MODULE TITLE	**Nature Inspired Computation**	**CREDIT VALUE**	**15**
MODULE CODE	**ECM3412**	**MODULE CONVENER**	**Dr Zeliang Wang (Coordinator)**

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	**11 weeks**	**0**	**0**

Number of Students Taking Module (anticipated)	**40**

DESCRIPTION - summary of the module content

There are a wide range of tasks, including product design, decision making, logistics and scheduling, pattern recognition and problem solving, which traditional computation finds it either difficult or impossible to perform. However, nature has proven to be highly adept at solving problems, making it possible to take inspiration from these methods and to create computing techniques based on natural systems. This module will provide you with the knowledge to create and apply techniques based on evolution, the intelligence of swarms of insects and flocks of animals, and the way the human brain is thought to process information. This module is appropriate for any student with an interest in natural systems, optimisation and data analysis who has some programming and mathematical experience.

Prerequisite module: ECM1410 and ECM1414 or equivalent

AIMS - intentions of the module

This module aims to provide you with the necessary expertise to create, experiment with and analyse modern nature-inspired algorithms and techniques as applied to problems in industry and industrially motivated research fields such as operations research.

The module also aims to provide you with knowledge of the limitations and advantages of each algorithm and the expertise to determine the appropriate algorithm selection for a given problem.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, **you should be able to**:

Module Specific Skills and Knowledge:
1 demonstrate a clear understanding of the difficulties associated with certain intelligence-related tasks that we would wish to program computers to do;
2 describe in broad terms, the execution of each nature-inspired algorithm;
3 discuss the circumstances and environments in which each algorithm is best employed;
4 define the different underlying natural mechanisms of each algorithm and explain how this leads to improved computational performance;
5 evaluate a difficult problem and determine the likely best algorithm selection.
Discipline Specific Skills and Knowledge:
6 implement software for addressing real-world optimisation problems with nature-inspired methods;
7 create software for addressing certain complex real-world pattern recognition problems.
Personal and Key Transferable / Employment Skills and Knowledge:
8 choose appropriate techniques for given problems from a very diverse toolbox of methods;
9 explain how new ideas in science and engineering can emerge from lateral thinking and ideas from other disciplines;
10 digest and communicate succinctly information from publications in the field to individuals unfamiliar with the material.

SYLLABUS PLAN - summary of the structure and academic content of the module

- classical vs. nature-inspired computation;
- evolutionary algorithms (including genetic programming and multi-objective evolutionary algorithms);
- ant colony optimisation;
- particle swarm optimisation;
- swarm intelligence;
- neural computation (including multi-layer perceptrons and self-organising maps);
- artificial life;
- cellular automata;
- immune system methods.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	21.00	**Guided Independent Study**	129.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled learning and teaching activities	18	Lectures
Scheduled learning and teaching activities	3	Workshops/tutorials
Scheduled learning and teaching activities	30	Individual assessed work
Guided independent study	99	Guided independent study

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Not applicable			

SUMMATIVE ASSESSMENT (% of credit)

Coursework	40	Written Exams	60	Practical Exams	

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Written exam – closed book	60	2 hours - Summer Exam Period	1, 2, 3, 4, 5, 8, 9	Oral, on request
Coursework – programming & report	40	30 hours	1, 5, 10 and one of 6, 7	Written

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-assessment
Written exam – closed book (60%)	Written exam (60%) (2 hrs)	1, 2, 3, 4, 5, 8, 9	August Ref/Def
Coursework – programming & report (40%)	Coursework – programming & report (40%)	1, 5, 10 and one of 6, 7	August Ref/Def

RE-ASSESSMENT NOTES

Reassessment will be by coursework and/or written exam in the failed or deferred element only. For referred candidates, the module mark will be capped at 40%. For deferred candidates, the module mark will be uncapped.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

ELE – http://vle.exeter.ac.uk

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Eberhart, R. Shui, Y. and Kennedy, J.	Swarm Intelligence		Morgan Kaufmann	2001		[Library]
Set	Bishop, C	Neural Networks for Pattern Recognition		Clarendon Press	1995		[Library]
Set	Mitchell, M	An Introduction to Genetic Algorithms		MIT Press	1998		[Library]
Set	Dorigo, M and Stutzle, T	Ant Colony Optimization		Bradford Book	2004		[Library]
Extended	Corne, D., Bentley, P. (eds.)	Creative Evolutionary Systems		Morgan Kaufmann	2002	1558606734	[Library]
Extended	Goldberg, D	Genetic Algorithms in Search, Optimization and Machine Learning		Addison Wesley	1989		[Library]
Extended	Wolfram; S.	Cellular Automata and Complexity		Perseus Publishing	2002	9780201626643	[Library]

CREDIT VALUE	15	ECTS VALUE	7.5
PRE-REQUISITE MODULES	ECM1410, ECM1414		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	3 (NQF Level 6)	AVAILABLE AS DISTANCE LEARNING	No
ORIGIN DATE	Tuesday 10 July 2018	LAST REVISION DATE	Friday 11 February 2022
KEY WORDS SEARCH	Evolutionary computation; neural networks; swarm intelligence; ant colony optimisation; particle swarm optimisation; artificial immune systems.		