

Discrete Structures: CMPSC 102

Oliver BONHAM-CARTER

Fall 2022
Week 2
Slides 02

Get Python3

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Get Python

Warm-up

Key
Components


Mathematical
Terminology

Mathematical
Terminology

Properties of
Real Numbers

Properties of
Sequences
Commutative

Connecting
Math and
Python



python™

About Downloads Documentation Con

```
# Python 3: List comprehensions
>>> fruits = ['Banana', 'Apple', 'Lime']
>>> loud_fruits = [fruit.upper() for fruit in
fruits]
>>> print(loud_fruits)
['BANANA', 'APPLE', 'LIME']

# List and the enumerate function
>>> list(enumerate(fruits))
[(0, 'Banana'), (1, 'Apple'), (2, 'Lime')]
```

- Get Python3 from the Python Software Foundation
 - <https://www.python.org/downloads/>
- Or just stick with Jupyter <https://jupyter.cs.allegheny.edu/>

Install Your Own Python3

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Download the latest source release

Download Python 3.10.7

Looking for Python with a different OS? Python for [Windows](#), [Linux/UNIX](#), [macOS](#),
[Other](#)

Want to help test development versions of Python? [Prereleases](#), [Docker images](#)

Looking for Python 2.7? See below for specific releases



- Download and install the version of Python3 for your OS being sure to add the PATH to the environmental variables (check the path option!)
- Check with the installation material to learn how to launch Python3 from your machine.

Running the Python3 Shell

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- Type statements or expressions at prompt:
- `print(" Hello, world")`
- `x = 12**2`
- `print(x)`
- `print(x/2)`
- `# bla bla bla...`
 - (This is a comment: everything after the # is ignored)

Data types

Note: Use identifiers to help you remember the types!

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- Integers, counting numbers
 - `num_int = 1`
- Floats, decimals
 - `num_float = 3.1415`
- Strings:
 - `s_str = " Hello World"`

```
height_int = 5
print(f" The height is: {height_int}")
print(" The height is:", height_int) # print another way

num_float = 3.14
print(f" The float variable is : {num_float}")

s_str = ("Hello World'')
print(" The integer is equal to: ", s_str)
```

Key Components

All programs built out of ...

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- **Function calls:** Granting temporary kernel-time and/or using issuing parameters to a sub-sequence of instruction in a program.
- **Assignment statements:** The issuing of a value to a variable or place in memory to contain the value.
- **Iteration constructs:** Structures used in computer programming to repeat the same computer code multiple times (*loops*).
- **Conditional logic:** the use of logical rules in code to govern steps taken.

Key Components

All programs built out of ...

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- **Variable creation:** The introduction of an object in memory to contain some value.
- **Variable computations:** The use of values contained in variables to create new value using an operator.
- **Variable output:** The revealing of some value in a variable by printing or another means.

Application

Using Python to Find a Name in a File

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```
file = open("names")
for line in file:
    if line.startswith("John"):
        print(line)
```

- Can you explain the behavior of this program segment?
- What are the **constructs** inside of this program segment?
- How is this different than a full-fledged Python program?
- What is the purpose of the *open* function?
- What is the purpose of the *line.startswith* function?

Application

Using Python to Find an Email in a File

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```
file = open("emails")
for line in file:
    name, email = line.split(",")
    if name == "John Davis":
        print(email)
```

- Can you explain the behavior of this program segment?
- What are the **constructs** inside of this program segment?
- How is this different than a full-fledged Python program?
- What is the purpose of the *open* function?
- What is the purpose of the *line.split* function?

Runnable Application

Using Python to Find an Email in a File

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```
#!/usr/bin/env python3
""" Demo program"""

myFile_list =["Bob Bye,bob@big.com",
"Julie Roth, Jroth@thinktank.com",
"John Davis, JDavis@KingOfTheWorld.com"]

print(" Opening myFile :{myFile_str}")
#file = open("emails")
for line in myFile_list:
    print(f"\t + line : {line}, {type(line)}")
    name, email = line.split(",")
    if name == "John Davis":
        print(f" Name found: {email}")
```

- Can you explain the behavior of this program segment?
- What are the **constructs** inside of this program segment?

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```
sum = 0
count = 0
myFile = open("data.txt")
for line in myFile:
    n = int(line)
    sum += n
    count += 1
print(sum/count)
```

- What are the contents of the `data.txt` file?
- What is the purpose of the `for line in file` statement?

Runnable Application

Using Python to Find an Email in a File

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```
#!/usr/bin/env python3
""" Demo program"""

myFile = [1,2,3,4,5,6,7,8,9,10]
sum = 0
count = 0
#file = open("observations.txt")
for line in myFile:
    n = int(line)
    sum += n
    count += 1
print(sum/count)
```

- Can you explain the behavior of this program segment?
- What are the **constructs** inside of this program segment?

File: [getAverage.demo.py](#)

Mathematical Terminology

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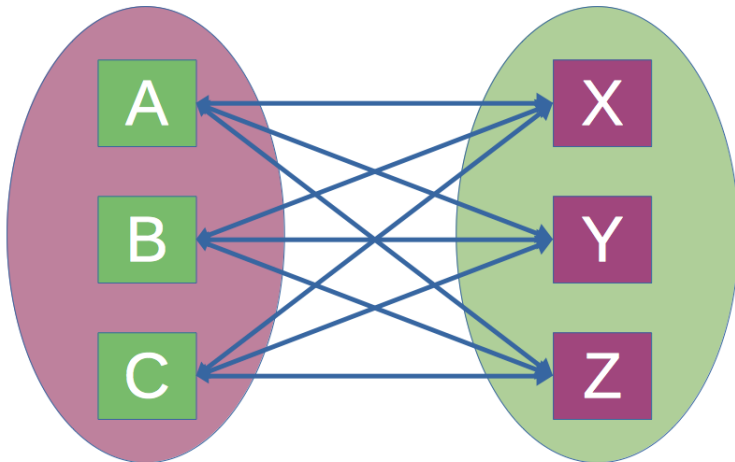
Properties of
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Connecting
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- Mathematical terminology is a vocabulary for discussing Python programs
- What are mathematical terms that aid programming?
- **Set:** an unordered collection of different entities
- **Sequence:** an ordered collection of entities
- **Relation:** a set that relates pairs of things with each other
- **Mapping:** a set of ordered pairs in every element is unique (sometimes called a “function” in mathematics)
- Can you find these mathematical concepts in the Python programs? For instance: *What is a file?*

Mathematical Terminology

Is this a function?



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General Properties of Real Numbers

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Property	Addition	Multiplication
Commutative	$a + b = b + a$	$a \cdot b = b \cdot a$
Associative	$a + (b + c) = (a + b) + c$	$a \cdot (b \cdot c) = (a \cdot b) \cdot c$
Distributive	$a \cdot (b + c) = a \cdot b + a \cdot c$	$a \cdot (b + c) = a \cdot b + a \cdot c$
Identity	$a + 0 = a$	$a \cdot 1 = a$
Inverse	$a + (-a) = 0$	$a \cdot \frac{1}{a} = 1$

Properties

Commutative

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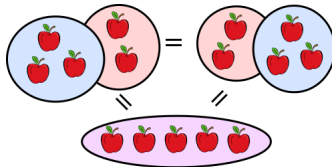
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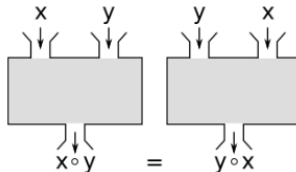
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- The term “commutative” is used in several related senses.
- A binary operation $*$ on a set S is called *commutative* if:
 $x * y = y * x$ for all $x, y \in S$
 - An operation that does not satisfy the above property is called *non-commutative*.
- One says that x *commutes* with y under $*$ if: $x * y = y * x$
- A binary function $f : A \times A \rightarrow B$ is called *commutative* if:
 $f(x, y) = f(y, x)$ for all $x, y \in A$



Commutative

- The operator each side of equation do not create inequality
- Think operators like: Addition, multiplication, division



Not Commutative

- The operator each side of equation creates inequality
- Think operators like: subtraction
- $x - y \neq y - x$; $5 - 3 \neq 3 - 5$

Properties

Non-Commutative operations

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- Washing and drying clothes resembles a noncommutative operation; washing and then drying produces a markedly different result to drying and then washing.
- Putting on left and then right socks on feet is commutative
- Putting on shirt and then sweater is not-commutative

Strings

```
a = "face"
b = "book"
a + b == b + a # run the test!
"facebook" != "bookface"
```

Connecting Math and Python

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- Program **variables** and their associated **types** exist in both **discrete mathematics** and in **Python programs**
- Connecting ****mathematical variables**** to ****Python variables****:
 - $a \in \mathbb{Z}$ means that a is an integer value in Python
 - $a \in \mathbb{R}$ means that a is a floating point value (real numbers) in Python
 - Python variables have descriptive names like **temperature_celcius**
 - Python variables can also store character strings like **music**
 - Python variables have **practical limitations** not faced by mathematical ones! What are they? Why do they exist? Why is it important to know about them?

Practical Variable Limitations in Python

Programming has computational limits

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Python Output

```
>>> 2**2**8 # a long number
115792089237316195...584007913129639936
```

```
>>> 2**2**10 # a very, very long number!!
17976931...6329624224137216
```

```
>>> 2**2**100
^CTraceback (most recent call last):
  File "stdin", line 1, in module
KeyboardInterrupt
```

- Mathematical thinking is infinite unlike computational wisdom

Practical Variable Limitations in Python

More computational limits

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Python Output

```
>>> 1.0 == 1.1
False
>>> 1.0 == 1
True
>>> 'h' + 'i' + '!'
'hi!'
>>> .33333 + .33333 + .33333 == 1
False
>>> .33333333333 + .33333333333 + .33333333333 == 1
False
>>> 1/3
0.3333333333333333
>>> 1/3 + 1/3 + 1/3 == 1
True
```

File: [explore-python-variables.ipynb](#)

Test Your Understanding

- Understanding the ****connections**** between ****mathematics**** and ****programming****:
 - **Q1**: What is a **mapping** in the mathematics?
 - **Q2**: What is a **function** in mathematics and Python?
 - **Q3**: What are the **limits** for variables in the Python language?
 - **Q4**: What kinds of computational limits exist in Python? Or for any programming?

THINK