

**NEW YORK CITY COLLEGE OF TECHNOLOGY**  
**The City University of New York**

**DEPARTMENT:** Mathematics

**COURSE:** MAT 1630

**TITLE:** Introduction to Computational Science

**DESCRIPTION:**

This is a project-based course, which offers an introduction to scientific computing, inspired by different STEM applications. It introduces students with little or no prior programming experience to computational thinking and problem solving, which has become a fundamental skill in both academia and industry, as it allows you to formulate a problem and implement an algorithmic solution to be carried out by a computer. This course covers a range of topics, including basic data analysis and visualizations, and an introduction to more advanced topics such as Monte Carlo simulations, optimization, dynamic programming, image processing and data science.

**RECOMMENDED TEXTS:**

1. [\*R for Data Science\*](#), by Garrett Golemund and Hadley Wickham, RStudio.
2. [\*Introduction to Computation and Programming Using Python: with application to understanding data\*](#), by John V. Guttag, 2nd edition, The MIT Press, 2016.

**CREDITS:** 3 (2 class hours and 2 lab hours)

**PRE OR COREQUISITE:** MAT 1475 or higher

**PREPARED BY:** Prof. Kostadinov and Prof. Thiel, Fall 2017, updated Fall 2020.

**A. Testing Guidelines:**

The following exams should be scheduled:

1. Homework/Lab/Class Assignments
2. Midterm
3. Project
4. Final Exam

### Course Intended Learning Outcomes/Assessment Methods

Learning Outcomes:	Assessment Methods
<b>Creativity:</b> Students can understand and build simple mathematical models to represent a STEM problem.	Classroom discussions, quizzes, projects, homework and exams.
<b>Critical Thinking:</b> Students can think algorithmically and solve STEM problems using computational tools.	Classroom discussions, quizzes, projects, homework and exams.
<b>Communication:</b> Students can explain basic algorithms and code by preparing written presentation reports.	Classroom discussions, quizzes, projects, homework and exams.

### General Education Learning Outcomes/Assessment Methods

Learning Outcomes:	Assessment Methods
<b>Creativity (as defined above)</b>	Classroom discussions, quizzes, projects, homework and exams.
<b>Critical Thinking (as defined above)</b>	Classroom discussions, quizzes, projects, homework and exams.
<b>Communication (as defined above)</b>	Classroom discussions, quizzes, projects, homework and exams.

### New York City College of Technology Policy on Academic Integrity

Students and all others who work with information, ideas, texts, images, music, inventions, and other intellectual property owe their audience and sources accuracy and honesty in using, crediting, and citing sources. As a community of intellectual and professional workers, the College recognizes its responsibility for providing instruction in information literacy and academic integrity, offering models of good practice, and responding vigilantly and appropriately to infractions of academic integrity. Accordingly, academic dishonesty is prohibited in The City University of New York and at New York City College of Technology and is punishable by penalties, including failing grades, suspension, and expulsion. The complete text of the College policy on Academic Integrity may be found in the catalog.

## MAT 1630 Introduction to Computational Science

A tentative list of projects and schedule. Projects and code will be provided.

Session	Introduction to Computational Science	Homework/Project
1	Introduction	Paper coding floor patterns
2-4	Algorithms and Flowcharts - decisions, loops, notation, quadratic root counter	The taxicab distance problem
5-7	Python or R Basics - data types, variables, operators, functions, if/else, for and while loops, functions	The metrocard problem
8-10	Interest - compound interest, credit card payments, mortgage payments, savings accounts	Refinancing a mortgage Adjustable rate mortgage comparison
11, 12	Recursion - recursive definitions, the Fibonacci sequence, the McNugget problem, betting on the roulette wheel, max/min, sorting	Recursive data type conversion
13	Python: list comprehensions and an introduction to plotting with Matplotlib R: an introduction to plotting with ggplot2	Plotting derivatives
14, 15	Bisection and Newton's Method - finding roots	Rent-a-Center interest rates
16	<b>Midterm</b>	
17-19	Monte Carlo Methods - card and dice simulations, computing areas	The birthday/die roll problem
20-22	Dynamic Programming - maze path counter, 0/1 knapsack problem, max palindrome detection	The subset sum problem
23, 24	Discrete Models - population models, disease infections, the logistic map, automata (Rule 30)	New Zealand sheep populations
25	Python: an introduction to NumPy - lists vs. arrays, matrices, image manipulation R: image processing using Imager and Magick	The square drawing function
26, 27	Python: introduction to Pandas - dataframes R: introduction to dataframes in the Tidyverse	Filtering a dataframe
28	<b>Project Presentations</b>	
29	<b>Review</b>	
30	<b>Final Exam</b>	

## MAT 1630 Introduction to Computational Science (PROPOSAL)

A tentative list of projects and schedule. Projects and code will be provided.

Session	Introduction to Computational Science	Homework/Project
1	Introduction	Paper coding floor patterns
2-4	Algorithms and Flowcharts - decisions, loops, notation, quadratic root counter	The taxicab distance problem
5-7	Python or R Basics - data types, variables, operators, functions, if/else, for and while loops, functions	The metrocard problem
8,9	Python: list comprehensions and an introduction to plotting with Matplotlib R: an introduction to plotting with ggplot2	Plotting derivatives
10-13	Interest - compound interest, credit card payments, mortgage payments, savings accounts	Refinancing a mortgage Adjustable rate mortgage comparison
14	Bisection Method	Rent-a-Center interest rates
15, 16	Recursion - recursive definitions, the Fibonacci sequence, the McNugget problem, betting on the roulette wheel, max/min, sorting	Recursive data type conversion
17	<b>Midterm</b>	
18, 19	Discrete Models - population models, disease infections, the logistic map, automata (Rule 30)	New Zealand sheep populations
20-23	Monte Carlo Methods - card and dice simulations, estimating probabilities, areas.	The birthday/die roll problem
24	Python: an introduction to NumPy - lists vs. arrays, matrices, image manipulation R: image processing using Imager and Magick	The square drawing function
25-27	Python: introduction to Pandas - dataframes R: introduction to dataframes in the Tidyverse	Filtering a dataframe
28	<b>Project Presentations</b>	
29	<b>Review</b>	
30	<b>Final Exam</b>	