Discrete Structures: CMPSC 102

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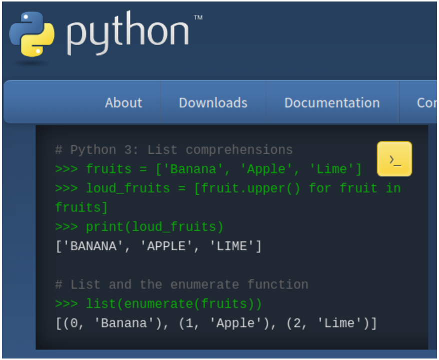
Week 2
Slides 02

Get Python3

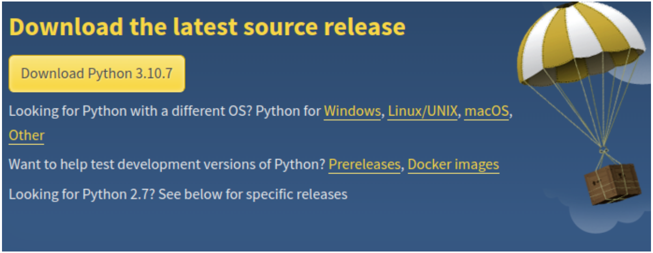


```
# Python 3: List comprehensions
>>> fruits = ['Banana', 'Apple', 'Lime']
>>> loud_fruits = [fruit.upper() for fruit in
fruits]
>>> print(loud_fruits)
['BANANA', 'APPLE', 'LIME']

# 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



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

- 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!

- 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 ...

- **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 ...

- **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

```
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

```
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

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

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

print("\n 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"\tName found: {email}")
```

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

File: openEmail_Demo_i.py

Runnable Application

Using Python to Find an Email in a File

Now try this one; what's different?!

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

mylist =[
    "Bob Bye,bob@big.com",
    "Julie Roth,Jroth@thinktank.com",
    "John Davis,JDavis@KingOfTheWorld.com",
    "Tylor Swift,tSwift@Swifter.com",
    "The Hulk,greenThumb@gardeningHelp.com",
    "Sherlock Holmes,sHolmes@consultingDetective.com"
        ]

print("\n Opening mylist :{mylist}")
for line in mylist:
    print(f"\t + line : {line}, {type(line)}")
    name, email = line.split(",")
    if name == "John Davis":
        print(f"\t Name found: {email}")
    if "Sherlock" in name:
        print(f"\t Detective's Name found: {email}")
```

File: openEmail_Demo_ii.py

Runnable Application

Using Python to Find an Email in a File

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

myFile = [1,2,3,4,5,6,7,8,9,10]
sum = 0
count = 0
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

Runnable Application Opening a File

Using Python to Find an Email in a File

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

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?

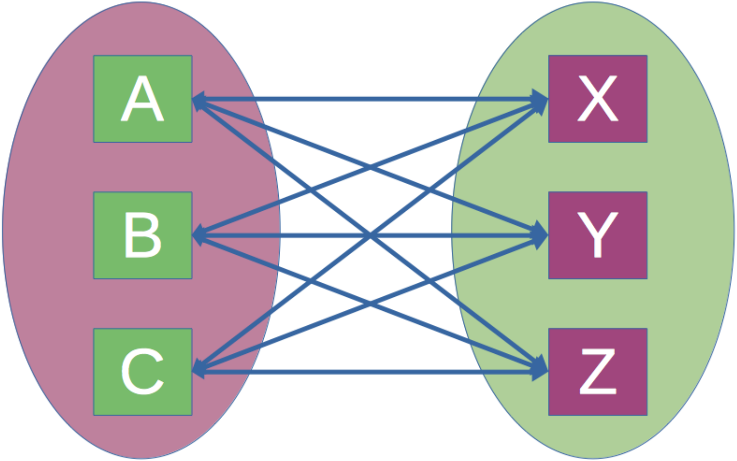
`File: getAverage_file.py`

Mathematical Terminology

- 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?



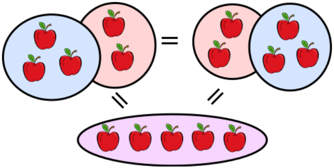
General Properties of Real Numbers

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

- 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 $f : A \times A \to B$ is called *commutative* if: $f(x, y) = f(y, x)$ for all $x, y \in A$

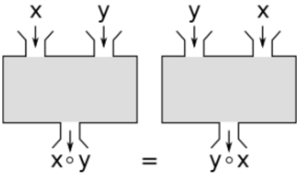


Properties

Examples

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

- 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

- 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

Python Output

```
>>> 2**2**8 # a really 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

Python Output

```
>>> 1.0 == 1.1
False
>>> 1.0 == 1
True
>>> 'h' + 'i' + '!'
'hi!'
>>> .33333 + .33333 + .33333 == 1
False
>>> .33333333333 + .33333333333 + .3333333333 == 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?