Welcome!

## CMPSC 102 – Discrete Structures

ALLEGHENY COLLEGE
1815

Textbook

Programming
and
Mathematical
Thinking

A Gentle Introduction to
Discrete Math
Featuring Python

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Programming and Mathematical Thinking - A Gentle Introduction to Discrete Math Featuring Python by Allan M. Stavely; ISBN paperback 978-1-938159-00-8 and ISBN ebook: 978-1-938159-01-5

Textbook
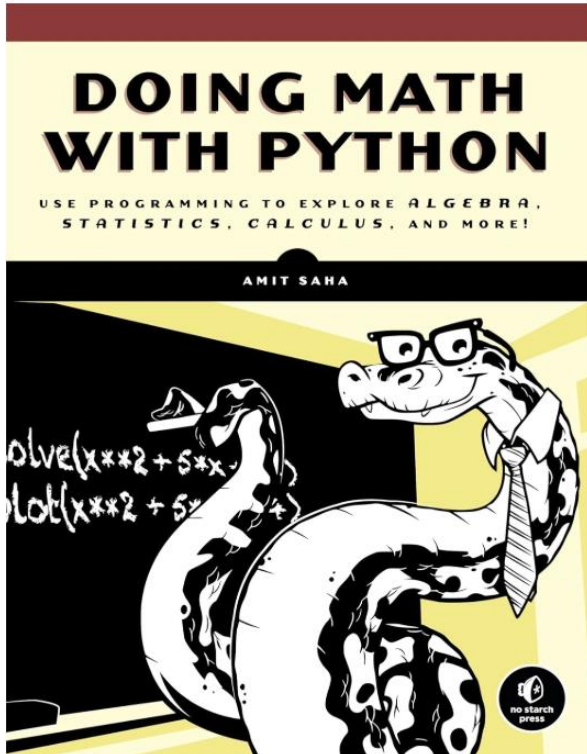
Doing Math with Python by Amit Saha; ISBN paperback:1-59327-640-0

Key Question

How can I connect mathematical terminology (e.g., mapping, function, number, sequence, and set) to Python programming concepts, such as declaring and calling functions, as well as declaring and manipulating variables?

Learning Objectives

To remember and understand some of the discrete mathematics and Python programming concepts, setting the stage for the exploration of discrete structures.

Discrete Structures - In terms of programming

Discrete Structures = Math + Code

Discrete mathematics is composed of fundamental concepts such as:

- Symbols, character strings, and truth values.
- Objects and collections of these entities (e.g., stored in sets or tuples).

Specification (S) and Program (P)

- Specification (S): The detailed description and design of a computer program.
  - Define the input, output, and internal objects.
  - Use the vocabulary of discrete mathematics to formalize ideas.
- Program (P): The implementation of the specification in a programming language.
  - Translate the specification into code.
  - Implement and test the program.

Our goal: To implement a program P that meets a particular specification S

Discrete Structures - In terms of mathematics

"An introduction to the foundations of computer science with an emphasis on understanding the abstract structures used to represent discrete objects."

We keep using the word, discrete. What do we mean here?

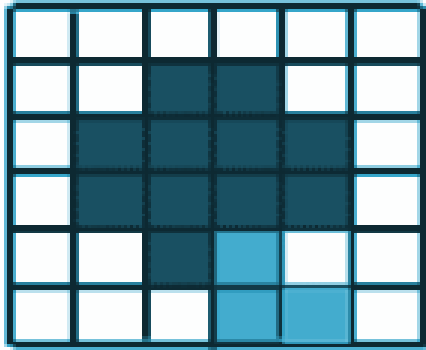- Discrete means separate, not continuous or not sharing any common space

Discrete and Countable Objects

- *Discrete* means "countable" (can be listed in an order)
- We can count the number of animals.
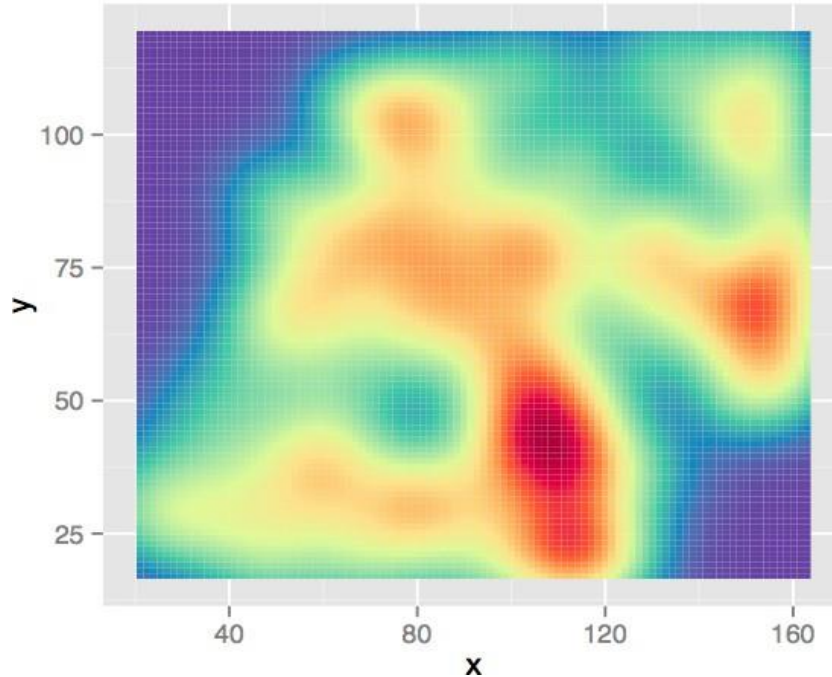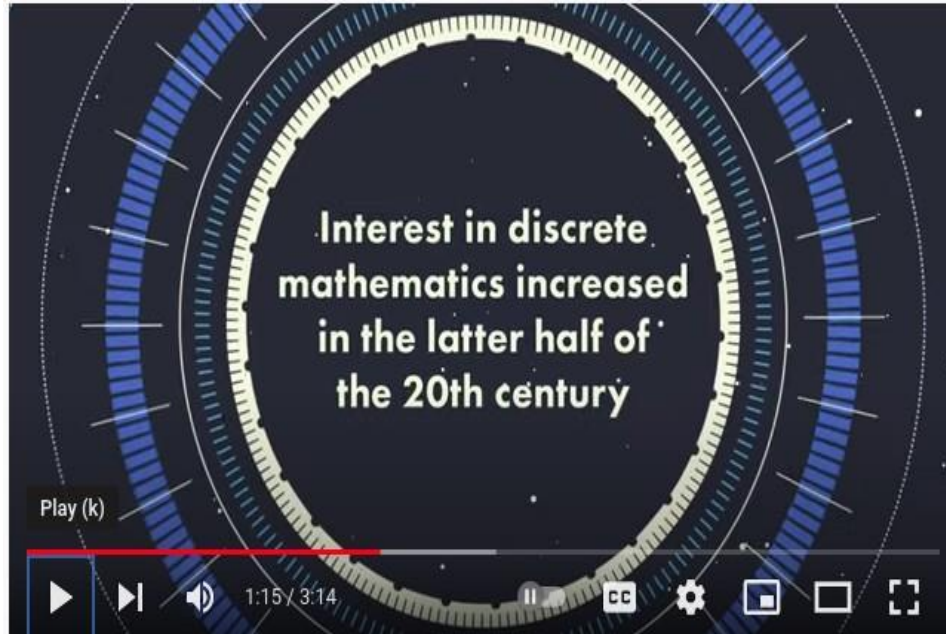
Discrete and Countable Objects

- Discrete mathematics involves being able to count (list) things individually.

Continuous Objects

- "Overlapping" objects cannot be counted (i.e., listed) separately.

Discrete Mathematics

Interest in discrete mathematics increased in the latter half of the 20th century

- Discrete Mathematics for Computer Science (developed during the latter half of the 20th century!
- https://www.youtube.com/watch?v=q4L-wUF3yig

Non-Discrete and Un-Countable Objects

- Are the numbers of grains *un*countable (i.e., unlistable)?
- Is anything *un*countable at the beach?
- How do we count an uncountable object? Why?

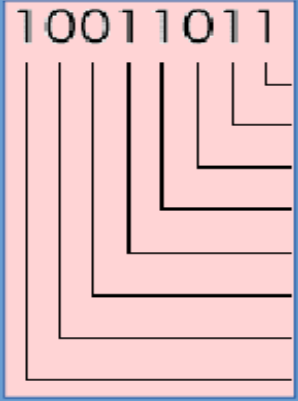# Relationships to Computing - computer MUST be able to count to compute

You will have to put uncountable stuff into a system that counts!!

Binary Numbers

In mathematics and digital electronics, a binary number is a number expressed in the base-2 numeral system or binary numeral system, which uses only two symbols: typically, 0 (False, zero) and 1 (True, one).

- Computers use binary to function
- Processes (i.e., memory, computation, networking) are broken down into binary-driven procedures

Binary Numbers

Binary Value				Decimal Representation			Decimal Value
				8	4	2	1	
0	0	0	0	0 + 0 + 0 + 0			0
0	0	0	1	0 + 0 + 0 + 1			1
0	0	1	0	0 + 0 + 2 + 0			2
0	0	1	1	0 + 0 + 2 + 1			3
0	1	0	0	0 + 4 + 0 + 0			4
0	1	0	1	0 + 4 + 0 + 1			5
0	1	1	0	0 + 4 + 2 + 0			6
0	1	1	1	0 + 4 + 2 + 1			7
1	0	0	0	8 + 0 + 0 + 0			8
1	0	0	1	8 + 0 + 0 + 1			9
1	0	1	0	8 + 0 + 2 + 0			10

- Computing implies digital processing
- Computing binary values is a countable task.
- Can anything, or any number, that a computer computes be written in binary?

Countable and Not Countable?

What can be listed and what cannot be listed?

- Discuss with your neighbors!
- What are **countable** (i.e. *list-able*) objects? Can you give an example?
- Can you think of **un-countable** objects that cannot be listed? Give an example?
  - Can you think of types of numbers that may fit into each of these above groups?
  - Need a hint about such numbers? Check out Numberphile's video: https://www.youtube.com/watch?v=elvOZm0d4H0