

Discrete Math & Computing with Python

Course Sequence Overview

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Computing Wisdom

Course Sequence Description

- This is a four-course sequence Discrete Math & Computing with Python for gifted/high-achieving 9th-12th graders and beyond, i.e. including college students and adult learners.
- Each course in the sequence lasts for one term, which consists of 18 sessions with 2.5 hours in each session.
- Discrete Math serves as the math foundation for computing. Python is a popular, general-purpose, and user-friendly language for software programming. It makes great sense to incorporate Discrete Math, Computing, and Python together into a course sequence offering a comprehensive introduction to the world of computing.

Course Sequence Description

- This course sequence provides an alternative to standard high school AP/IB/AICE STEM courses and first-year university STEM courses.
- It covers advanced topics that are not included in standard classrooms, such as number theory, combinatorics, probability, and graph theory, which are essential for excelling in major math competitions such as MATHCOUNTS and the AMC Competitions.
- The sequence is proof-intensive, offering in-depth coverage of proof methods and strategies found in proof-based math competitions like the USA Mathematical Talent Search (USAMTS), USA Junior Mathematical Olympiad (USAJMO), and USA Mathematical Olympiad (USAMO).
- It includes standard algorithms and data structures crucial for the USA Computing Olympiad (USACO).

Prerequisites

- A comprehensive and rigorous Algebra course sequence such as *Algebra* offered in our *Competitive STEM* program
- Little or no prior programming experience

Topic Coverage

- 1 Discrete Math
 - The study of discrete structures and techniques including Logic and Proofs, Set Theory, Number Theory, Induction and Recursion, Combinatorics and Discrete Probability, Functions and Relations, Graph Theory, Trees, and Formal Languages and Grammars
 - Mathematical foundations for computing disciplines such as Computer Science, Computer Engineering, Data Science, and Information Technology
- 2 Computing
 - Algorithms such as searching algorithms, sorting algorithms, brute-force algorithms, greedy algorithms, recursive algorithms, dynamic programming, graph algorithms, and tree algorithms
 - Time complexity of algorithms
 - Data Structures such as lists, stacks, queues, linked lists, hash tables, graphs, and trees
- 3 The Python 3 Standard Library

Course Materials

- Lecture slides and notes
- Jupyter notebooks
- [R] Kenneth H. Rosen, Discrete Mathematics and its Applications, Eight Edition, McGraw-Hill Education, 2018
- [RM] Paul Resnick and Brad Miller, Foundations of Python Programming, Runestone Interactive

Classroom Delivery Methods

- The Python standard library will be taught through a flipped classroom approach using the interactive textbook [RM].
 - Python reading and problems sets are assigned from the textbook. Students work directly in the interactive environment integrated with the textbook.

Classroom Delivery Methods

- Discrete math and computing topics will be taught in a traditional classroom approach through Zoom.
 - Instructions are presented in slides and notes, which based primarily on [R], but also other textbooks, articles, and videos, and are available in Google classroom.
 - Algorithms written in Python for instructions, Python assignments and their solutions, Python problem set solutions, and Python projects are available in Vocareum¹. Students can work directly in Vocareum for Python assignments and Python projects or work locally on their computing device and then upload their completed work to Vocareum.

¹Vocareum is a cloud-based lab environment for programming classes.

Expectation of Students

- This is a very demanding course sequence. Besides the 2.5 class hours per session, each course requires approximately 4-6 hours between sessions to review class materials and to complete homework assignments and Python projects.
- But at the end, after exposing to many challenging and interesting real-world mathematics, knowing many important and useful algorithms and data structures, and gaining experience in developing many fun and practical projects using Python, you will have great satisfaction what you accomplish. You would most definite want to list what you learned on your resume and your LinkedIn profile.

Expectation of Students

- Below is a table summaries the breakdown of the different components of this course sequence.

Part	A	B	C	D
Lessons	14 × 2.5 h	14 × 2.5 h	14 × 2.5 h	14 × 2.5 h
Written problem sets	13	14	14	14
Python reading sets	12	8	none	none
Python problem sets	12	8	none	none
Python exercises	none	4	TBD	TBD
Python projects	2	2	2	2
Review sessions	2 × 2.5 h	2 × 2.5 h	2 × 2.5 h	2 × 2.5 h
Exams	2 × 2.5-3 h	2 × 2.5-3 h	2 × 2.5-3 h	2 × 2.5-3 h

Grading Policy

Each course has 2 marking periods for a total of 8 in the course sequence. Below is the grading policy per marking period:

- Homework assignments: 40%
 - Written assignments:
 - Python assignments (Python reading & problem sets and other Python exercises):
 - One homework assignment with the lowest grade will be dropped
- Python Projects: 30%
- Exams: 30%