencing strategies; from the human genome project to large scale metagenomics projects, with a specific focus on Next Generation Sequencing technologies.
Transcriptomics A detailed analysis of the complete set of RNA transcripts produced by the genome at a particular time, or in response to external stimuli. This will involve a detailed overview of current microarray and RNA Seq technologies.
Proteomics Analyses of the entire protein complement of an organism. Techniques covered will include Western blots, 2D-SDS PAGE, LC, MS, ICAT, and protein arrays.
Metabolomics A systematic study of how metabolic profiling can give an instantaneous snapshot of the physiology of an organism. This will involve a detailed overview of metabolic profiling and analytical techniques in the context of the Human Microbiome Project.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Written Report	A written report on specific 'omics' technologies, their application and impact. This report will be based on the scientific literature and written in manuscript format.	1,2,3,4,5,6	70.0	Sem End
Presentation	An oral presentation based on the written report.	1,2,3,4,5,6	30.0	Sem End

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Directed Learning	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	Review of lecture material and recommended reading	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	0.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Directed Learning	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	Review of lecture material and recommended reading	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	0.00

Module Resources

Recommended Book Resources
• **Preeti Arivaradarajan & Gauri Misra 2018, *Omics Approaches, Technologies And Applications*, 1st Ed., Springer**
This module does not have any article/paper resources
This module does not have any other resources

Title:	Scien. Prog. for Biologists APPROVED
Long Title:	Scientific Programming for Biologists

Module Code:	COMP9087	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Advanced
Field of Study:	Computer Science
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Next Review Date:	April 2021
Module Coordinator:	Sean McSweeney
Module Author:	Mohammed Hasanuzzaman
Module Description:	Computational and experimental biologists as well as biostatisticians often develop a 'workflow' that involves several steps such as data collection, analysis, model building and testing hypothesis. This module aims at learning to program for scientific computation. The learners will be equipped with the skills to effectively use a collection of non-commercial tools and libraries for computational biology and bioinformatics.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Analyse fundamental components of high-level programming language.
LO2	Develop programs for solving specific tasks using standard programming concepts.
LO3	Compare programming techniques to clean, transform and automate biological data analysis.
LO4	Integrate off-the-shelf libraries and their associated functionalities to address biological questions.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Introduction Importance of programming in today's world, categories of programming language, their typical application in scientific computing, basic concepts in Python programming: source code, text editors, syntax, semantics, statements, Python versions and installation.
String Manipulation Learn to write and execute simple python programs. Works in the context of biological sequence manipulation-concepts of terminals, standard output, variables and naming, strings and characters, special characters, comments, and error handling.
Flow control Importance of flow control- conditional statements, loops. Learn truth and falsehood, Boolean logic, identity and equality, evaluation of statements, branching, iteration, and ranges.
Data Structures Various data structures such as arrays, lists, tuples, dictionaries, sets and how to use them.
Functions Learn how to write functions in Python. Concepts of argument passing, encapsulation, data flow through a program.
File handling Introduce the importance of files in biological pipelines and workflows, and explore the Python interfaces for reading from and writing to files. Concepts: paths and folders, relationships between variables and values, text and binary files, and newlines.
Python library How to find and install packages, create data objects defined in the package, and write programs that use these objects. Introduction BioPython (or maybe SciKit Bio)- tools for computational biology and bioinformatics.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Reflective Journal	Compendium of labs into a report ensuring that the student is engaging in practical laboratory sessions.	1,2,3	50.0	Week 7
Project	Develop a workflow to address specific biological problems using Python libraries and techniques. Produce a report documenting findings and critically analyzing results.	2,3,4	50.0	Sem End

No End of Module Formal Examination

Reassessment Requirement

Coursework Only
This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended books and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended books and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Eric Matthes 2019, *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, 2nd Edition Ed., No Starch Press [ISBN: 1593279280]**
- **Al Sweigart 2019, *Automate the Boring Stuff with Python*, 2nd Edition Ed., No Starch Press [ISBN: 1593279922]**
- **Dr Martin Jones 2020, *Biological data exploration with Python, pandas and seaborn: Clean, filter, reshape and visualize complex biological datasets using the scientific Python stack*, Independently published (3 Jun. 2020) [ISBN: 9798612757238]**
- **Tiago Antao 2018, *Bioinformatics with Python Cookbook: Learn how to use modern Python bioinformatics libraries and applications to do cutting-edge research in computational biology*, 2nd Ed., Packt Publishing [ISBN: 1789344697]**

Recommended Article/Paper Resources

- **Valentin Zulkower, Susan Rosser 2020, *DNA Features Viewer, a sequence annotations formatting and plotting library for Python*, Bioinformatics, Volume 36, Issue 15, 1 August 2020 https://doi.org/10.1093/bioinformatics/btaa213**
- **Sam M Ireland, Andrew C R Martin 2020, *atomium—a Python structure parser*, Bioinformatics, Volume 36, Issue 9, 1 May 2020 https://doi.org/10.1093/bioinformatics/btaa072**
- **David J Wooten, Réka Albert 2020, *synergy - A Python library for calculating, analyzing, and visualizing drug combination synergy*, Bioinformatics, 22 September 2020 https://doi.org/10.1093/bioinformatics/btaa826**

Other Resources

- **Website: *Biopython* https://biopython.org/**
- **Website: *SciPy library* https://www.scipy.org/**
- **Website: *NumPy* https://numpy.org/**
- **Website: *Pandas - Python Data Analysis Library* https://pandas.pydata.org/**

Institiúid Teicneolaíochta Chorcaí
Cork Institute of Technology

BIOT9009: Bioinformatics
(Semester:2 Mandatory)

Title:	Bioinformatics APPROVED
Long Title:	Bioinformatics

Module Code:	BIOT9009	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	Francesca Bottacini
Module Description:	This module provides a comprehensive overview of bioinformatics and the application of computational methods for the analysis and representation of DNA sequences and biological data. The students will gain and in-depth understanding of how application of bioinformatics methods can lead to biological discoveries in the areas of genomics, life sciences and pharmaceutical industry.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Critically review advantages and application of bioinformatic strategies for the evaluation and interpretation of sequence data.
LO2	Critically assess the organisation and file structure of sequence data and apply suitable tools for file format interconversion.
LO3	Critically review available options for storage, retrieval and analysis of nucleotide and protein sequence data.
LO4	Critically evaluate strength and limitations of current gene prediction methods and recommend suitable options for different organisms.
LO5	Critically review principles and methods for sequence motif finding and their application in genomic datasets.
LO6	Critically review principles and methods of sequence alignment and their application for data mining and function prediction.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed

Module Content & Assessment

Indicative Content
Bioinformatic methods and applications An introduction to common bioinformatic methods and their application for sequence data analysis.
Sequence data format and databases A detailed overview of typical sequence file formats and their file structure and organisation. Resources available for sequence visualisation, editing and file format conversions. Overview of public databases available for storage and distribution of genomic datasets. Available utilities for batch download of genomic data.
Gene prediction and motif finding A comprehensive evaluation of the available methods and tools for gene mining in genomic datasets. Critical analysis and application of the available tools in various organisms, their strengths and weaknesses and selection criteria. Motifs and motif finding in genomic datasets, significance, prediction sensitivity and challenges in current methods.
Sequence alignments A comprehensive overview of global and local, pairwise and multiple sequence alignment algorithms and their application in homology searches and sequence data analysis. Protein-profile and profile-profile HMM-based alignments for the detection of remote homologs and protein domains.
Functional prediction and analysis A detailed review of the predictive methods for functional annotation of genomic sequence data. Commonly used sequence comparison tools and their utilisation for protein function assignment. Review of online resources for functional classification of enzymes and metabolic pathways.
Phylogenetic analysis A comprehensive analysis of the current methods in phylogenetic inference. Construction of phylogenetic trees and evaluation of strengths and weaknesses in phylogenetic inference and statistical assessment. File format and available tools for inspection and representation of phylogenetic data.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Multiple Choice Questions	20 MCQ questions with negative marking	1,2,3	20.0	Week 6
Multiple Choice Questions	20 MCQ questions with negative marking	4,5,6	20.0	Week 12
Practical/Skills Evaluation	Practical evaluation of a problem-based assessment with presentation of methods, results and discussion.	1,2,3,4,5,6	60.0	Sem End

No End of Module Formal Examination

Reassessment Requirement
Repeat examination *Reassessment of this module will consist of a repeat examination. It is possible that there will also be a requirement to be reassessed in a coursework element.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online learning	2.0	Every Week	2.00
Lab	Online learning	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Individual study	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online learning	2.0	Every Week	2.00
Lab	Online learning	2.0	Every Week	2.00
Independent Learning	Individual study	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Arthur M. Lesk 2019, *Introduction to Bioinformatics*, Oxford University Press [ISBN: 9780198794141]**
- **A. D. Baxevanis, G. D. Bader, D. S. Wishart 2020, *Bioinformatics*, Wiley [ISBN: 9781119335580]**

Supplementary Book Resources

- **David W. Mount 2004, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Press [ISBN: 9780879697129]**

This module does not have any article/paper resources

Other Resources

- **Website: *Pubmed***
  https://pubmed.ncbi.nlm.nih.gov/
- **Website: *NCBI***
  https://www.ncbi.nlm.nih.gov/

Institiúid Teicneolaíochta Chorcaí
Cork Institute of Technology

DATA9002: Distributed Data Management
(Semester:2 Mandatory)

Title:	Distributed Data Management APPROVED
Long Title:	Distributed Data Management

Module Code:	DATA9002	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Data Format
Valid From:	Semester 1 - 2017/18 (September 2017)
Module Delivered In	1 programme(s)
Module Coordinator:	Sean McSweeney
Module Author:	Ignacio Castineiras
Module Description:	Big data analytics turns big datasets into high-quality information, providing deeper insights enabling better decisions. However, big data requires novel data storage and data process techniques. In this module, the learner will be introduced to different NoSQL-based data models, their possible combination and the best use-cases for each of them. The learner will also compare and contrast different large scale analytics libraries, comparing them in terms of their expressiveness and efficiency.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Appraise the challenges posed by big data and the new infrastructure, data models and processing techniques it demands.
LO2	Compare and contrast the main NoSQL-based data models, discriminating the best fit for different use-cases.
LO3	Combine document-oriented and graph-based data models for a fit for purpose multi-component system.
LO4	Demonstrate the scalability, flexibility and reliability of a distributed data cluster supporting large data sets.
LO5	Compare and contrast the MapReduce and Spark large-scale analytics libraries in terms of their expressiveness and efficiency.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*

Module Content & Assessment

Indicative Content
The Big Data Revolution. Data storage and data process: Historical evolution. New infrastructure, data models and processing techniques required to deal with big data. Main challenges: Capture, store, search, analyse and visualise the data.
NoSQL Databases. Alternative to relational databases to address big data challenges. Impedance mismatch, scale-out vs. scale-up. Wide range of data models: Pure key/value, columnn-based, document-oriented and graph-based. Polyglot persistance. CAP theorem, partition tolerance, BASE vs. ACID transactions.
Document-oriented DBs. Efficient, scalable and resilient data storage: Replication and sharding. Clusters, configuration nodes, shards, chunk of data, shard key range, balancing backgroud operators. Expressive and efficient data queries: JSON-based document representation. Aggregation framework: Commands and pipelines.
Graph-based DBs. Efficient, scalable and resilient data storage: Property graph data model. Nodes, relationships, properties and labels. Expressive and efficient data queries: Cypher declarative SQL-like language. Graph formalism and optimal path-traversal algorithms. Polyglot persistance: On combining document-oriented and graph-based data models for a fit for purpose multi-component system.
Large-Scale Data Framework. Storage: Distributed File System. Data nodes vs. name nodes. Large files splitting and distribution algorithms. Analysis: Map-Recude. Divide and conquer algorithm schema. Map-sort-reduce process. Parallel processing. Key/value-based communication. Standard I/O file streaming. Spark: Resilient Distributed Dataset. Transformations and actions, basic API. Lazy evaluation. Context, cluster manager and worker nodes.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Practical/Skills Evaluation	Given a large data set to be stored and queried, produce a report comparing and contrasting a document-oriented vs. graph-based solution for it. Implement a polyglot persistance-based solution combining two components using the document-oriented and graph-based approaches, respectively.	1,2,3	50.0	Week 7
Practical/Skills Evaluation	Given a large data set to be stored and analysed, produce a report comparing and contrasting a Map-Reduce vs. Spark-based solution for it. Implement the two solutions, comparing them in terms of their expressiveness and efficiency.	1,4,5	50.0	Week 12

No End of Module Formal Examination

Reassessment Requirement

Coursework Only
This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Lecture based on Indicative Content	1.0	Every Week	1.00
Lab	Lab based on Indicative Content	3.0	Every Week	3.00
Independent Learning	Independent student learning	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Lecture based on Indicative Content	1.0	Every Week	1.00
Lab	Lab based on Indicative Content	3.0	Every Week	3.00
Independent Learning	Independent student learning	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Pramod J. Sadalage and Martin Fowler 2013, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*, Addison-Wesley [ISBN: 9780321826626]**
- **Ofer Mendelevitch, Casey Stella and Douglas Eadline 2017, *Practical Data Science with Hadoop and Spark: Designing and Building Effective Analytics at Scale*, Pearson Education [ISBN: 9780134024141]**

Supplementary Book Resources

- **John Sharp et. al 2013, *Data Access for Highly-Scalable Solutions: Using SQL, NoSQL, and Polyglot Persistence*, Microsoft patterns & practices [ISBN: 9781621140306]**
- **Kristina Chodorow 2013, *MongoDB: The Definitive Guide*, O'Reilly Media [ISBN: 9781449344689]**
- **Srinath Perera and Thilina Gunarathne 2013, *Hadoop MapReduce Cookbook*, Packt Publishing [ISBN: 9781849517294]**

Supplementary Article/Paper Resources

- **Sugam Sharma et. al. 2014, *A Brief Review on Leading Big Data Models*, Data Science Journal, 13**
- **A. B. M. Moniruzzaman and Syed Akhter Hossain 2013, *NoSQL Database: New Era of Databases for Big data Analytics - Classification, Characteristics and Comparison*, CoRR/abs/1307.0191.**
- **Landset, S., Khoshgoftaar, T.M., Richter, A.N. et al. 2015, *A survey of open source tools for machine learning with big data in the Hadoop ecosystem*, Journal of Big Data, 2:24**
- **Kyong-Ha Lee et. al. 2012, *Parallel data processing with MapReduce: a survey*, ACM SIGMOD, 40:4**

Other Resources

- **Website: *MongoDB documentation***
  https://docs.mongodb.com/
- **Website: *Neo4j documentation***
  https://neo4j.com/docs/
- **Website: *Hadoop Cloudera Map-Reduce documentation***
  https://www.cloudera.com/documentation/e nterprise/5-5-x/categories/hub_mapreduce .html
- **Website: *Hadoop Cloudera Spark documentation***
  https://www.cloudera.com/documentation/e nterprise/5-5-x/categories/hub_spark.htm l

Title:	Processing and Visualization APPROVED
Long Title:	Data Processing and Visualization

Module Code:	COMP9086	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Computer Science
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Sean McSweeney
Module Author:	Haithem Afli
Module Description:	The complexity of biological problems requires the understanding of networks and interactions of chemical components, as well as the analysis of relations such as gene regulation, metabolic pathways, variance, co-variance etc. As a consequence, this knowledge frequently relies on data visualisation. In this module, the learner will investigate a variety of data processing techniques and visualisation concepts. More advanced visualisation methods and tools for analysing multi dimensional data, large data sets and geospatial data will also be examined and appraised. The learner will also research and critique some of the major current challenges within biological data processing and visualisation.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Investigate programming techniques to clean, transform and query data.
LO2	Integrate standard programming libraries and their associated functionality to perform analysis of datasets and solve data-driven problems.
LO3	Develop appropriate data visualisation techniques to solve biological data analysis problems.
LO4	Assess patterns and knowledge discovered as a result of developing data visualisation techniques to a variety of biological data analysis problems.

Pre-requisite learning

Module Recommendations
This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).

No recommendations listed

Incompatible Modules
These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.

No incompatible modules listed

Co-requisite Modules

No Co-requisite modules listed

Requirements
This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.

No requirements listed

Module Content & Assessment

Indicative Content
Data Array Manipulation Overview of standard programming libraries for numerical computation. Creating multi-dimensional arrays. Performing operations such as indexing, slicing, boolean indexing, fancy indexing, building queries, transposing and applying conditional logic to arrays.
Data visualisation pre-processing techniques Learn data cleaning techniques relevant to data visualisation - data aggregation, data sampling, impute missing data, find inconsistencies. Learn transformation techniques - data normalisation, construct new variables, Investigate how to use regular expressions and data manipulation techniques to pre-process data sets.
Advanced visualisation techniques Investigate python libraries for visualisation and their features - interactivity, geospatial methods, hierarchical and networks solutions.
Data processing and visualization libraries Use Python libraries for data processing and visualization e.g. NumPy, SciPy, Matplotlib, Seaborn, Pandas and Plotly.

Assessment Breakdown	**%**
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Project	Design and implement programs that apply a range of programming concepts and libraries to solve data-driven problems.	1,2	50.0	Week 6
Project	Evaluate and implement a visualisation technique to solve a problem; research, critique and communicate the biological data analysis topic.	3,4	50.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Martin Jones 2020, *Biological data exploration with Python, pandas and seaborn: Clean, filter, reshape and visualize complex biological datasets using the scientific Python* [ISBN: 9798612757238]**
- **Yasha Hasija and Rajkumar Chakraborty, *Hands on Data Science for Biologists Using Python*, 2021 Ed., Taylor & Francis Ltd [ISBN: 0367546795]**

Recommended Article/Paper Resources

- **Tallat et. al 2019, *Visualization and Analytics of Biological Data by Using Different Tools and Techniques*, 2019 16th International Bhurban Conference on Applied Sciences and Technology (IBCAST)**
  https://ieeexplore.ieee.org/document/8667214
- **Raiha Tallat, Rana M. Amir Latif, Ghazanfar Ali, Ahmad Nawaz Zaheer, Muhammad Farhan and Syed Umair Aslam Shah 2020, *Jarvis: A Multimodal Visualization Tool for Bioinformatic Data***
  https://ieeexplore.ieee.org/abstract/document/8667214?casa_token=CRTxgpXVdB0AAAA A:ajpfWJOSVwgXjSB2YEyzf-hRGQTdeWiVWb5TC0bjQOxCs6gHyV1Kog-eALak-G2Sju2x3t7ZjJ8

Other Resources

- **Website: *Visualizing Biological Data in Python/v3***
  https://plotly.com/python/v3/ipython-not ebooks/bioinformatics/
- **Website: *DATA VISUALIZATION IDEAS AND LIBRARIES FOR BIOINFORMATICS***
  https://seqqc.wordpress.com/2019/08/18/d ata-visualisation-ideas-and-libraries-fo r-bioinformatics/
- **A source-code repository: *Plotly BioVisualization with Python***
  https://github.com/furkanmtorun/Plotly_B ioVisualization

Title:	Research Practice & Ethics APPROVED
Long Title:	Research Practice & Ethics

Module Code:	COMP9011	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Computer Science
Valid From:	Semester 1 - 2018/19 (September 2018)
Module Delivered In	**5 programme(s)**
Module Coordinator:	Sean McSweeney
Module Author:	Donna OShea
Module Description:	The purpose of this module is to introduce students to the tools and techniques for doing research. In addition, students will examine the concept of research integrity and ethics applied to their field of study. On completion of this module students will develop a research proposal outlining the context of the topic, its research aims, objectives, methodologies, work plan, ethical considerations etc. This proposal will then be developed further in an implementation phase.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Develop a research proposal defining the project aims, objectives and research methodology that will be applied to the research project.
LO2	Review the current state of the art in the topic related to the proposed research outlining the contribution the research will make to the general field.
LO3	Evaluate the main research integrity and ethical considerations that need to be considered in the proposed project.
LO4	Develop a project schedule and plan that considers the identified research integrity and ethical considerations.
LO5	Communicate effectively the idea and contribution of the proposed research project.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Research Methods and Methodologies Definitions. Knowledge kinds and interrelationships. Empirical Research. Basic Research. Applied Research. Practical Research. Action Research. Parameters of research. Kinds of research: qualitative, descriptive and experimental. Applying research methodologies to computing, software and software development. Case studies and examples.
Research and Research Strategies Constitution of research papers. Standards. Search strategies including: web, library, inter-library loan, databases such as IEEE and ACM, search engines. Literature review and systematic literature review.
Research Planning Issues within a research project that relate specifically to computing/software projects including: problem definition, software planning, specification and system definition, choosing environments for development, timing issues relating to the software process, prototyping, iteration, risk evaluation, slippage, performance issues, evaluations and conclusions.
Research Documentation Documentation appropriate to research and the programme specifications. This includes research proposal documentation, report documentation, research paper formats and citation formats.
Ethics for Computer Scientists Ethics in Information & communication technology. Ethics, privacy and information security. Computer Ethics. Cyber ethics. Social, regulation and legal issues. Ethical design. Impact of IoT on ethics - environment monitoring and data collection. Impact of AI on ethics. Posthuman era, machine ethics, unintended consequences. Case studies - Facebook Mood Manipulation Experiments, Internet of Things, Google Maps.
Research Ethics & integrity Human subjects - ethical, legal, social and political issues. Research ethics committee in CIT. Categories of research ethics - questionnaires/surveys for adults versus children. Consent.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Essay	The student will propose an initial research topic and will define some initial context behind the idea. In addition, the student will define some preliminary research aims and objectives. The student will then be expected to present their idea with the aim of effectively communicating the broad research topic and context.	1,2	40.0	Week 9
Other	The student will develop the research proposal detailing fully the idea and relevant state of the art, aims, objective, methodologies, work plan schedule and ethical issues that need to be considered. The student may also be required to present their proposal.	1,2,3,4,5	60.0	Sem End

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Lecture delivering theory underpinning learning outcomes.	2.0	Every Week	2.00
Lab	Practical to develop individual proposal.	1.0	Every Week	1.00
Independent & Directed Learning (Non-contact)	Independent Study.	4.0	Every Week	4.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	3.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Lecture delivering theory underpinning learning outcomes.	2.0	Every Week	2.00
Lab	Practical to develop individual proposal.	1.0	Every Week	1.00
Independent & Directed Learning (Non-contact)	Independent Study.	4.0	Every Week	4.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	3.00

Module Resources

Recommended Book Resources

- Martyn Denscombe 2014, *The Good Research Guide*, 5 Ed., Open University Press, McGraw-Hill Education [ISBN: 9780335264704]

Supplementary Book Resources

- Steven J. Taylor, Robert Bogdan, Marjorie DeVault 2016, *Introduction to Qualitative Research Methods: A Guidebook and Resource*, 4 Ed., Wiley [ISBN: 9781118767214]
- Prabhat Pandey, Meenu Mishra Pandey 2015, *Research Methodology: Tools and Techniques*, 1 Ed., Bridge Center [ISBN: 9786069350270]
- James D. Lester 2014, *Writing Research Papers: A Complete Guide*, 15 Ed., Pearson [ISBN: 9780321952950]
- K. Schwalbe 2011, *Information Technology Project Management*, 6 Ed., Cengage Learning [ISBN: 9781111221751]
- Dennis Lock 2007, *Project management*, Gower Aldershot [ISBN: 978-0566087721]
- Nick Bostrom 2016, *Superintelligence: Paths, Dangers, Strategies*, OUP Oxford [ISBN: 9780198739838]

Recommended Article/Paper Resources

- Shaw, M. 2003, *Writing Good Software Engineering Research Papers*, Proceeding of the 25th International Conference on Software Engineering: IEEE Computer Society, 726-736
- Nick Bostrom, Eliezer Yudkowsky 2014, *The Ethics of Artificial Intelligence*, The Cambridge handbook of artificial intelligence, 316-3
  https://intelligence.org/files/EthicsofAI.pdf
- Francine Berman and Vinton G. Cerf 2017, *Social and Ethical Behavior in the Internet of Things*, Communications of the ACM, 60(2)
  http://www.cs.rpi.edu/~bermaf/Berman+Cerf_IoT.pdf

Supplementary Article/Paper Resources

- Nick Bostrom 2009, *The Future of Humanity*, New Waves in Philosophy of Technology
  https://nickbostrom.com/papers/future.html

Other Resources

- Website: *APA reference style: Tightening up you citations.*
  http://linguistics.byu.edu/faculty/henri chsenl/APA/APA11.html
- Website: Henrichsen, L. et al. 2007, *Taming the Research Beast*
  http://linguistics.byu.edu/faculty/henri chsenl/ResearchMethods/
- Website: The Atlantic 2014, *Everything We Know About Facebook's Secret Mood Manipulation Experiment*
  https://www.theatlantic.com/technology/a rchive/2014/06/everything-we-know-about-facebooks-secret-mood-manipulation-exper iment/373648/
- Website: Berkman Klein Centre for Internet & Society at Harvard University *Ethics and Governance of Artificial Intelligence*
  https://cyber.harvard.edu/research/ai?pa ge=2

Title:	Applied Genomics APPROVED
Long Title:	Applied Genomics

Module Code:	BIOT9008	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	Francesca Bottacini
Module Description:	This module provides practical and molecular knowledge to implement computational tools for the analysis of genomic datasets. This module focuses on equipping the students with theoretical and practical skills for evaluating and applying current tools available for comparative analysis and representation of genomic data.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Critically evaluate methods and tools available for the analysis of genomic datasets
LO2	Critically review and apply genome assembly and annotation pipeline for genomic and metagenomic dataset.
LO3	Critically review and apply comparative genomic methods for genome analysis and representation of genomic datasets.
LO4	Critically review and apply genomic analysis methods for taxonomical and functional profiling of microbiome datasets
LO5	Critically evaluate and apply analysis methods for the evaluation of differential gene expression in genomic data.
LO6	Demonstrate ability to apply available tools for high-throughput sequencing reads mapping and analysis

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Genomic data analysis for shotgun sequencing data An introduction to common genomic methods for the analysis of (meta)genomic and (meta)transcriptomic datasets.
Assembly and annotation of genomic datasets A detailed overview of de novo, reference-based and hybrid assembly methods for the assembly of sequencing raw reads obtained from different NGS platforms. Available tools for the automatic gene prediction and functional annotation of genomic and metagenomic datasets. Computational methods and binning algorithms for the obtainment and validation of metagenome reconstructed genomes.
Comparative genomics and pangenome analysis A critical evaluation of comparative genomic analysis methods. Available tools for the implementation of comparative genomic workflows for data analysis and data visualisation. Comparison, evaluation and application of available pipelines for pangenome analysis and representation. Phylogenomic inference based on computed orthologous core genes.
Taxonomical profiling of microbiomes A comprehensive evaluation of current strategies and best procedures for the analysis of metagenomic sequencing datasets. Current methods in taxonomical and functional profiling of microbiome communities. Evaluation of OTU classification performance and accuracy. Gene mining an marker gene classification in metagenomic datasets.
Differential gene expression An overview of current methods for the evaluation of differential gene expression in transcriptomic datasets. Evaluation of available pipelines for reads alignment, read counting, differential expression analysis and data representation.
SNP genotyping Analysis of current methods for the detection of single nucleotide polymorphisms in genomic datasets. Reads mapping and extraction of nucleotide variants. Data format for storage of reads alignment data and alignment visualisation strategies.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Multiple Choice Questions	20 MCQ questions with negative marking	1,2,3	20.0	Week 6
Multiple Choice Questions	20 MCQ questions with negative marking	4,5,6	20.0	Week 12
Practical/Skills Evaluation	Practical evaluation of a problem-based assessment with detailed description of methods and results, to be uploaded online	1,2,3,4,5,6	60.0	Every Second Week

No End of Module Formal Examination

Reassessment Requirement
Repeat examination *Reassessment of this module will consist of a repeat examination. It is possible that there will also be a requirement to be reassessed in a coursework element.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online learning	2.0	Every Week	2.00
Lab	Online learning	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Individual study	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online learning	2.0	Every Week	2.00
Lab	Online learning	2.0	Every Week	2.00
Independent Learning	Individual study	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **T. A. Brown 2018, *Genomes 4*, Garland Science [ISBN: 9780815345084]**
- **J. Izard 2015, *Metagenomics for Microbiology*, Elsevier Academic Press [ISBN: 9780124104723]**

Supplementary Book Resources

- **Arthur M. Lesk 2017, *Introduction to Genomics*, Oxford University Press [ISBN: 9780198754831]**

This module does not have any article/paper resources

Other Resources

- **Website: *NCBI***
  https://www.ncbi.nlm.nih.gov
- **Website: *Pubmed***
  https://pubmed.ncbi.nlm.nih.gov/
- **Website: *Bioconda***
  https://bioconda.github.io/

Title:	Machine Learning in Biology APPROVED
Long Title:	Applied Machine Learning in Biology

Module Code:	COMP9085	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Computer Science
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Sean McSweeney
Module Author:	Haithem Afli
Module Description:	The biological sciences field is becoming increasingly data-rich and information-intensive. Machine Learning techniques promise to be useful tools for better analysing the growing amount of available biological data, in order to select and extract needed knowledge. This module will focus on the application of machine learning to real-world biological data analysis problems. It will also equip students with the skills to comprehensively evaluate models and apply appropriate pre-processing methods.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Analyse machine learning workflows to facilitate pre-processing, dimensionality reduction and model selection.
LO2	Compare and apply appropriate machine learning algorithms to specific Biological datasets.
LO3	Develop supervised machine learning models for classification tasks.
LO4	Develop unsupervised machine learning models for clustering tasks.
LO5	Evaluate the accuracy of predictive models using standard methods and interpret their results.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Machine Learning Fundamentals Needs, definitions, challenges and what to expect from ML, learning types and overview of popular algorithms etc.
Feature engineering and pre-processing Feature engineering on text, numeric, temporal and image data; Application of a standard machine learning pre-processing methodology using techniques such as dimensionality reduction, model selection, feature selection.
Model building, evaluation and hyper-parameter optimization Overview of evaluation metrics such as precision, recall, confusion matrices.
Supervised Machine Learning Building predictive models using Scikit-Learn for solving classification and regression problems. Using machine learning algorithms such as instance based learners, naive Bayes, ensembles etc.
Unsupervised Machine Learning Unsupervised learning techniques such as association rule mining, K-Means, density-based and hierarchical clustering techniques.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Project	Apply a range of machine learning classification algorithms to a complex real-world problem such as Biological Image Analysis. The findings should be documented.	1,2,3,5	50.0	Week 6
Project	Apply clustering algorithms for Biological Data. A comprehensive reporting evaluating the performance of the algorithms should be submitted.	1,2,4,5	50.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 2nd Edition Ed., O'Reilly Media, Inc. [ISBN: 9781492032649]**

Recommended Article/Paper Resources

- **Tabe-Bordbar, S., Emad, A., Zhao, S. D. & Sinha, S. 2018, *A closer look at cross-validation for assessing the accuracy of gene regulatory networks and models*, Engineering, Sci. Rep. 8, 6620**
- **David T. Jones 2019, *Setting the standards for machine learning in biology*, Nature Reviews Molecular Cell Biology**

Other Resources

- **Research paper: Yang et. al 2020, *Review on the Application of Machine Learning Algorithms in the Sequence Data Mining of DNA* , Front. Bioeng. Biotechnol. 8:1032. doi: 10.3389/fb https://www.frontiersin.org/articles/10. 3389/fbioe.2020.01032/full**

Title:	Structural Biology APPROVED
Long Title:	Structural Biology

Module Code:	BIOT9013	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	ROY SLEATOR
Module Description:	To provide a deep understanding of protein structure, function, evolution and engineering principles.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Critically assess the classification systems underlying the main protein databases.
LO2	Critically appraise methods to identify protein analogues of low sequence identity.
LO3	Apply comparative modelling to resolve protein structure and evaluate the accuracy of the resulting models.
LO4	Analyze the current computational approaches to predicting protein function.
LO5	Demonstrate an understanding of the processes shaping protein evolution and how this knowledge can be applied to protein engineering.
LO6	Demonstrate the ability to write a professional scientific report and communicate the content through an oral presentation

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Classification of Protein Structure An insight into the classification systems underlying the main structural databases.
Domains, Folds and Motifs An overview of the main conserved protein domains and their role in protein identification and classification.
Prediction of Protein Secondary Structure & Function An overview of the principal methods for the prediction of protein structure and interpretation of the results in terms of protein function.
Comparative Modelling 3D protein structure prediction. Specifically, the use of fold recognition and target-template alignment to detect structural, functional and evolutionary relationships.
Protein Evolution An introduction to evolutionary relationships which exist between proteins, at the level of sequence, structure and function.
Protein Engineering An overview of protein engineering methods and resulting applications.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Written Report	A written report on a specific protein; focusing on structure, function, evolution and engineering. The report will be based on the scientific literature and written in manuscript format.	1,2,3,4,5	70.0	Sem End
Presentation	An oral presentation on the subject of your written report.	1,2,3,4,5	30.0	Sem End

No End of Module Formal Examination

Reassessment Requirement

Coursework Only
This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Directed Learning	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	Review of lecture material and recommended reading	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	0.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Directed Learning	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	Review of lecture material and recommended reading	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	0.00

Module Resources

Recommended Book Resources

- **Gary Walsh 2014, *Proteins - Biochemistry and Biotechnology*, 2nd Ed., Wiley Blackwell [ISBN: 0470669853]**

This module does not have any article/paper resources

This module does not have any other resources

Title:	Applied Statistics for Biology APPROVED
Long Title:	Applied Statistics for Biology

Module Code:	STAT9008	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Advanced
Field of Study:	Statistics
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Next Review Date:	May 2026
Module Coordinator:	David Goulding
Module Author:	Noreen Quinn
Module Description:	This module focuses on the application of statistical methods to biological data. Students will acquire knowledge, skills and competences in the areas of statistical models, sampling theory, hypothesis testing, design of experiments and regression analysis. Upon completion, students will be able to plan, conduct, analyse, and interpret controlled experiments using appropriate statistical data analysis.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Evaluate the results of statistical analyses performed using software packages.
LO2	Construct an appropriate experimental design for a given problem, identify the correct statistical analysis to use and interpret the outcome of this analysis.
LO3	Apply regression techniques to experimental data and interpret the results.
LO4	Differentiate between when parametric and non-parametric statistical methods should be used and apply these methods to biological data.
LO5	Communicate the outputs of statistical analyses to a wider audience of peers through presentation and/or report of professional scientific standard.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
The Importance of the Normal Distribution Features of the normal distribution and relevance of it to biological data. Testing for normality.
Hypothesis Testing One-sample, Two independent sample, Related Samples, ANOVA
Design of Experiments Experimental Design for ANOVA, 2-factor factorial experiments, experiments with more than 2 factors, split plot designs, Calculating the number of replicates.
Regression Analysis Least squares, simple linear regression models. Assumptions, collinearity, interpreting coefficients, model fitting and model diagnostics.
Non-parametric methods Non-Parametric versus Parametric methods. Typical Non-parametric methods: The sign test, Kruskal Wallos, Analysis of Ranks.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Project	Following analysis of a real world data set, design a suitable experiment using appropriate software to test a hypothesis and justify the approach taken.	1,2	50.0	Week 7
Project	Apply statistical techniques to a real world biological data set. Summarise results in the form of a scientific report and/or presentation.	3,4,5	50.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Theory on course topics and discussion of relevant examples from biological sciences.	2.0	Every Week	2.00
Lab	Development of practical competency through laboratory-based learning.	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Review of lecture notes and recommended material and preparation of reports for selected laboratory sessions and in-class topics.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Theory on course topics and discussion of relevant examples from biological sciences.	2.0	Every Week	2.00
Lab	Development of practical competency through laboratory-based learning.	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Review of lecture notes and recommended material and preparation of reports for selected laboratory sessions and in-class topics.	4.0	Every Week	4.00
			Total Hours	8.00
			Total Weekly Learner Workload	8.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Jerrold H. Zar 2010, *Biostatistical Analysis*, 5th Ed., Prentice-Hall/Pearson [ISBN: 0132065029]**
- **Thomas Glover, Kevin Mitchell 2015, *An Introduction to Biostatistics*, 3rd Ed., Waveland Press [ISBN: 1478627794]**

Supplementary Book Resources

- **Marc M. Triola, Mario F. Triola 2014, *Biostatistics for the biological and health sciences*, Pearson Education [ISBN: 1292039647]**
- **Richard K. Burdick, David J. LeBlond, Lori B. Pfahler, Jorge Quiroz, Leslie Sidor, Kimberly Vukovinsky, Lanju Zhang 2017, *Statistical Applications for Chemistry, Manufacturing and Controls (CMC) in the Pharmaceutical Industry*, Springer [ISBN: 9783319501864]**
- **Susan Morgan, Tom Reichert, Tyler R. Harrison 2016, *From Numbers to Words - Reporting Statistical Results for the Social Sciences*, Routledge [ISBN: 9781138638082]**

This module does not have any article/paper resources

This module does not have any other resources

Title:	Deep Learning APPROVED
Long Title:	Deep Learning

Module Code:	COMP9067	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Computer Science
Valid From:	Semester 1 - 2018/19 (September 2018)
Module Delivered In	1 programme(s)
Module Coordinator:	Sean McSweeney
Module Author:	Ted Scully
Module Description:	Deep learning techniques, which are a subfield of machine learning, has led to significant advances in challenging real-world problems such as natural language processing and image recognition. This module focuses on equipping students with both the theoretical and practical skills that will enable them to build and apply deep learning models to real-world problems.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Implement and evaluate a gradient descent-based machine learning algorithm.
LO2	Build, train and apply deep neural networks to problems such as computer vision.
LO3	Perform hyperparameter optimization, regularization and optimization for deep learning networks.
LO4	Create convolutional neural network models and apply to image datasets.
LO5	Build and train Recurrent Neural Networks (RNNs).

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Regression and Gradient Descent. Introduction to linear regression and gradient descent. Multiple linear regression and metrics for evaluating regression models. Logistic regression and activation functions. Using a vectorized implementation.
Build and evaluate deep neural networks. Build and train shallow neural networks. Forward and backward propagation. Key parameters for neural networks. Create and train a fully connect deep learning model. Initialization, L2 and dropout regularization, gradient checking and batch normalization. Convergence algorithms. Best-practice for evaluating performance and analyzing for bias and variance.
Convolutional neural network. Overview of convolutional neural networks. Methodology for stacking layers in a deep network to address multi-class image classification problems. Object detection and the YOLO algorithm. Deep residual learning for image recognition.
Recurrent Neural Networks (RNNs). The basic recurrent unit (Elman unit) and LSTM (long short-term memory) unit. Overview of the GRU (gated recurrent unit). Build and train recurrent neural networks. Approaches for mitigating the vanishing gradient problem.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Project	Perform a comparative analysis between a basic gradient descent-based machine learning model and a deep learning neural network applied to a dataset from a specific application domain.	1,2,3	50.0	Week 7
Project	Build and train a convolutional or recurrent neural network and apply to a dataset from a specific application domain. A comprehensive evaluation should be completed.	4,5	50.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student undertakes independent study. The student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Delivers the concepts and theories underpinning the learning outcomes.	2.0	Every Week	2.00
Lab	Application of learning to case studies and project work.	2.0	Every Week	2.00
Independent Learning	Student undertakes independent study. The student reads recommended papers and practices implementation.	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **I. Goodfellow , Y. Bengio, A. Courville 2017, *Deep Learning (Adaptive Computation and Machine Learning series)*, 1st Ed., MIT Press [ISBN: 9780262035613]**

Supplementary Book Resources

- **T. Laville 2017, *Deep Learning for Beginners: Concepts, Techniques and Tools*, 1st Ed., CreateSpace Independent Publishing [ISBN: 9781979311182]**
- **F. Chollet 2017, *Deep Learning with Python*, 1st Ed., Manning Publications [ISBN: 9781617294433]**

Recommended Article/Paper Resources

- **S. Ioffe, C. Szegedy 2015, *Batch Normalization: Accelerating Deep Network Training by Reducing Internal Covariate Shift*, International Conference on Machine Learning**
- **K. He, X. Zhang, S. Ren, J. Sun 2016, *Deep Residual Learning for Image Recognition*, IEEE Conference on Computer Vision and Pattern Recognition (CVPR)**

Other Resources

- **Website: TensorFlow *https://www.tensorflow.org/***
- **Website: Theano *http://deeplearning.net/software/theano/***
- **Website: Caffee *http://caffe.berkeleyvision.org/***

Title:	Enzymes & Therapeutics APPROVED
Long Title:	Enzymes & Therapeutics

Module Code:	BIOT9010	**Duration:**	1 Semester

Credits:	5
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	Eamonn Culligan
Module Description:	This module provides a comprehensive overview of discovery, development and applications of enzymes and therapeutics of importance in the pharmaceutical, biotechnology and food industries.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Critically assess key enzymes relevant to the pharmaceutical, biotechnology and food industries.
LO2	Critically assess key therapeutics relevant to the pharmaceutical and biotechnology industries.
LO3	Appraise conventional and novel approaches for enzyme and drug discovery.
LO4	Critically review specific examples of microbiome 'mining' in the context of enzyme and drug discovery from the scientific literature.
LO5	Demonstrate the ability to write a professional scientific report and communicate the content through an oral presentation.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Enzymes & Therapeutics Lipases, proteases, cellulases, etc., biocatalysts, bioactives, 'value-added' enzymatic conversions, enzymatic production of active pharmaceutical ingredients (APIs). DNA, RNA, & protein therapeutics. Vaccines, CRISPR, Antimicrobial peptides.
Discovery & Engineering Conventional and novel approaches: Culture-based screening, genome sequencing and mining. Cell free extracts and activity screening. Culture-independent approaches - functional metagenomics. Directed evolution, random and rational mutagenesis, expanding the genetic code and non-canonical amino acids. Metabolic engineering of strains.
Microbiome 'mining' Review relevant case studies from the literature in relation to the discovery of microbiome-derived novel enzymes, small molecules and antimicrobials, and critically assess their applications in the pharmaceutical, biotechnology and food industries.

Assessment Breakdown	%
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Presentation	Oral presentation based on course material.	1,2	10.0	Week 6
Written Report	Written report based on an enzyme or therapeutic with industrial or clinical relevance.	1,2,3,4,5	70.0	Week 13
Presentation	Oral presentation based on written report.	1,2,3,4,5	20.0	Week 13

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	No Description	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Online Lectures	4.0	Every Week	4.00
Independent & Directed Learning (Non-contact)	No Description	3.0	Every Week	3.00
			Total Hours	7.00
			Total Weekly Learner Workload	7.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

- **Goutam Brahmachari, Arnold L Demain, Jose L Adrio 2016, *Biotechnology of Microbial Enzymes : Production, Biocatalysis and Industrial Applications*, 1st Edition Ed., Elsevier Science Publishing [ISBN: 9780128037256]**
- **Raymond G Hill 2012, *Drug Discovery and Development : Technology in Transition*, 3rd Edition Ed., Elsevier Health Sciences [ISBN: 9780702042997]**

This module does not have any article/paper resources

Other Resources

- **Website: *PubMed***
  https://pubmed.ncbi.nlm.nih.gov/

Institiúid Teicneolaíochta Chorcaí
Cork Institute of Technology

BIOT9003: Research Project
(Semester:5 Mandatory)

Title:	Research Project APPROVED
Long Title:	Research Project

Module Code:	BIOT9003	**Duration:**	1 Semester

Credits:	30
NFQ Level:	Expert
Field of Study:	Biotechnology
Valid From:	Semester 1 - 2021/22 (September 2021)
Module Delivered In	no programmes
Module Coordinator:	Brigid Lucey
Module Author:	Eamonn Culligan
Module Description:	This project takes place in Semester 5 of a 90-credit Masters Programme. Its focus is to undertake independent research by applying computational approaches to a Biological Science question. The project can be work-based (within industry or a clinical lab, for example) or within an existing research group in the Departments of Biological Sciences and Computer Science.

Learning Outcomes	
On successful completion of this module the learner will be able to:	
LO1	Initiate and direct work spanning the interdisciplinary areas of Biological Sciences and Computer Science.
LO2	Interact in a professional manner with experts in interdisciplinary teams in the pursuance the project.
LO3	Demonstrate the integration of critical thinking processes within their project.
LO4	Critically appraise the role of the project within a wider context, to identify potential future development.
LO5	Contextualise their project within the broader economic environment, with particular reference to its potential development in a relevant sector (e.g. the biotechnology, pharmaceutical, and food industries, clinical laboratories, academia, etc.).

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.*
No requirements listed

Module Content & Assessment

Indicative Content
Content The content of the Masters Project is characterized by the submission of a Thesis
Deliverable The actual deliverable will be negotiated with the supervising team at the beginning of the Module (and would normally be based upon the outcome of developing a project proposal in the 'Research Ethics & Practice' module). The thesis must include some critical review of research or work of others in the field. Projects must meet the criteria of being challenging, interactive, and based upon a systematic approach to the solving of a stated problem or the achievement of a stated goal.
Thesis The Thesis shall be circa 20,000 words

Assessment Breakdown	**%**
Course Work	100.00%

Course Work

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Written Report	Thesis	1,2,3,4,5	80.0	Sem End
Presentation	Oral Presentation of Project Work	1,2,3,4,5	20.0	Sem End

No End of Module Formal Examination

Reassessment Requirement
Coursework Only *This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

The institute reserves the right to alter the nature and timings of assessment

Note: The Research Project (BIOT9003) can be completed by the end of semester 4 of the MSc programme. The learner has the option of submitting by 31 August of that year or of extending the project to semester 5.

Module Workload

Workload: Full Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Independent & Directed Learning (Non-contact)	Project Work and Independent Learning	35.0	Every Week	35.00
Lecturer-Supervised Learning (Contact)	No Description	1.0	Every Week	1.00
			Total Hours	36.00
			Total Weekly Learner Workload	36.00
			Total Weekly Contact Hours	1.00

Workload: Part Time				
WorkLoad Type	*WorkLoad Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Independent & Directed Learning (Non-contact)	Project Work and Independent Learning	35.0	Every Week	35.00
Lecturer-Supervised Learning (Contact)	No Description	1.0	Every Week	1.00
			Total Hours	36.00
			Total Weekly Learner Workload	36.00
			Total Weekly Contact Hours	1.00

Module Resources

Recommended Book Resources

- **Pat Cryer, *The Research Student's Guide to Success*, 3rd Edition Ed., Open University Press [ISBN: 9780335221172]**
- **Renata Phelps, Kath Fisher, Allan H Ellis, *Organizing and Managing Your Research*, 1st Edition Ed., SAGE Publications Ltd. [ISBN: 9781412920643]**

This module does not have any article/paper resources

Other Resources

- **Website: *PubMed***
  https://pubmed.ncbi.nlm.nih.gov/
- **Website: Health Sciences Library System *OBRC: Online Bioinformatics Resources Collection***
  https://www.hsls.pitt.edu/obrc/