Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2022-2023
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Peyrin Thomas
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Course Title	ALGORITHMS FOR THE REAL WORLD
Course Code	MH3400
Academic Units	4
Contact Hours	65
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	{MH1201, MH1301, MH1402, MH2500} OR {MH1201, MH1301, MH1403, MH2500} OR{MH1301, MH1403, MH2500, MH2802}
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

With the development of digitalization, algorithms have become more and more pervasive inour lives, and this trend is likely to accelerate in the future. Almost all industries are now widely embracing the possibilities offered by efficient algorithms. How can companies with a huge amount of data search in their database? How can your map application find the shortest path from your location to a certain destination? How can Internet packets be routed to maximize the efficiency of the network? How can you render electricity distribution more efficient? How booking websites manage to find for you the best hotels according to several criterions? Etc. The aim of this course is to show you some crucial algorithmic paradigms, while using strong connections to real-world applications as examples. This will allow you to learn new problem-solving techniques and very important algorithms, while developing your general knowledge in where and how algorithms are actually used in real-world applications.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Formulate a problem and express its solution in such a way that a computer can effectively carry it out
ILO 2	Code efficient algorithms in Python for sorting or searching into large amount of data
ILO 3	Represent certain real-life problem as a graph instance
ILO 4	Apply efficient algorithms to solve realistic problems related to graphs
ILO 5	Identify what algorithmic paradigm to use for various classical types of problems

Course Content

Complexity
Divide and Conquer
(balanced) Binary search trees
Advanced sorting
Dynamic programming
Linear programming
Integer programming
Graphs
Shortest path
Minimum spanning trees
Network flow

Reading and References (if applicable)

Algorithm Design and Applications, Michael T. Goodrich and Roberto Tamassia, WILEY, 1stEdition, ISBN-13 978-1118335918

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Complexity	1	Presentation slides are lecture notes.	In-person	
2	Divide and Conquer	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
3	(balanced) Binary search trees	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
4	Advanced sorting	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
5	Dynamic programming	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
6	Linear programming	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
7	Midterm	5		In-person	No lecture (midterm), no lab session/tutorial.
8	Integer programming	1,2,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
9	Graphs	1,2,3, 4,5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
10	Shortest path	1, 2, 3, 4, 5,	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
11	Minimum spanning trees	1, 2, 3, 4, 5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	
12	Network flow	1, 2, 3, 4, 5	Presentation slides are lecture notes. Programming assignment related to the week's course.	In-person	

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
13	Revision	5	Revision lecture, no lab session/tutorial.	In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures (39 hours)	Lectures will serve to introduce the algorithmic concepts necessary for the course, as well as examples to illustrate these concepts (LO 1,3,4,5).
Laboratories (26 hours)	Practice is really key to this course and tutorials/lab sessions play a central role. During the tutorials/lab sessions, the students are expected to try to solve the tutorial exercises by themselves using Python, and only check the solutions provided after having spent some efforts solving the problem. This will develop the ability of the students to understand a problem and design algorithms to solve it. Tutors will help the students by guiding them in finding the solution by themselves. (LO 1,2,3,4,5)

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Assignment)	1,2,3,4	1. a, d 2. a 4. a 5. a	25		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Midterm exam)	1,3,4,5	1. a 2. a	25		Individual	Analytic	Multistructural
3	Summative Assessment (EXAM): Others(Final examination)	1,3,4,5	1. a 2. a	50		Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

These are the relevant SPMS-MAS Graduate Attributes.
1. Competence
a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
d. Use computer technology to solve problems, and to communicate mathematical ideas
2. Creativity
a. Critically assess the applicability of mathematical tools in the workplace
4. Civic-mindedness
a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society
5. Character
a. Act in socially responsible and ethical ways in line with the societal expectations of a mathematics professional, particularly in relation to analysis of data, computer security, numerical computations and algorithms

Formative Feedback

Feedback on common mistakes and the level of difficulty of the problems will be discussed during the tutorial/lab sessions (LO 1,2,3,4,5)
Comments on answers and common errors are given to you after the midterm/final exams are marked (LO 1,3,4,5)
For laboratory assignments, individual feedback will be provided to you through the evaluation of your submissions (LO 1,2,3,4,5)

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Creative Thinking	Basic
Digital Fluency	Advanced
Learning Agility	Basic
Problem Solving	Advanced
Sense Making	Intermediate

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

(1) General
As a student of the course, you are expected to attend the lectures and the tutorial/labsessions, and to take all scheduled assignments by due dates. Not submitting a lab assignment before the corresponding deadline will be counted as no submission. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements they have missed. As a student of the course, you are required to abide by both the University Code of Conductand the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how you can report suspected misconduct. The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing. These policies and codes concerning students can be found in the following link. http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx

Policy (Absenteeism)

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about

how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Appendix 1: Assessment Rubrics

Rubric for Laboratories: Assignment (25%)

Description: You will have to submit a programming assignment in Python, relative to the lecture topic of the week. This assignment is an individual assessment.

Assessment:

Understanding of the problem and solution targeted (40% - LO 1,3,4,5). A good understanding means that all different subcases of the problem are taken into account and planned for in the solution. A medium understanding means that most subcases of the problem are taken into account and planned for in the solution. A poor understanding means that many subcases of the problem are not taken into account nor planned for in the solution.

Validity of the implementation (40% - LO 2). A valid implementation must run without errors for valid inputs, and return the proper solution all the time.

Clarity of the code produced (20% - LO 2). The code must be well organized and commented.

You will have to analyze given problems, propose and analyze a solution, implement it and test it. It is important that the solution is properly explained and justified, and that the code is clear and tested.

Rubric for Mid-semester Quiz: Midterm exam (25%)

Description: midterm exam. This exam is closed book, on-paper, and will consist of various parts (from simple knowledge questions to more complex problem-solving exercises).

Assessment: valid answers are required for simple knowledge questions, while comprehension of the problem and quality of the solution will be more important for problem-solving questions - LO 1,3,4,5

Rubric for Examination: Final exam (50%)

Description: final exam. This exam is closed book, on-paper, and will consist of various parts (from simple knowledge questions to more complex problem-solving exercises).

Assessment: valid answers are required for simple knowledge questions, while comprehension of the problem and quality of the solution will be more important for problem-solving questions - LO 1,3,4,5