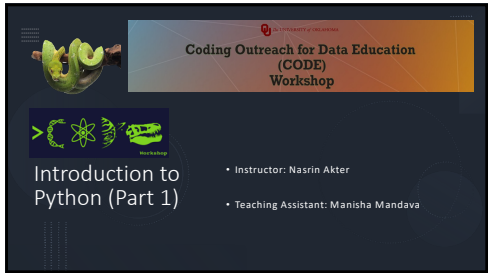
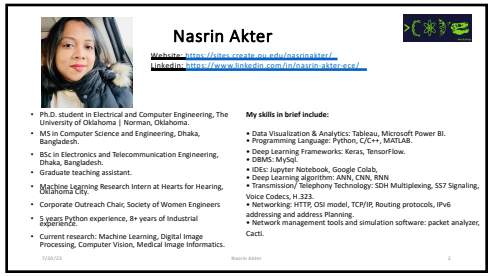
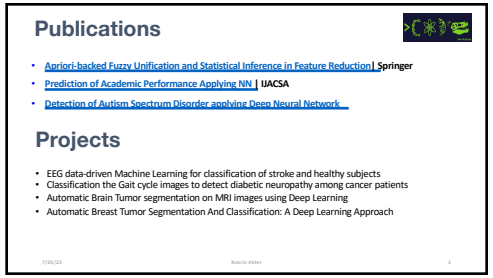

THE UNIVERSITY of OKLAHOMA
Coding Outreach for Data Education
(CODE)
Workshop
Introduction to
Python (Part 1)
• Instructor: Nasrin Akter
• Teaching Assistant: Manisha Mandava

1


Nasrin Akter
Website: https://sites.create.ou.edu/nasrinakter/
LinkedIn: https://www.linkedin.com/in/nasrin-akter-ece/
• Ph.D. student in Electrical and Computer Engineering, The University of Oklahoma | Norman, Oklahoma.
• MS in Computer Science and Engineering, Dhaka, Bangladesh.
• BSc in Electronics and Telecommunication Engineering, Dhaka, Bangladesh.
• Graduate teaching assistant.
• Machine Learning Research Intern at Hearts for Hearing, Oklahoma City.
• Corporate Outreach Chair, Society of Women Engineers
• 5 years Python experience, 8+ years of Industrial experience
• Current research: Machine Learning, Digital Image Processing, Computer Vision, Medical Image Informatics.
My skills in brief include:
• Data Visualization & Analytics: Tableau, Microsoft Power BI.
• Programming Language: Python, C/C++, MATLAB.
• Deep Learning Frameworks: Keras, TensorFlow.
• DBMS: MySql.
• IDEs: Jupyter Notebook, Google Colab.
• Deep Learning algorithm: ANN, CNN, RNN
• Transmission/ Telephony Technology: SDH Multiplexing, SS7 Signaling, Voice Codecs, H.323.
• Networking: HTTP, OSI model, TCP/IP, Routing protocols, IPv6 addressing and address Planning.
• Network management tools and simulation software: packet analyzer, Cacti.
7/20/23
Nasrin Akter
2

2


Publications
• Apriori-backed Fuzzy Unification and Statistical Inference in Feature Reduction | Springer
• Prediction of Academic Performance Applying NN | IJACSA
• Detection of Autism Spectrum Disorder applying Deep Neural Network
Projects
• EEG data-driven Machine Learning for classification of stroke and healthy subjects
• Classification the Gait cycle images to detect diabetic neuropathy among cancer patients
• Automatic Brain Tumor segmentation on MRI images using Deep Learning
• Automatic Breast Tumor Segmentation And Classification: A Deep Learning Approach
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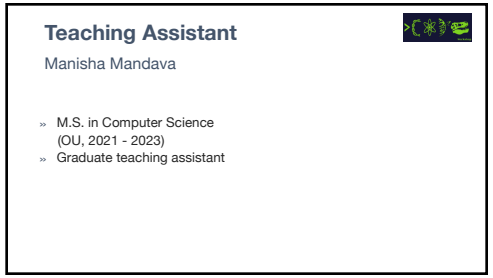
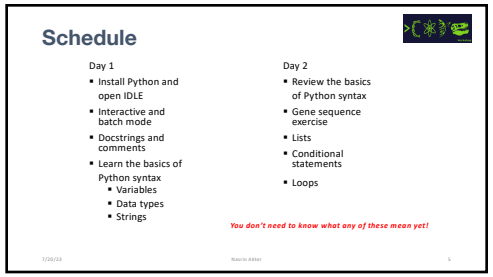
3


Teaching Assistant
Manisha Mandava
» M.S. in Computer Science (OU, 2021 - 2023)
» Graduate teaching assistant

4


Schedule
Day 1
▪ Install Python and open IDLE
▪ Interactive and batch mode
▪ Docstrings and comments
▪ Learn the basics of Python syntax
▪ Variables
▪ Data types
▪ Strings
Day 2
▪ Review the basics of Python syntax
▪ Gene sequence exercise
▪ Lists
▪ Conditional statements
▪ Loops
You don't need to know what any of these mean yet!
7/20/23
Nasrin Akter
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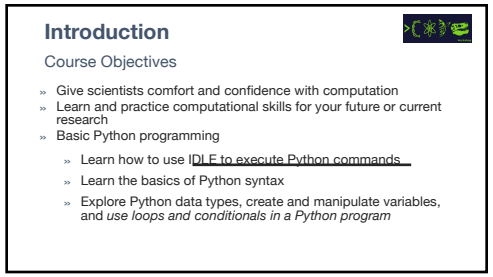
Introduction
Course Objectives
» Give scientists comfort and confidence with computation
» Learn and practice computational skills for your future or current research
» Basic Python programming
» Learn how to use IDLE to execute Python commands
» Learn the basics of Python syntax
» Explore Python data types, create and manipulate variables, and use loops and conditionals in a Python program

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Introduction

- **What you need to succeed:**
  - A logical and organized way of thinking (or at least organized notes for your future self!)
  - Determination
  - Practice, practice, practice
- **What you don't need:**
  - A math background
  - Previous programming experience

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Let's get started!!

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What is Programming?

- Providing a set of instructions for a computer to execute
- A way to automate tasks, perform difficult data analysis, document the process, and save time
- There are many programming languages and applications
  - Python
  - Java
  - R
  - Perl

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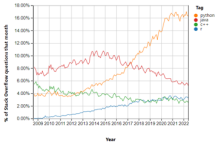
Why Python?

- Easy to learn
- Popular
- Free and open-source
- Interchangeable between Windows, Linux, and iOS
- High-level and object-oriented
- Many applications use Python



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What is a Program(Script)?

- A detailed set of instructions for how to do something
  - Definitions/symbols:
    - pi = 3.1416
  - Actions
    - Area = pi x radius^2
  - Loops
    - Repeat 2 times
    - Repeat until…
  - Conditional
    - If (something) do (something)
  - Results (Output)

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Setup Environment

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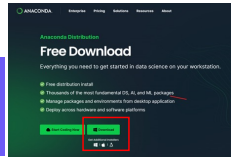
Download and Install Anaconda

- a distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment.
- The distribution includes data-science packages suitable for Windows, Linux, and macOS.

https://www.anaconda.com/download



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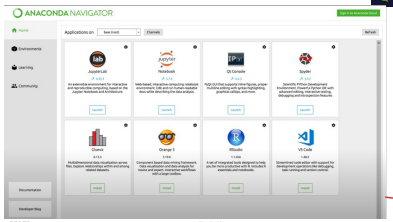
Anaconda Environment



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Execution Mode

Two Basic Python Execution Modes:

- Interactive mode (front-end) — a terminal or a console where as soon as you type a python command and press enter it's going to execute immediately. Use JupyterLab or Jupyter Notebook.
- Batch mode (a script) — a file editor or an IDLE where you're going to be writing a lot of code and then running all of that code at once. Use like spider or vs code to write some python code and then use the python interpreter to execute all of the code in that file.

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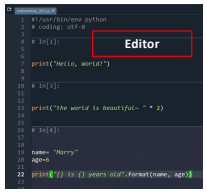
Batch Mode



https://docs.spyder-ide.org/5/editing/0ut-this-will-render-first?__cmt=bu%20vs%20ipyn%20ru%20in%20ide%20and%20vs%20co

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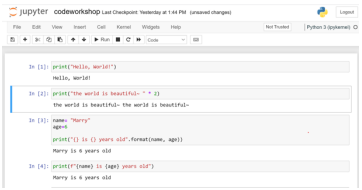
Interactive Mode



https://docs.anaconda.com/ae-notebooks/user-guide/basic-tasks/apps/jupyter/index.html

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IDLE (Integrated Development and Learning Environment)

- IDLE is a program used to write and execute Python code
- For windows:
  - Navigate to the Start Menu at the bottom left corner of the screen
  - Type 'IDLE' in the search bar and click on the application
- For Mac:
  - Open the Finder and type 'IDLE' in the search menu
  - You can also open the Applications folder in the Finder and find the IDLE program

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Execution in Interactive Mode

Two Basic Python Modes:

- Interactive mode (front-end)
  - Interactive mode is a command line shell which gives immediate feedback for each statement
  - Executing code in the interactive window happens in 3 steps:
    - 1. Python **reads** the code entered at the prompt (>>>)
    - 2. Python **evaluates** the code
    - 3. Python **prints** the result and waits for more input (>>>)

```
>>>print("Hello, world!")
Hello, world!
>>> 1 + 1
2
```


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Python print( ) function

- A Python **function** is a code that performs a task and can be invoked by a name. For example: print( ); sum( ); len( )
- The print( ) function prints the given object to the standard output device (screen)
- You need the print( ) function to see variable values, results, list contents, etc. *** Especially important in batch mode*

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Python print( ) function

The function accepts several arguments as shown below with their default values:

```
print(*objects, sep=' ', end=  '\n')
```

***objects :** The thing to be printed is represented by the first argument *objects and can be basically anything. It is commonly a string but may be an integer, a float, a variable, a list, or a dictionary, among others. The print() function can also take more than one object.

```
In [1]: print("Hello, World!")

        Hello, World!
```

Normal string operations may be used within the function. As an example, you can multiply a string by an integer as shown here

```
In [2]: print("the world is beautiful~ " * 2)

        the world is beautiful~ the world is beautiful~
```


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Python print( ) function

str.format(). where the replacement fields are indicated with curly braces

```
In [4]: name= "Marry"
        age=6

        print("{} is {} years old".format(name, age))

        Marry is 6 years old
```

Similar to this is f-string formatting, but more compact

```
In [5]: print(f"{name} is {age} years old")

        Marry is 6 years old
```

starred expression is useful If to print an iterable object like a list or an array

```
In [8]: print(*["lisa", "John", "harris"])

        lisa john harris

In [9]: print(["lisa", "John", "harris"])

        ['lisa', 'John', 'harris']
```


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Python print( ) function

Sep: The second argument of the Python print() function defines the separator. If more than one object is given as the first argument, then sep defines what delimiter to place between them.

```
In [18]: # \n starts a new line
         print(*[1, 2, 3, 4], sep="\n")

         1
         2
         3
         4

In [19]: # use a seperator as _
         print("Hello","world", sep = "-")

         Hello-world
```

end: The end keyword allows you to define something to be printed automatically at the end of the output.

```
In [20]: result=20
         print("Result of experiment", result, sep=" is ", end="!")

         Result of experiment is 20!
```


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Python Programming/Batch Mode

Two Basic Python Modes

- Batch Mode (script)
  - The Python Shell (interactive mode) is convenient for executing a few simple commands. If you need to give the computer more complex instructions, it is a good idea to write a script. **A script is a set of instructions you can easily edit and run.**
  - When a program is executed from such a text file, rather than line-by-line in an interactive interpreter, it is called batch mode.
  - 1. Go to **File >>> New File** to create a new script
  - 2. In your script, write: **print("Hello!")**
  - 3. Go to **File >>> Save As…** to save your script. Choose a location and a name. Be sure it saves as a .py file extension
  - 4. Go to **Run >>> Run Module** to run your script. The Python shell will reopen and display: "Hello!"

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Comments and Docstrings

Programming Best Practices: Commenting and Clarity

- The top priority is making your program easy to understand
  - Makes it possible to verify correct outputs
  - Simplifies modifying and updating
  - Promotes reuse and sharing
- Requirements
  - Docstrings: Block quotes with triple quotation marks are called docstrings. They are used in the interpreter to provide help.
  - Comments: Introduced by using the # symbol. Use comments to describe the steps in your program, helpful notes or clarification, and titles.

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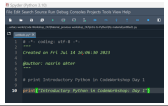
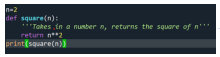
Comments and Docstrings

- Comments



- Docstrings



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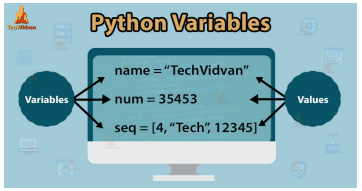
Variables



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Variables

- A variable is a value you can change and access throughout your script *(variables are just names)*
- Variable names can only contain these characters:
  - Lowercase letters
  - Uppercase letters
  - Digits (0 through 9)
  - Underscore(_)
- Names cannot begin with a digit
  - 1
  - 1a
  - 1_

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Variables: Assign a Variable

- The **assignment operator** is the equal sign (=)
- Pick variable names that are distinct and memorable
  - course = "Python 101"
  - num_students = 30
  - greeting = "Hello world"
- Variables *are case sensitive* (greeting ≠ Greeting)
- Mixed case:
  - numStudents = 30
  - introPythonCourse = "This course is a formal introduction to Python"
  - listOfNames = ["Angie", "Sanjana"]
- Lower case with underscores*:
  - name_of_class = "Introduction to Python"

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Variables: Assign a Variable

- Python has a set of reserved words that cannot be used as variable names

Python Keywords

False	def	if	raise
None	del	import	return
True	elif	in	try
and	else	is	while
as	except	lambda	with
assert	finally	nonlocal	yield
break	for	not	
class	from	or	
continue	global	pass	

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Variable Names

Which of the following is a good variable name for a variable holding a value for “meters per second”?

- m/s = 35
- meters_per_second = 35
- metersPerSecond = 35
- m = 35
- speed = 35

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Basic Variable Types

Numbers

- Integer numbers
  - A whole number (not a decimal)
  - Examples:
    - 100
    - -7
    - 1
    - 1863210897465
- Floating point numbers
  - Numbers that contain a decimal
  - Examples:
    - 3.1416
    - 0.7851
    - 1.0

```
>>> type(1.3)
<class 'float'>
>>> type(5)
<class 'int'>
```


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Basic Variable Types

Numbers

- You can check the variable type using the function **type( )**
- You can change the variable type (with certain exceptions) by using the variable type as a function
  - Convert to integer: **int( )**
  - Convert to float: **float( )**

```
a = 5.2
print(a)
print(type(a))

b = int(a)
print(b)
print(type(b))
```

```
5.2
<class 'float'>
5
<class 'int'>
```


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Basic Variable Types

Boolean

- True
- False
- Some functions only return a True or False
  - Example: isinstance*(object, type)*

```
print(isinstance(3.14, float))
print(isinstance(3.14, int))
```


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Basic Variable Types

Strings

- A sequence of zero or more characters that are enclosed within a pair of quotation marks.
  - Single quotes, double quotes, triple single quotes, triple double quotes
- Strings are immutable (‘read-only’)
- A string can contain letters, digits, punctuation, white spaces, and other characters.
  - my_string = “Hello world! 123 True”

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Basic Variable Types

Typecasting between variable types

From	To	Function	Possible?
Integer	Float	float( )	Yes
Integer	String	str( )	Yes
Integer	Boolean	bool( )	Yes, but…
Float	Integer	int( )	Yes
Float	String	str( )	Yes
Float	Boolean	bool( )	Yes, but…
String	Integer	int( )	Yes, if…
String	Float	float( )	Yes, if…
String	Boolean	bool( )	Yes, but…
Boolean	Integer	int( )	Yes - binary
Boolean	Float	float( )	Yes – binary
Boolean	String	str( )	Yes

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Basic Variable Types

Integer to Boolean: Any non-zero integer results in True, while 0 results in False.

```
In [21]: integer_value = 5
         boolean_value = bool(integer_value)
         print(boolean_value)  # Output: True

         integer_value = 0
         boolean_value = bool(integer_value)
         print(boolean_value)  # Output: False

         True
         False
```

float to Boolean: Similar approach

```
In [22]: float_value = 3.14
         boolean_value = bool(float_value)
         print(boolean_value)  # Output: True

         float_value = 0.0
         boolean_value = bool(float_value)
         print(boolean_value)  # Output: False

         True
         False
```


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Basic Variable Types

String to integer: Possible when there is numerical expression.

```
In [23]: string_value = "123"
         integer_value = int(string_value)
         print(integer_value)  # Output: 123
         print(type(integer_value))  # Output: <class 'int'>

         123
         <class 'int'>
```


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Operators

- An operator is a symbol that indicates a calculation using one or more operands

Operator	Description	Example
+ Addition	Adds values on either side of the operator	>>> 5 + 2 7
- Subtraction	Subtracts right hand operand from left hand operand	>>> 5 – 2 3
* Multiplication	Multiplies values on either side of the operator	>>> 5 * 2 10
/ Division	Divides left hand operand by right hand operand	>>> 5 / 2 2.5
// Integer Division	The whole number smaller than the floating point result	>>> 5 // 2 2
% Modulus	Integer remainder after b/a	>>> 5 % 2 1
** Exponent	Performs exponential (power) calculation on operators	>>> 5 ** 2 25

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Operators

Operator	Description	Example
=	Assigns values from right side expression to left side operand	c = a + b assigns c the values of a + b
+= Add AND	It adds right operand to the left operand and assign the result to left operand	c += a is equivalent to c = c + a c += 1 is equivalent to c = c + 1
-= Subtract AND	It subtracts right operand to the left operand and assign the result to left operand	c -= a is equivalent to c = c - a
*= Subtract AND	It multiplies right operand to the left operand and assign the result to left operand	c *= a is equivalent to c = c * a
/= Divide AND	It divides left operand to the right operand and assign the result to left operand	c /= a is equivalent to c = c / a
//= Integer Division AND	It performs floor division on operators and assign value to the left operand	c //= a is equivalent to c = c // a
%= Modulus AND	It takes modulus using two operands and assign the result to left operand	c %= a is equivalent to c = c % a
** Exponent	Performs exponential (power) calculation on operators and assign value to the left operand	c **= a is equivalent to c = c ** a

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Operators

Box Model

Beginner programmers are often puzzled by syntax such as:

```
b = 2
b = 4 + b
print(b)
```

Before you run this, what do you think the answer is?

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Operators

Box Model

- Think of variables as boxes
  - A box is a location in the computer's memory
  - The variable name is a label on the box, or the box's name
  - Assigning b = 2 copies a value from a temporary location into the box

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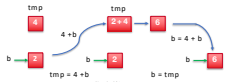
Operators

Box Model

b = 2

b = 4 + b

- 4 is loaded in a temporary space
- b is added to 2 in the temporary space
- The result is copied back into b



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Operators

Box Model

- The box model is conceptual
- You can check where the variable is stored using the id( ) function
- Try this:

```
>>>n = 6
>>>id(n)
1349663056
```

```
>>>n = n + 4
>>>id(n)
1349663120
```

- The memory address changes when the value of n is changed

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Operators

Arithmetic Operators:

```
# Arithmetic operators:
a = 10
b = 3

# Addition
c = a + b
print(c)  # Output: 13

# Subtraction
c = a - b
print(c)  # Output: 7

# Multiplication
c = a * b
print(c)  # Output: 30
```

```
# Division
c = a / b
print(c)  # Output: 3.3333333333333335

# Floor Division
c = a // b
print(c)  # Output: 3

# Modulo
c = a % b
print(c)  # Output: 1

# Exponentiation
c = a ** b
print(c)  # Output: 1000
```


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Operators

Comparison Operators:

```
a = 5
b = 3

# Equal to
result = a == b
print(result)  # Output: False

# Not equal to
result = a != b
print(result)  # Output: True

# Greater than
result = a > b
print(result)  # Output: True
```

```
# Less than
result = a < b
print(result)  # Output: False

# Greater than or equal to
result = a >= b
print(result)  # Output: True

# Less than or equal to
result = a <= b
print(result)  # Output: False
```


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Operators

Assignment Operators:

```
a = 5

# Addition assignment
a += 3  # Equivalent to: a = a + 3
print(a)  # Output: 8

# Subtraction assignment
a -= 2  # Equivalent to: a = a - 2
print(a)  # Output: 6

# Multiplication assignment
a *= 4  # Equivalent to: a = a * 4
print(a)  # Output: 24
```

```
# Division assignment
a /= 6  # Equivalent to: a = a / 6
print(a)  # Output: 4.0

# Modulo assignment
a %= 3  # Equivalent to: a = a % 3
print(a)  # Output: 1.0

# Exponentiation assignment
a **= 2  # Equivalent to: a = a ** 2
print(a)  # Output: 1.0
```


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Operators

Logical Operators:

```
a = True
b = False

# Logical AND
result = a and b
print(result)  # Output: False

# Logical OR
result = a or b
print(result)  # Output: True

# Logical NOT
result = not a
print(result)  # Output: False
```


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Operators

Box Model

Beginner programmers are often puzzled by syntax such as:

```
b = 2
b = 4 + b
print(b)
```

Before you run this, what do you think the answer is?

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Strings (again)

- Strings are a collection of characters enclosed by quotation marks
- Strings are immutable, meaning they cannot be changed after they are created
- You can use **string methods** to return a new value for the string (but it does not alter the original string)
- It is important to know how characters are indexed in Python
  - alphabet_string = "ABCDEFG"
  - Python indexing starts at 0

String Character	A	B	C	D	E	F	G
Position	0	1	2	3	4	5	6

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String Indexing

- You can extract a character using [ ]
- The index will return the character at a given index point
- Look at the following examples:
  dna_seq = "ANTGCTG"
  dna_seq[0]
  dna_seq[5]
- Before running this code, what do you think the results will be?

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String Slicing

- Slicing extracts a series of characters from a string
- The character positions of a slice are specified by two or three integers inside square brackets, separated by a colon

dna_seq = "ANTGCTG"
dna_seq[1:4]

Indicates the position of the first character to be extracted

Indicates where the slice ends. **This character will not be included in the slice**

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String Concatenation

- String concatenation puts two or more strings together

```
a = "Hello"
b = "world"

print(a + b)
print(a + " " + b)
```

```
===============
Helloworld
Hello world
>>>
```

- Can be combined with the input( ) function to create personalized strings

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String Functions

- A function is a piece of code written to carry out a specified task and is called by a name.
- The following are **built-in functions:** print( ); input( ); len( )
- len( ) returns the length of a string:

```
dna_seq = "ANTGCTG"
len(dna_seq)
```

* Note: using the len( ) function in batch mode will not return a value without adding a print( ) statement

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String Methods

1) len(): Returns the length of the string.
```
dna_seq = "ANTGCTG"
length = len(dna_seq)
print(length)  # Output: 7
```

2) lower(): Converts the string to lowercase.
```
lower_seq = dna_seq.lower()
print(lower_seq)  # Output: antgctg
```

3) upper(): Converts the string to uppercase.
```
upper_seq = dna_seq.upper()
print(upper_seq)  # Output: ANTGCTG
```

4) strip(): Removes leading and trailing whitespace from the string.
```
stripped_seq = dna_seq.strip()
print(stripped_seq)  # Output: ANTGCTG
```

5) split(): Splits the string into a list of substrings based on a delimiter.
```
split_list = dna_seq.split("T")
print(split_list)  # Output: ['AN', 'GC','G']
```

6) replace(): Replaces occurrences of a specified substring with another substring.
```
new_seq = dna_seq.replace("TG", "AA")
print(new_seq)  # Output: ANAACAA
```

7) startswith(): Checks if the string starts with a specified substring.
```
starts_with_AN = dna_seq.startswith("AN")
print(starts_with_AN)  # Output: True
```

8) endswith(): Checks if the string ends with a specified substring.
```
ends_with_TG = dna_seq.endswith("TG")
print(ends_with_TG)  # Output: True
```


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In-Class Exercise

- dnaseq = ATgTCtCATTcAAAGCANNNNNATGCGAGTTATGA"
- Write a simple Python script to:
  - Replace "N" into "G" in the variable dnaseq, and print the sequence
  - Capitalize all the lowercase letters in the variable dnaseq and print the sequence
  - Get the length of dnaseq and print the length
  - Calculate the number of "G" in dnaseq and print the number
- Hints:
  - Write comments as necessary
  - Use string methods and functions

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Lists

What is a list?

- A list is a collection of characters made from zero or more items, separated by commas, and surrounded by square brackets.
- Examples:
  - empty_list = [ ]
  - weekdays = ["Monday", "Tuesday", "Wednesday", "Thursday", "Friday"]
  - birds = ['emu', 'ostrich', 'cassowary']
- Items can be of any data type
  - my_list = [123, 'John', 'Terry', 1.45, True]

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Lists

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Lists

 # Creating lists
```
fruits = ['apple', 'banana', 'orange']
numbers = [1, 2, 3, 4, 5]
mixed_list = [1, 'apple', True, 3.14]
```

 # Accessing lists
```
print(fruits[0])
# Output: apple
```

 # Slicing lists- the last item will be not included
```
print(numbers[1:4])
# Output: [2, 3, 4]
```

 # Reassigning lists (mutable)
```
fruits[0] = 'pear'
print(fruits)
# Output: ['pear', 'banana', 'orange']
```

 # Deleting elements
```
del fruits[1]
print(fruits)
# Output: ['pear', 'orange']
```

 # Multidimensional Lists # let's assume a 3x3 matrix
```
matrix = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
print(matrix[1][2])
# Output: 6
```

 # Concatenation of Lists
```
combined_list = fruits + numbers
print(combined_list)
# Output: ['pear', 'orange', 1, 2, 3, 4, 5]
```

 # Operations on Lists
```
print(len(fruits))  # Output: 2
print(max(numbers))  # Output: 5
print(min(numbers))  # Output: 1
print(sum(numbers))  # Output: 15
```


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Lists

 # Iterating on a list
```
for fruit in fruits:
    print(fruit)
# Output pear orange
```

 # List Comprehension (a concise and powerful way to create lists
```
squares = [x**2 for x in numbers]
print(squares)
# Output: [1, 4, 9, 16, 25]
```

 # Built-in Functions
```
print(len(fruits))
# Output: 2
print(sorted(numbers))
# Output: [1, 2, 3, 4, 5]
print(sum(numbers))
# Output: 15
```

 # Built-in Methods
```
fruits.append('grape')
print(fruits)
# Output: ['pear', 'orange', 'grape']

fruits.remove('pear')
print(fruits)
# Output: ['orange', 'grape']

fruits.insert(1, 'apple')
print(fruits)
# Output: ['orange', 'apple', 'grape']
```


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Lists

How to access list elements or items:

- As with strings, you can extract a single value from a list by indexing.

```
>>>sequences = ["AAA", "TTT", "GGG"]
>>>sequences[0]
    'AAA'
>>>sequences[1]
    'TTT'
```


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Changing a List / Changing a String

Lists	Strings
• Lists are **mutable**	• Strings are **immutable**
>>>sequences = ["AAA", "TTT", "GGG"] >>>sequences[2] = "CCC" >>>print(sequences) ['AAA', 'TTT', 'CCC']	DNAseq = "ANTGCTG" DNAseq[1] = "G" Returns a **type error**

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Any Questions

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