

# 7SENG010W

## Data Structures & Algorithms





# Course Overview

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# The Aims of the module

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The module provides the knowledge required to select, design, implement and analyse a wide range of standard data, structures and algorithms.

Examples are provided of how these can be used within a range of typical applications. The data structures and algorithms are implemented using an object oriented language. The module also covers the use of standard libraries.

- It is intended to provide students with sufficient knowledge, skills and experience to enable them to understand **data structures and algorithms**
- As part of the assessment of this module, the student will undertake assignments that use the programming language Java & C# .



# Aims and Objectives

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- The module aims to provide students with an introduction to data structures and algorithms using an object-oriented programming language (e.g., Python, C#, Java).
- It covers a wide range of Abstract Data Types (ADTs), including linear data structures, tree structures, and graph structures etc.
- The module also addresses various standard algorithms and techniques for algorithm analysis. In addition, it introduces students to the types of data structures and algorithms available within the standard libraries of typical object-oriented languages..



# Syllabus

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## ■ Data Structures and Concepts:

- Categories of data structures e.g. linear, non-linear.
- Abstract data types (ADTs), e.g. data + operations.
- Types of algorithms, e.g. brute force.
- Analysis of algorithms, e.g. Big "O"

## ■ Data structures

- Representation & use of: Arrays, Lists, Stacks, Queues,
- Trees, Heaps, Graphs.
- .NET Framework Collection classes

## ■ Algorithms

- Searching, sorting, traversal of data structures, path finding.

## ■ Analysis of Algorithms

- Complexity of an Algorithm, Types of algorithms, analysis metrics, analysis techniques.



## Teaching and Learning Methods and schedule

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The timetabled activity is divided equally between whole-class lectures and laboratory work, with typically eleven sessions of each.

The laboratory sessions are held both online and on-site, using the advanced thin client application AppAnywhere.

The programming languages for this module are C#, Java and Python.





# Teaching and Learning schedule (what should be covered )

Week	Lecture Topic
1	Introduction to Module and DS & Alg Concepts
2	Arrays & Algorithms
3	Introduction to Lists
4	Stacks & Queues
5	Introduction to Trees
6	University Engagement, Skills and Employability Week
7	Balanced Trees (AVL, B)
8	Priority Queues (Heaps)
9	Introduction to Graphs
10	Graph Traversal (DFS, BFS)
11	Graphs Shortest Paths (Dijkstra)
12	Classic Graph Problems (MST, Euler, Hamilton)(optional topics)



# Tutorial Activities

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- Answer questions and draw diagrams about data structures and algorithms.
- Walk through code and pseudocode algorithms related to data structures and report the outcomes.
- Complete partially implemented ADTs and their associated algorithms.
- Implement ADTs and their associated algorithms based on pseudocode.
- Analyze algorithms with respect to standard metrics, e.g.,  $O(N)$ .
- Use online resources to investigate and analyze data structures and algorithms.
- Research and investigate data structures and/or algorithms not covered or fully covered in the lectures.





# Useful Books and Web Links

## \* Essential Reading \*

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- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2022), *Introduction to Algorithm 4<sup>th</sup> Edition*
- Marcin Jamro(2018), *C# Data Structures and Algorithms : Explore the possibilities of C# for developing a variety of efficient applications*
- Mark Weiss (2011), *Data Structures and Algorithm Analysis in Java 3rd Edition*
- Bradley N. Miller and David L. Ranum(2011) *Problem Solving with Algorithms and Data Structures using Python*
- Narasimha Karumanchi (2023), *Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles*
- Rod Stephens(2013), *Essential Algorithms : A Practical Approach to Computer Algorithms*  
And (2011), *Algorithms 4<sup>th</sup> Ed*

# Useful Web Links and tools

Microsoft Visual Studio (2022 Community Edition)

<https://visualstudio.microsoft.com/downloads/>

- Microsoft's online .NET & C documentation:

<https://docs.microsoft.com/en-gb/dotnet/csharp/>

- Java APIs documentation: <https://docs.oracle.com/javase/8/docs/api/>

- Data Structures & Algorithms Visualization tool, David Galles, University of San Francisco <https://www.cs.usfca.edu/~galles/visualization/Algorithms.html>

- DEMOS – a graph plotting tool.

<https://www.desmos.com/calculator>

- Mathscard – useful maths definitions for analysing algorithms.

<https://www.mathscard.co.uk/online/algebra-graphs/>

- Calculator.net – Log base 2 Calculator <https://www.calculator.net/log-calculator.html?base=2>

- WolframAlpha Calculator & Graph Plotter for analysing algorithms.

<https://www.wolframalpha.com/examples/mathematics/plotting-and-graphing/>



# Course assessment

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Assessment	Type	Weight (%)	Due Date
Group Coursework	Mini-Project	50	May
In-Class Test	In-Class Test	50	Week12



## Group Coursework (50%)

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- Work in a group of 3 or 5 to design & implement data structures & algorithms to produce an application that solves a problem.
- Produce a report documenting the development of the application, including an analysis of the data structures and algorithms
- Group presentation of the work to your peers after submitting the work.
- **In-Class Test (50%)**
  - Covering the module topics, closed book, done under exam conditions, duration 90 minutes.



# Lectures and Tutorials

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- All lectures will be delivered synchronously online via Blackboard Collaborate sessions/MS Teams and onsite. They will be recorded using Panopto/MS Teams which provides video presentations.
- Practical tutorials guide you and teach you how to apply and use the concepts in practice.
- Learning how to program takes time. Make sure you understand the lectures and complete the experiments and exercises.
- You have been allocated to tutorial groups on Thursdays (i.e., gp1 and gp2 )



Please familiarize yourself with the features of [Blackboard](#).

## Important documents:

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- **Learning Resources** section will include key learning material. It will also provide links to the module reading list and a discussion board for you to ask questions on the module at any time.
- **Panopto Recordings** will link to all recorded lectures.
- **Blackboard Collaborate Ultra** All tutorials and seminars for the semester will be delivered synchronously online, i.e The tutorial/seminar content will be delivered live.
- **Assessment** section includes assessment details and assessment submission links.



Lectures and tutorials:are timetabled as follows:

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	<u>Time</u>	<u>Location</u>	<u>Lecturer &amp; Tutor)</u>
<b><u>Lectures</u></b>	<u>Thursday 9:30-11:00</u>	<u>Copland 5.107</u>	<u>Dr. David Huang</u>
<b><u>Tutorials</u></b> <b><u>Gp1 &amp; Gp2</u></b>	<u>Gp2 Thursday 11:00-12:30</u> <u>Gp1 Thursday 15:00-16:30</u> <u>See timetable</u>	<u>Copland LG106</u> <u>Copland LG102</u>	<u>Dr. David Huang</u>

