COIT29224 *Evolutionary Computation*
Term 1 - 2024

Profile information current as at 05/09/2024 01:34 pm

General Information

Overview
Evolutionary Computation, an area of Artificial Intelligence, comprises machine learning optimisation and classification paradigms based on principles from biological sciences. In this unit, you will explore how principles from theories of evolution and natural selection can be used to construct intelligent systems. You will learn the theoretical concepts of representation, selection, reproduction, and recombination. You will apply evolutionary algorithms, such as evolution strategies, genetic programming, and particle swarm optimisation to tackle science, engineering, social, and business problems and opportunities.

Details
Career Level: *Postgraduate*
Unit Level: *Level 9*
Credit Points: *6*
Student Contribution Band: *8*
Fraction of Full-Time Student Load: *0.125*

Pre-requisites or Co-requisites
Pre-requisite: COIT20277 Introduction to Artificial Intelligence
Important note: Students enrolled in a subsequent unit who failed their pre-requisite unit, should drop the subsequent unit before the census date or within 10 working days of Fail grade notification. Students who do not drop the unit in this timeframe cannot later drop the unit without academic and financial liability. See details in the Assessment Policy and Procedure (Higher Education Coursework).

Offerings For Term 1 - 2024

- Online

Attendance Requirements
All on-campus students are expected to attend scheduled classes – in some units, these classes are identified as a mandatory (pass/fail) component and attendance is compulsory. International students, on a student visa, must maintain a full time study load and meet both attendance and academic progress requirements in each study period (satisfactory attendance for International students is defined as maintaining at least an 80% attendance record).

Website
This unit has a website, within the Moodle system, which is available two weeks before the start of term. It is important that you visit your Moodle site throughout the term. Please visit Moodle for more information.

Class and Assessment Overview

Recommended Student Time Commitment

Each 6-credit Postgraduate unit at CQUniversity requires an overall time commitment of an average of 12.5 hours of study per week, making a total of 150 hours for the unit.

Class Timetable

Regional Campuses
Bundaberg, Cairns, Emerald, Gladstone, Mackay, Rockhampton, Townsville

Metropolitan Campuses
Adelaide, Brisbane, Melbourne, Perth, Sydney

Assessment Overview

1. **Practical Assessment**
Weighting: 25%
2. **Practical Assessment**
Weighting: 35%
3. **Written Assessment**
Weighting: 40%

Assessment Grading

This is a graded unit: your overall grade will be calculated from the marks or grades for each assessment task, based on the relative weightings shown in the table above. You must obtain an overall mark for the unit of at least 50%, or an overall grade of 'pass' in order to pass the unit. If any 'pass/fail' tasks are shown in the table above they must also be completed successfully ('pass' grade). You must also meet any minimum mark requirements specified for a particular assessment task, as detailed in the 'assessment task' section (note that in some instances, the minimum mark for a task may be greater than 50%). Consult the University's Grades and Results Policy for more details of interim results and final grades.

CQUniversity Policies

All University policies are available on the CQUniversity Policy site.
You may wish to view these policies:

- Grades and Results Policy
- Assessment Policy and Procedure (Higher Education Coursework)
- Review of Grade Procedure
- Student Academic Integrity Policy and Procedure
- Monitoring Academic Progress (MAP) Policy and Procedure – Domestic Students
- Monitoring Academic Progress (MAP) Policy and Procedure – International Students
- Student Refund and Credit Balance Policy and Procedure
- Student Feedback – Compliments and Complaints Policy and Procedure
- Information and Communications Technology Acceptable Use Policy and Procedure

This list is not an exhaustive list of all University policies. The full list of University policies are available on the CQUniversity Policy site.

Previous Student Feedback

Feedback, Recommendations and Responses

Every unit is reviewed for enhancement each year. At the most recent review, the following staff and student feedback items were identified and recommendations were made.

Feedback from Student evaluation

Feedback
Expect to see more examples for particle swarm optimisation.

Recommendation
Include more example solutions on particle swarm optimisation.

Unit Learning Outcomes

On successful completion of this unit, you will be able to:

1. Formulate an evolutionary computation search or optimisation problem by analysing an authentic case or scenario
2. Design an evolutionary algorithm for a problem applying the core evolutionary computation concepts and mechanisms
3. Build a software application to implement an evolutionary algorithm for a complex search or optimisation problem
4. Write an article that evaluates the performance and interprets the results of your software application of evolutionary computation paradigm to an authentic problem.

The Skills Framework for the Information Age (SFIA) standard covers the skills and competencies related to information and communication technologies. SFIA defines levels of responsibility and skills. SFIA is adopted by organisations, governments and individuals in many countries. SFIA is increasingly being used when developing job descriptions and role profiles. SFIA can be used by individuals for creating personal skills profile. The Australian Computer Society (ACS) recognises the SFIA and provides MySFIA for ACS members to build a skills profile.
This unit contributes to the following workplace skills as defined by SFIA 7 (the SFIA code is included):

- Software design (SWDN)
- Programming/software development (PROG)
- Testing (TEST)
- Application Support (ASUP).

Alignment of Learning Outcomes, Assessment and Graduate Attributes

— N/A Level · • Introductory Level · • Intermediate Level · • Graduate Level · ◦ Professional Level · ◦ Advanced Level

Alignment of Assessment Tasks to Learning Outcomes

Assessment Tasks	Learning Outcomes			
	1	2	3	4
1 - Practical Assessment - 25%	•	•	•	
2 - Practical Assessment - 35%	•	•	•	
3 - Written Assessment - 40%				•

Alignment of Graduate Attributes to Learning Outcomes

Graduate Attributes	Learning Outcomes			
	1	2	3	4
1 - Knowledge	◦	◦	◦	◦
2 - Communication		◦		◦
3 - Cognitive, technical and creative skills	◦	◦	◦	
4 - Research				◦
5 - Self-management			◦	
6 - Ethical and Professional Responsibility				◦
7 - Leadership			◦	
8 - Aboriginal and Torres Strait Islander Cultures				

Alignment of Assessment Tasks to Graduate Attributes

Assessment Tasks	Graduate Attributes							
	1	2	3	4	5	6	7	8
1 - Practical Assessment - 25%	◦	◦	◦		◦			
2 - Practical Assessment - 35%	◦	◦	◦		◦		◦	
3 - Written Assessment - 40%	◦	◦		◦		◦		

Textbooks and Resources

Textbooks

COIT29224

Prescribed

Particle Swarm Optimization
(2006)
Authors: Maurice Clerc
Wiley
ISBN: 9780470612163
Binding: eBook

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)

Referencing Style

All submissions for this unit must use the referencing style: Harvard (author-date)
For further information, see the Assessment Tasks.

Teaching Contacts

Sujan Chowdhury Unit Coordinator
s.chowdhury2@cqu.edu.au

Schedule

Week 1 - 04 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic
	Chapter 3 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons. Available here.	
PARTICLE SWARM OPTIMIZATION (PSO): BASIC ALGORITHM & PYTHON IMPLEMENTATION	Tharwat, A., Gaber, T., Hassanien, A.E. and Elnaghi, B.E., 2017. Particle swarm optimization: a tutorial. In Handbook of research on machine learning innovations and trends (pp. 614-635). IGI global. Available here.	

Week 2 - 11 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic
PSO: ALGORITHMIC EFFICIENCY & BENCHMARKS WITH PYTHON EXAMPLE	• Chapter 1 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons. • Chapter 6 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons.	

Week 3 - 18 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic

PSO: PARAMETER SETTINGS	Chapter 7 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons.	

Week 4 - 25 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic
PSO: PROBLEMS & APPLICATIONS - PART ONE	• Chapter 10 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons. • Chapter 13 Clerc, M., 2006. Particle Swarm Optimization. John Wiley & Sons. • Clerc, M., Standard Particle Swarm Optimisation: From 2006 to 2011, 2012. URL http://clerc. maurice. free. fr/pso/SPSO_ descriptions. pdf. Zambrano-Bigiarini, M., Clerc, M. and Rojas, R., 2013, June. Standard particle swarm optimisation 2011 at cec-2013: A baseline for future pso improvements. In 2013 IEEE Congress on Evolutionary Computation (pp. 2337-2344). IEEE.	

Week 5 - 01 Apr 2024

Module/Topic	Chapter	Events and Submissions/Topic
PSO: PROBLEMS & APPLICATIONS - PART TWO		**Assessment 1 - Solve real world problem using optimisation algorithm** Due: Week 5 Friday (5 Apr 2024) 11:45 pm AEST

Vacation Week - 08 Apr 2024

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 15 Apr 2024

Module/Topic	Chapter	Events and Submissions/Topic
INTRODUCTION TO EVOLUTION STRATEGY (ES)	Beyer, H.G. and Schwefel, H.P., 2002. Evolution strategies–a comprehensive introduction. Natural Computing, 1(1), pp.3-52.	

Week 7 - 22 Apr 2024

Module/Topic	Chapter	Events and Submissions/Topic
THE BASIC ES ALGORITHM	Chapter 1 from Niching in derandomized evolution strategies and its applications in quantum Evolution Strategy A comprehensive introduction - Section 4	

Week 8 - 29 Apr 2024

Module/Topic	Chapter	Events and Submissions/Topic
ADAPTATION OF STRATEGY PARAMETERS & CO-VARIANCE MATRIX		**Assessment 2 - Build software solution using Evolution Strategy Optimization (ESO).** Due: Week 8 Friday (3 May 2024) 11:45 pm AEST

Week 9 - 06 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
COVARIANCE MATRIX ADAPTATION EVOLUTION	The CMA evolution strategy	

Week 10 - 13 May 2024

Module/Topic	Chapter	Events and Submissions/Topic

INTRODUCTION TO TREE-BASED GENETIC PROGRAMMING	Chapter 2. A field guide to genetic programming, Poli, R., Langdon, W.B.,McPhee, N.F. and Koza, J.R., 2008	

Week 11 - 20 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
GENETIC PROGRAMMING PREPARATORY STEPS	Chapter 3. A field guide to genetic programming, Poli, R., Langdon, W.B., McPhee, N.F. and Koza, J.R., 2008,	

Week 12 - 27 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
AUTOMATICALLY DEFINED FUNCTIONS		

Review/Exam Week - 03 Jun 2024

Module/Topic	Chapter	Events and Submissions/Topic
		Assessment 3 - Application of Genetic Programming (GP) to develop solution for a regression problem. Due: Review/Exam Week Friday (7 June 2024) 11:45 pm AEST

Exam Week - 10 Jun 2024

Module/Topic	Chapter	Events and Submissions/Topic

Term Specific Information

Designing programs applying evolutionary computation to tackle many real-world optimisation problems are very sought-after skill.

- This unit teaches seemingly complex topics delivered simply to suit your skills.
- Regular studies are required to follow and master the topics taught in this unit.
- Ensure that you attend classes regularly and clarify your doubts along the way.
- Actively engage in a Q&A forum to share and discuss ideas on topics learned.

Read the Unit Profile carefully, and understand the relevant university policies including those on plagiarism, assessment extension, and review of grades.
Clarify Your Doubts in a Video Chat with the Unit Coordinator during the lecture and tutorial.
Regards
Unit Coordinator
Dr. Sujan Chowdhury
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School of Engineering and Technology
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Phone: +61 4269 37599
Email: s.chowdhury2@cqu.edu.au

Assessment Tasks

1 Assessment 1 - Solve real world problem using optimisation algorithm

Assessment Type
Practical Assessment

Task Description
Assessment 1 will be an individual practical assessment which is based on the contents from weeks 1-4. Through this assessment, students will demonstrate their ability to select the appropriate optimisation algorithm to solve a real-world problem. This assessment will address the following unit learning outcome

- Formulate an evolutionary computation search or optimisation problem by analysing an authentic case or scenario

Assessment Due Date
Week 5 Friday (5 Apr 2024) 11:45 pm AEST

Return Date to Students
Week 6 Friday (19 Apr 2024)

Weighting
25%

Assessment Criteria

- Writing professional academic report
- Modularise Code
- Use of repo management and practice agile
- Evaluate and design the best optimisation technique for the problem
- Successful implementation of the optimisation technique to solve the problem

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Online via Moodle

Graduate Attributes

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Self-management

Learning Outcomes Assessed

- Formulate an evolutionary computation search or optimisation problem by analysing an authentic case or scenario
- Design an evolutionary algorithm for a problem applying the core evolutionary computation concepts and mechanisms
- Build a software application to implement an evolutionary algorithm for a complex search or optimisation problem

2 Assessment 2 - Build software solution using Evolution Strategy Optimization (ESO).

Assessment Type
Practical Assessment

Task Description
Assessment -2 is an individual work where students have to write Python code to build the software solution using ES. Students have to design and build the software solution applying the ES technique to solve the problem(s) and have to justify the reason for choosing the specific parameters. This assessment will address the following unit learning outcome

- Design an evolutionary algorithm for a problem applying the core evolutionary computation concepts and mechanisms

Assessment Due Date
Week 8 Friday (3 May 2024) 11:45 pm AEST

Return Date to Students
Week 10 Friday (17 May 2024)

Weighting
35%

Assessment Criteria

- Build a robust solution for the optimization problem by analysing an authentic case
- Comparison with other techniques
- Unit testing
- Apply core Evolutionary Strategy (ES)

Referencing Style

- Harvard (author-date)

Submission
Online

Graduate Attributes

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Self-management
- Leadership

Learning Outcomes Assessed

- Formulate an evolutionary computation search or optimisation problem by analysing an authentic case or scenario
- Design an evolutionary algorithm for a problem applying the core evolutionary computation concepts and mechanisms
- Build a software application to implement an evolutionary algorithm for a complex search or optimisation problem

3 Assessment 3 - Application of Genetic Programming (GP) to develop solution for a regression problem.

Assessment Type
Written Assessment

Task Description
Assessment 3 is an individual task where students have to develop an application using Genetic Programming (GP) to solve a regression problem. Students will utilise their learning from Weeks 9-12 to build a robust solution. This assessment will address the following unit learning outcomes

- Build a software application to implement an evolutionary algorithm for a complex search or optimisation problem
- Write an article that evaluates the performance and interprets the results of your software application of the evolutionary computation paradigm to an authentic problem

Assessment Due Date
Review/Exam Week Friday (7 June 2024) 11:45 pm AEST

Return Date to Students

On certification of grade

Weighting
40%

Assessment Criteria
The students will be marked based on their ability to:

- choose appropriate optimisation techniques to solve authentic problems including social innovation challenges
- justify the reason for this choice
- develop modularise Python code
- learn to use industry tools to solve problems
- learn ethics for system development

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Online via Moodle

Graduate Attributes

- Knowledge
- Communication
- Research
- Ethical and Professional Responsibility

Learning Outcomes Assessed

- Write an article that evaluates the performance and interprets the results of your software application of evolutionary computation paradigm to an authentic problem.

Academic Integrity Statement

As a CQUniversity student you are expected to act honestly in all aspects of your academic work.

Any assessable work undertaken or submitted for review or assessment must be your own work. Assessable work is any type of work you do to meet the assessment requirements in the unit, including draft work submitted for review and feedback and final work to be assessed.

When you use the ideas, words or data of others in your assessment, you must thoroughly and clearly acknowledge the source of this information by using the correct referencing style for your unit. Using others' work without proper acknowledgement may be considered a form of intellectual dishonesty.

Participating honestly, respectfully, responsibly, and fairly in your university study ensures the CQUniversity qualification you earn will be valued as a true indication of your individual academic achievement and will continue to receive the respect and recognition it deserves.

As a student, you are responsible for reading and following CQUniversity's policies, including the **Student Academic Integrity Policy and Procedure**. This policy sets out CQUniversity's expectations of you to act with integrity, examples of academic integrity breaches to avoid, the processes used to address alleged breaches of academic integrity, and potential penalties.

What is a breach of academic integrity?
A breach of academic integrity includes but is not limited to plagiarism, self-plagiarism, collusion, cheating, contract cheating, and academic misconduct. The Student Academic Integrity Policy and Procedure defines what these terms mean and gives examples.

Why is academic integrity important?
A breach of academic integrity may result in one or more penalties, including suspension or even expulsion from the University. It can also have negative implications for student visas and future enrolment at CQUniversity or elsewhere. Students who engage in contract cheating also risk being blackmailed by contract cheating services.

Where can I get assistance?
For academic advice and guidance, the Academic Learning Centre (ALC) can support you in becoming confident in completing assessments with integrity and of high standard.

What can you do to act with integrity?

Be Honest
If your assessment task is done by someone else, it would be dishonest of you to claim it as your own

Seek Help
If you are not sure about how to cite or reference in essays, reports etc, then seek help from your lecturer, the library or the Academic Learning Centre (ALC)

Produce Original Work
Originality comes from your ability to read widely, think critically, and apply your gained knowledge to address a question or problem