**MODULE SPECIFICATION PROFORMA**

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| **Module Code:** | COM648 |

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| **Module Title:** | Computability and Optimisation |

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| **Level:** | 6 | **Credit Value:** | 20 |

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| **Cost Centre(s):** | GAPC | JACS3 **code**:<br>HECoS code: | I300<br>100374 |

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| **Faculty:** | Arts, Science and Technology | **Module Leader:** | Prof. Vic Grout |

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| Scheduled learning and teaching hours | 24 hrs |
| Guided independent study | 176 hrs |
| Placement | 0 hrs |
| **Module duration (total hours)** | 200 hrs |

| **Programme(s) in which to be offered (not including exit awards)** | Core | Option |
|---|---|---|
| BSc (Hons) Computer Science | ✓ | ☐ |
| BSc (Hons) Computer Science (with Industrial Placement) | ✓ | ☐ |

| **Pre-requisites** |
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| None |

**Office use only**
Initial approval: 28/11/2018 Version no:1
With effect from: 01/09/2019
Date and details of revision: Version no:

**Module Aims**

To introduce students to, and develop practical experience of, key concepts in problem solvability, computational complexity and exact and inexact (heuristic) optimisation; ranging from theoretical analysis of classical graph problems to coded implementation of modern metaheuristics and evolutionary computing.

**Intended Learning Outcomes**

Key skills for employability

| | |
|---|---|
| KS1 | Written, oral and media communication skills |
| KS2 | Leadership, team working and networking skills |
| KS3 | Opportunity, creativity and problem solving skills |
| KS4 | Information technology skills and digital literacy |
| KS5 | Information management skills |
| KS6 | Research skills |
| KS7 | Intercultural and sustainability skills |
| KS8 | Career management skills |
| KS9 | Learning to learn (managing personal and professional development, self-management) |
| KS10 | Numeracy |

| At the end of this module, students will be able to | | Key Skills | |
|---|---|---|---|
| 1 | Demonstrate an in-depth understanding of the underlying concepts of optimisation problems; their complexity and problem-solving algorithms. | KS3 | KS4 |
| | | KS5 | KS6 |
| | | KS9 | KS10 |
| 2 | Compare and contrast appropriate graph problems and algorithms, making appropriate selections in a variety of scenarios. | KS3 | KS4 |
| | | KS5 | KS6 |
| | | KS9 | KS10 |
| 3 | Select and apply different appropriate exact and heuristic optimisation techniques in complex real-world situations. | KS3 | KS4 |
| | | KS5 | KS6 |
| | | KS9 | KS10 |
| 4 | Implement appropriate exact and heuristic optimisation techniques as working programs in a high-level language, balancing objectives with constraints. | KS3 | KS4 |
| | | KS5 | KS6 |
| | | KS9 | KS10 |

**Transferable skills and other attributes**

**Derogations**

*None*

**Assessment:**

Indicative Assessment Tasks:

This module will be assessed through a group 'challenge' and an (individual) examination.

The examination will cover underlying concepts described in the lectures and researched through independent study. The weighting of the examination is 40%.

The weighting of the group challenge is 60% (work/report 40%+ presentation/viva 20%). The students will be asked to solve either a real-world continuous optimisation problem or a complex combinatorial optimisation problem. A range of evolutionary/heuristic algorithms will have to be applied and compared before a final approach is agreed and taken forward. The challenge will be undertaken by groups of two or three students. Their outcomes (algorithms and results) will be presented in a joint report but defended by individual viva. (Thus each group member will have a common and individual group mark component.)

| Assessment number | Learning Outcomes to be met | Type of assessment | Weighting (%) | Duration (if exam) | Word count (or equivalent if appropriate) |
|---|---|---|---|---|---|
| 1 | 1 2 | Examination | 40 | 2 Hours | |
| 2 | 3 4 | Group Project | 60 | 20 mins | 3,000 |

**Learning and Teaching Strategies:**

This module will be delivered through lectures, open-ended student experiments, tutorials and guided independent studies. Students will also discuss and exchange information through peer group discussions and presentations (using a VLE platform).

**Syllabus outline:**

Computational intractability, decidability and solvability
Optimisation objectives and constraints, combinatorial search and computational complexity ('O' notation)
Graph problems and algorithms
Complexity classes (P, NP, NP-complete)
Exact and heuristic methods; greedy algorithms and local search
Metaheuristics and genetic algorithms (ant colony optimisation, differential evolution, surrogate modelling, etc.)
Hard and soft constraints in multi-objective optimisation
Real-world optimisation and engineering applications
Evaluation of real-world solutions

**Indicative Bibliography:**

**Essential reading**

COM627 Moodle Page

Arora, R.K. (2015), *Optimization: Algorithms and Applications*. Boca Raton, FL: Taylor and Francis.

**Other indicative reading**

Eiben A. E. and Smith J. E. (2015) *Introduction to Evolutionary Computing.* 2nd ed. New York: Springer

Michalewicz, A. (2011), *Genetic Algorithms + Data Structure = Evolution Programs*. 3rd ed. New York: Springer.

Dorigo M. and Stutzle, T. (2004), *Ant Colony Optimization.* MIT Press.

IEEE Transactions on Evolutionary Computation

DE homepage: http://www1.icsi.berkeley.edu/~storn/code.html

ACO homepage: http://iridia.ulb.ac.be/~mdorigo/ACO/