COURSE OUTLINE: BS1009

Course Title	**Introduction to Computational Thinking**		
Course Code	**BS1009**		
Offered	Study Year 1, Semester 2		
Course Coordinator	Marek Mutwil (Asst Prof)	mutwil@ntu.edu.sg	6904 7503
Pre-requisites	None		
AU	3		
Contact hours	Technology-enhanced Learning: 20, Laboratories: 15, Tutorials: 9, Lectures: 4		
Approved for delivery from	AY 2019/20 semester 1		
Last revised	12 Nov 2019, 14:02		

Course Aims

Computational thinking (CT) is a problem-solving process that can be used to develop solutions for a wide range of problems across various disciplines, including math, science, engineering, business, finance and humanities. The aim of this course is to take you from having no prior experience of thinking in a computational manner to a point where you can apply abstraction, decomposition and algorithm design to solve some basic problems in sciences. In addition, the course will include topics to raise awareness of the socio-ethical issues arising from the pervasiveness of computing technology and impending trends.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Describe how computer hardware and software work together
2. Explain what tasks the different programming languages (e.g., Fortran, Python, R, Perl) can be applied to
3. Use the basic program constructs, such as loops and ‘if/else’ statements
4. Use abstraction and decomposition to solve complex problems
5. Apply pattern recognition to define universal solutions to different problems
6. Design algorithms to implement solutions to problems
7. Describe the limitations and trends of computing
8. Explain socio-ethical ramifications of pervasiveness of computing in our lives

Course Content

Computer hardware and software

Programming languages

Basic programming constructs: if/else, for loop and visual programming

Problem solving with abstraction and decomposition

Problem solving with pattern recognition

Implementing algorithms to solve problems

Limits of computing and algorithmic complexity

Current computing trends such as cloud, blockchain, quantum computing

Issues and ramifications of pervasiveness of computers

Assessment

Component	Course ILOs tested	SBS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Technology-enhanced Learning					
Multiple Choice Questions 1	1, 2, 3, 4, 5, 6, 7, 8	**1.** d **2.** a, b, d, e, f, g **3.** a **4.** a **5.** a, b, c, d, e **6.** a, c, d **7.** a, b, c, d	20	individual	See Appendix for rubric
Tutorials					
Project	3, 4, 5, 6	**2.** a, b, c, d, e, f, g, h **3.** a, b **4.** a **5.** a, b, c, d, e **7.** a, b, c, d	30	team	See Appendix for rubric
Mid-semester Quiz					
Multiple Choice Questions	3, 4, 5, 6	**1.** d **2.** a, b, d, e, f, g **3.** a **5.** a, b, c, d, e **7.** a, b, c	30	individual	See Appendix for rubric
Short Answer Questions	3, 4, 5, 6	**1.** d **2.** a, b, d, e, f, g **3.** a **5.** a, b, c, d, e **7.** a, b, c, d	20	individual	See Appendix for rubric
		Total	**100%**		

These are the relevant SBS Graduate Attributes.

1. **Recognize the relationship and complexity between structure and function of all forms of life, resulting from an academically rigorous in-depth understanding of biological concepts**

   d. Explain the relationship between structure and function of all forms of life at the organism level

2. **Critically evaluate and analyze biological information by applying the knowledge, scientific methods and technical skills associated with the discipline**

   a. Identify the assumptions behind scientific problems and issues

   b. Create and evaluate hypotheses

   c. Create abstract models of data

   d. Design experiments relevant to authentic problems and their models

   e. Analyze the validity of qualitative and quantitative scientific data

   f. Evaluate results in primary biological literature

   g. Evaluate the results of their own experiments and decide on the next step

   h. Identify unintended results as opportunities for discovery

3. **Develop and communicate biological ideas and concepts relevant in everyday life for the benefit of society**

   a. Simplify and explain scientific concepts and results of experiments to a non-biologist (avoiding jargon)

   b. Display and explain scientific results clearly and persuasively to peers both verbally and in writing (includes the ability to graph data appropriately and accurately).

4. **Acquire transferable and entrepreneurial skills for career development**

   a. Demonstrate innovative approaches to solving problems in biological science, leading to new approaches or techniques

5. **Develop communication, creative and critical thinking skills for life-long learning**

   a. Learn independently and then share that knowledge with others

   b. Learn collaboratively and be willing to share expertise with peers

   c. Demonstrate critical thinking skills such as analysis, discrimination, logical reasoning, prediction and transforming knowledge

   d. Question the assumptions, sources, and contexts of scientific investigation

   e. Demonstrate good observation skills and a curiosity about the world

6. **Develop codes of social responsibility and scientific ethics, particularly in relation to biological advancement and applications**

   a. Debate the ethical implications of scientific processes and results

   c. Respect regulations involving plagiarism and copyright

   d. Respect requirements regarding confidentiality, data protection, conflict of interest, and falsification of data

7. **Demonstrate information literacy and technological fluency**

   a. Locate and evaluate information needed to make decisions, solve problems, design experiments, and understand scientific data

   b. Work effectively with common technologies in biology

   c. Evaluate and use biological databases (literature and public datasets)

   d. Complete online learning independently

Formative Feedback

Online tasks
For online tasks, immediately after you submitted the answers, you will see your scores, your answers, the correct answers, feedback on your incorrect answers, and explanations for the correct answers. For online quizzes, individual feedback will be provided to students through evaluation of their submissions. Quiz answers will be discussed in the example class. You will also see the average scores of the other students in the same cohort. This helps you to achieve ILOs 1, 3, 4, 6 .

Hands-on assessment
Written/verbal feedback on the hands-on work, such as making a visual programming script will be provided to you. This helps you to achieve ILOs 1 to 8.

Learning and Teaching Approach

Technology-enhanced Learning (20 hours)	The online videos will cover the Computational Thinking topics and introduce the students to Python programming. Each lecture concludes with an MCQ to test the knowledge retention.
Laboratories (15 hours)	The laboratories will serve as hands-on sessions to equip students with practical knowledge.
Tutorials (9 hours)	The Example class will be used as a seminar session to solve problems in class and to clarify the contents of the online topic.
Lectures (4 hours)	The lectures will cover the initial topics of Computational Thinking, with a focus on basic computer operations and Python programming.

Reading and References

The course will not use a textbook. All required material is provided by the online lectures.

Course Policies and Student Responsibilities

You are expected to be responsible for your own learning. In general, you should attend lectures and tutorials. You should partake seriously in the tutorials and exercise due diligence in work submission. If for any reason you are unable to do so, you are expected to contact the course coordinator, and do the necessary follow-up.

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. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Marek Mutwil (Asst Prof)	SBS-02s-88h	6904 7503	mutwil@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Computational Thinking Concepts and Programming languages	2, 5, 6	Familiarization with Raspberry Pi (RPi) board, and various programming languages
2	Basic computer operations	1, 7	Connecting to RPi over LAN, introduction to Spyder IDE
3	Basic program structure	3, 6	Python programming exercises: variables
4	Computing trends and ethics	7	None - Chinese New Year
5	Boolean data types, relational operators, selection	3, 4, 6	Python programming exercises: Basic programs
6	Repetition and loops	3, 4, 6	Python programming exercises: Conditional Executions and Iterations
7	Abstraction, strings, composites	3, 4, 6	Python programming exercises: Iterations
8	Function development	3, 4, 6	Python programming exercises: Abstraction
9	Decomposition	3, 4, 6	Python programming exercises + Mini project - design
10	Pattern recognition	4, 5, 6	Python programming exercises + Mini project – coding
11	Algorithm design - sorting	3, 4, 6	Python programming exercises + Mini project – coding and debugging
12	Algorithm design - searching	3, 4, 6	Python programming exercises + Mini project – testing
13	Algorithm Complexity Analysis	7, 8	No class activities Mini project submission

Appendix 1: Assessment Rubrics

Rubric for Technology-enhanced Learning: Multiple Choice Questions 1 (20%)

You will complete 13 online video with MCQs. The total score will be scaled to 20%.

Rubric for Tutorials: Project (30%)

A 3 person team project, where you will make a program to solve a problem. The total score will be scaled to 30%.

	Standards		
	Fall standard (0-39%)	Pass standard (40-80%)	High standard (81-100%)
Criteria	Demonstrated less than 40% of the functionalities according to the specifications; Python and pseudocode accepted. OR Peer Evaluation: Inadequate contribution to team learning, i.e. you did not do your fair share of work. Average peer score <=2.5	Demonstrated 40% to 80% of the functionalities according to the specifications; Python and pseudocode accepted. AND Contribution to team learning was at least adequate, i.e. you put in your fair share of work. Average peer score >2.5	Demonstrated more than 80% of the functionalities according to the specifications. Only Python code accepted. AND Contribution to team learning was significant, i.e. not only did you put in your fair share of work, but you also supported other members' learning. Average peer score > 3

Your peer evaluation score may be formulated based on a peer evaluation form, such as the following:

Name: ___________________________________ Date: _________________

Write the names of your group members in the numbered boxes. Then, assign yourself a number for each listed attribute. Finally, do the same for each of your group members and total up the values.

Values: 1=Strongly Disagree; 2=Disagree; 3=Agree; 4=Strongly Agree

		Group Members	
Attributes	Yourself	Member #1:	Member #2:
Contributed the fair share of work			
Contributed to one another's learning			
Total Values			

Rubric for Mid-semester Quiz: Multiple Choice Questions (30%)

You will take 2 MCQs based online quizzes (which will be done in the Laboratory). The total score will be scaled to 30%.

Rubric for Mid-semester Quiz: Short Answer Questions (20%)

You will take 2 MCQs based quizzes related to the programming exercises (which will be done in the Laboratory). The total score will be scaled to 20%.

Appendix 2: Intended Affective Outcomes

As a result of this course, it is expected you will develop the following "big picture" attributes:

Gain enhanced problem-solving skills with abstraction, decomposition and algorithm design

Be aware of the multi-disciplinary nature of contemporary science

Become an independent scholar