

Programming Foundations in Python

Prepared by Dr. Hamada I. AbdulWakel

Lecture 1





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Introduction to Computer Programming and Python

Lecture 1

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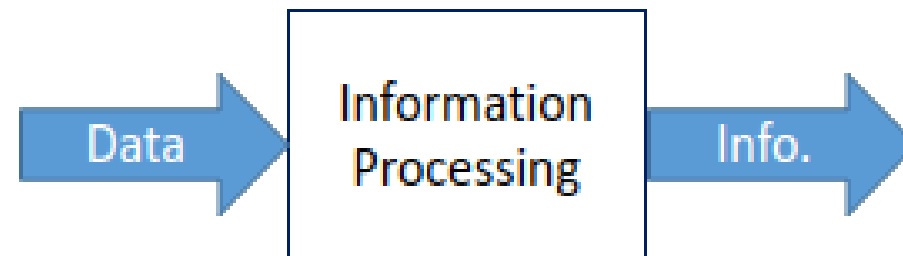
COMPUTER SCIENCE

- **Computer Science (CS):** the study of computation and information.
 - Solving problems is the core of CS.
- **Problem-solving:** the process of transforming the description of a **problem** into a **solution** using the problem-solving tools, strategies, and techniques.



INFORMATION PROCESSING

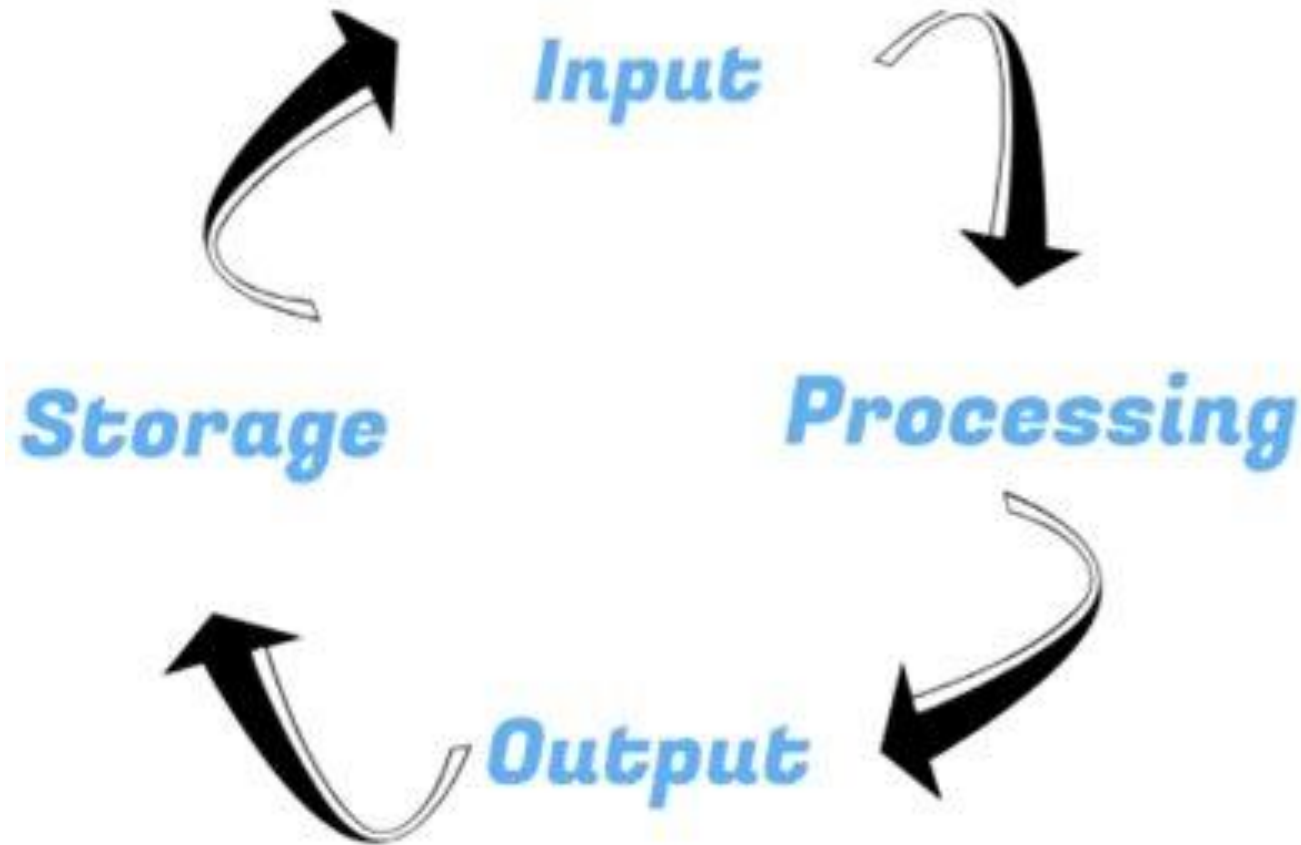
- **Data:** the raw, unorganized facts that can be in the form of text, graphics, audio, or video.
- **Information:** the processed data with a meaningful form.
- **Information processing:** the process of converting raw data into information.



Lecture

01

INFORMATION PROCESSING CYCLE



INFORMATION PROCESSING CYCLE

Cont'd

- **Input:** the stage where the computer is fed with the data from its user by the use of the input devices.
- **Processing:** after the unorganized facts (data) have been sent (input) into the computer's system, the computer processes and organize them to make them meaningful.



INFORMATION PROCESSING CYCLE

Cont'd

- **Output:** the step where the computer brings out information in the form understood to its users and displays it using the output devices.
- **Storage:** the organized data (information) is kept for future use. It can be stored on the internal hard disk or external on storage media.



COMPUTER SCIENCE & INFORMATION PROCESSING RELATIONSHIP

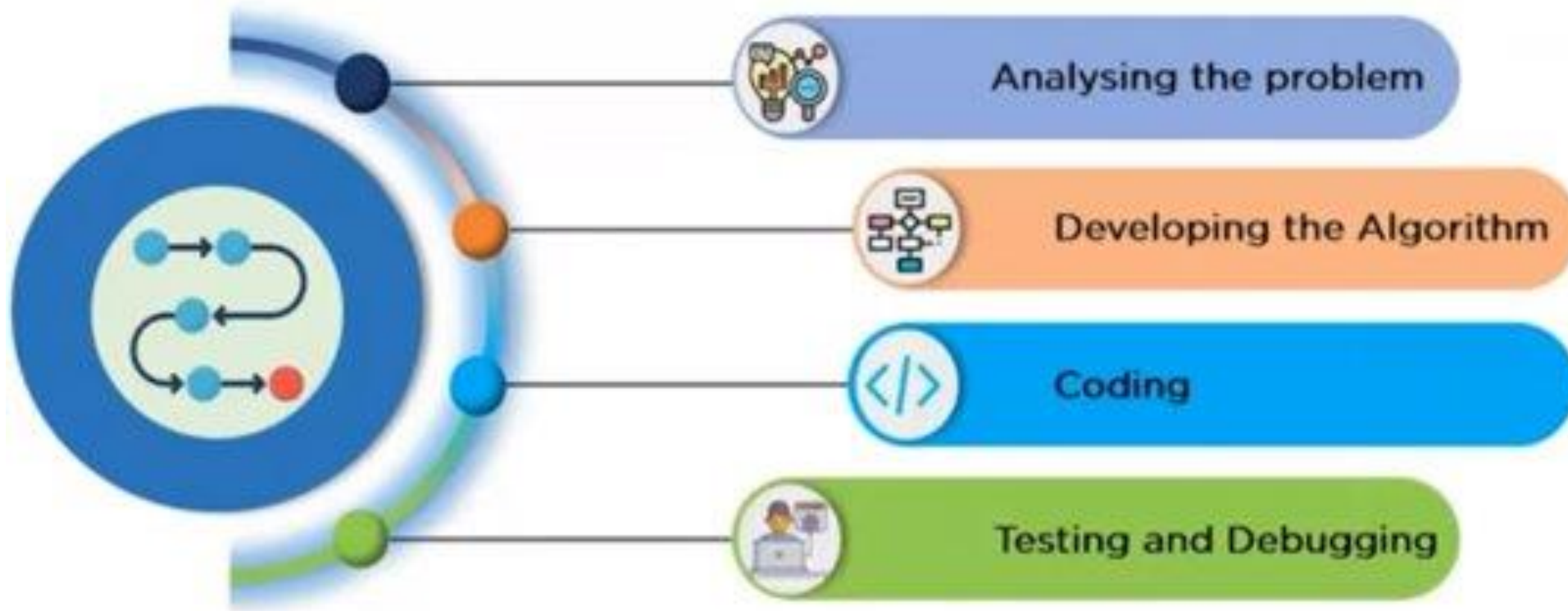
- In order to solve a problem on a computer, you must:
 - Know how to **represent** data describing the problem.
 - Determine the steps to **transform** the information from one representation to another.



Lecture

01

PROBLEM-SOLVING STEPS



PROBLEM-SOLVING STEPS

Cont'd

- **Analyzing the problem (Step 1):**
 - We can figure out the inputs and outputs to be carried out.
- **Developing the algorithm (Step 2):**
 - It is required to decide a solution before writing a program.



PROBLEM-SOLVING STEPS

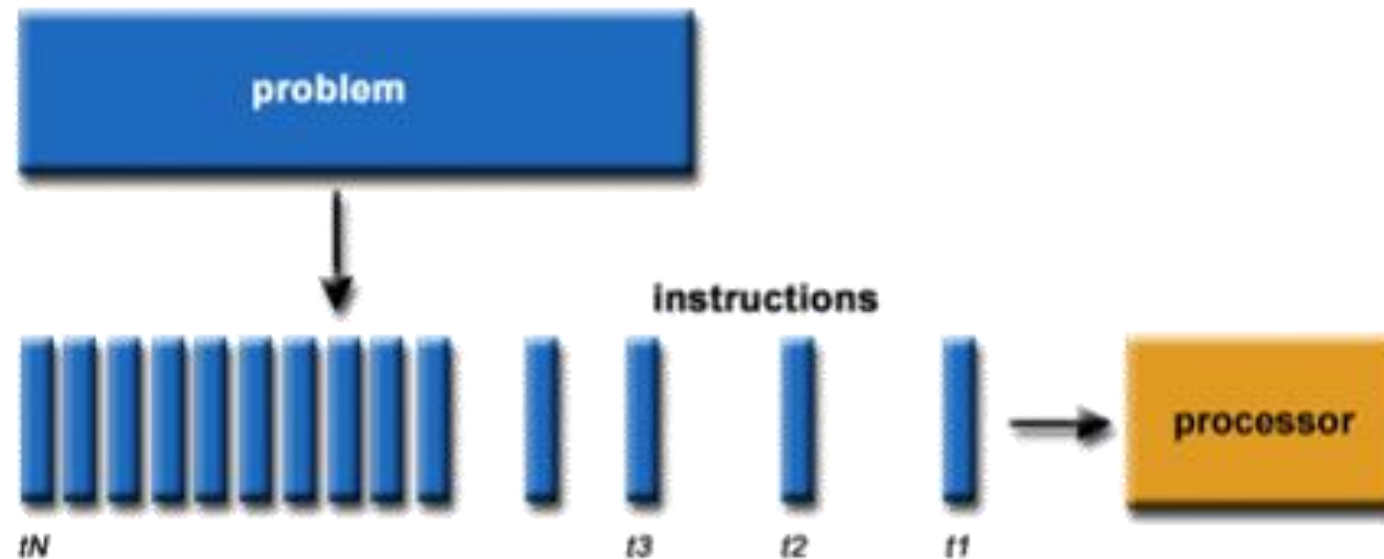
Cont'd

- **Coding (Step 3):**
 - We must convert the decided algorithm into a code.
- **Testing and debugging (Step 4):**
 - The developed code undergoes several rigorous tests.



ALGORITHM

- The sequence of steps that describes each of the computational processes.



ALGORITHM FEATURES

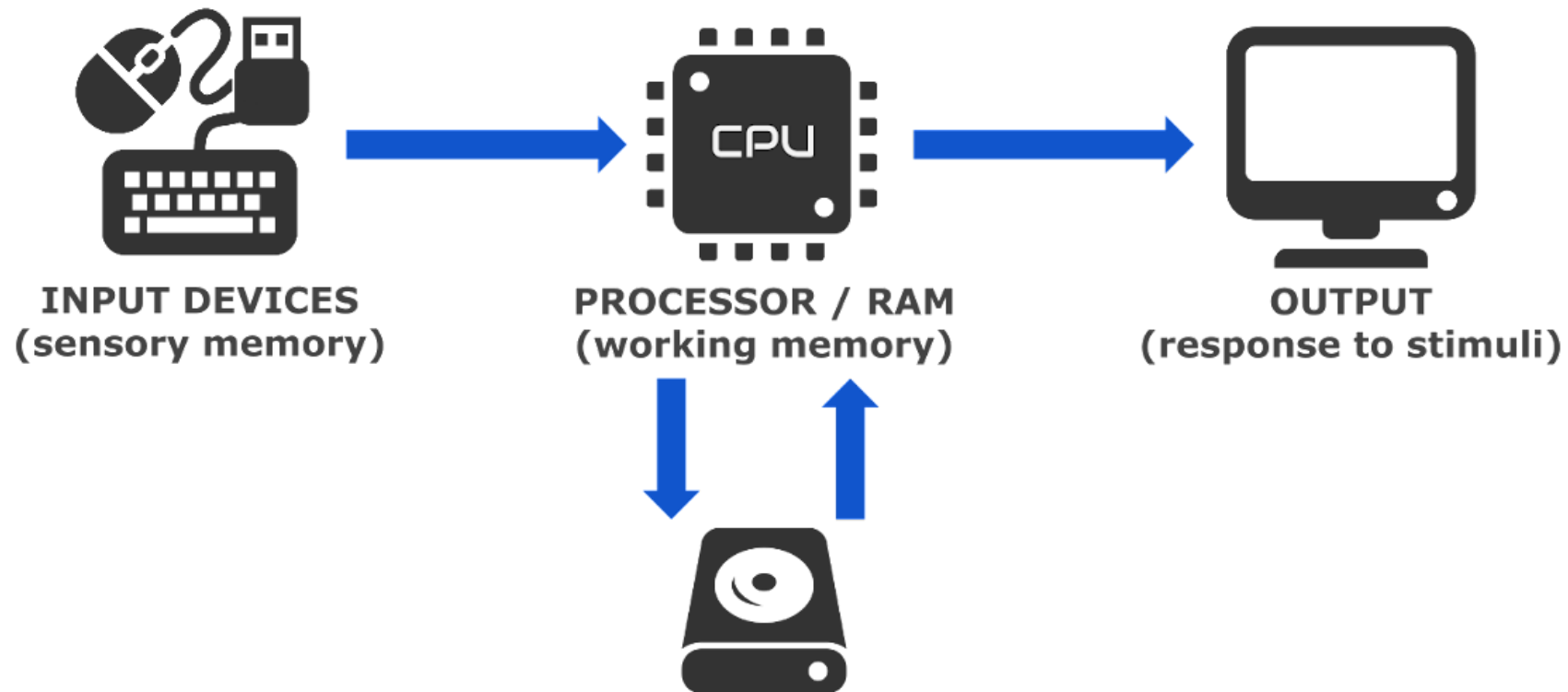
- It must consist of a **finite number** of instructions.
- Each algorithm instruction is well defined and **not ambiguous**.
- It should take **zero or more input**.
- It should **terminate** after a finite time and produce at least **one output**.
- It should be **deterministic** means giving the same output for the same input case.



Lecture

01

HARDWARE & SOFTWARE COLLABORATION



HARDWARE & SOFTWARE COLLABORATION

Cont'd

- A program (i.e., an algorithm) stored in computer memory must be represented in binary digits, or **machine code**.
- Each **loader** takes a set of machine language instructions as input and loads them into the appropriate memory locations.
- In CPU units performs the required computational, logical, and controlling the loaded instructions.



PROGRAMMING & PROGRAMMING LANGUAGES

- **Programming:** the design of software using a set of basic instructions.
- **Programming language:** abstract hardware instructions into basic statements, which are much easier to understand and handle.
- Using a programming language, one can write complex software, achieving tailored functionalities by combination of basic statements.



Lecture

01

FIRST PROGRAM IN PYTHON

- In order to write Python scripts (codes) in your machine (**offline**), we **must** install Python language.
- Writing Python scripts using any **online** editors does **not require** to install Python language on your machine.



FIRST PROGRAM IN PYTHON

Cont'd

- Follow these steps in writing codes:
 - Create a code folder in any location on your machine.
 - Create a Python script file.
 - Python has **.py** extension for its script files.
 - Open the script file in your IDE.
 - Write your code.

```
print("Hello World from Python")
```



PYTHON FORMATING STYLE

- **Indentation:** the leading whitespace before any statement in Python.
- We can use even if **one space** for code indentation, the default is **four spaces**.
- **A code block:** a group of statements that have the same indentation level (have the same number of leading whitespaces).
- It used to make the code more **readability**.





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Data Types & Input/Output Operations

Lecture 2

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CASE STUDY: DESIGN INCOME TAX CALCULATOR

Cont'd

- An English-style algorithm is called **Pseudocode**.
 1. Input the gross income and number of dependents.
 2. Compute the taxable income using the formula
 3. $\text{Taxable income} = \text{gross income} - 10000 - (2000 * \text{number of dependent})$
 4. Compute the income tax using the formula
 5. $\text{Tax} = \text{taxable income} * 0.20$
 6. Print the tax



CASE STUDY: TESTING INCOME TAX CALCULATOR

Cont'd

- Error types:
 - **Syntax error:** occurred due to the mistakes while typing or do not follow the syntax of the specified programming language.
 - **Run-time error:** When the program is running, and it is not able to perform the operation.
 - **Logical error:** an error that leads to an undesired output.



DISPLAYING OUTPUTS IN PYTHON

- Almost all programs have solutions that needed to be displayed to the user through outputting data from the program.
 - Use the print() function.
`help(print)`
`print("Hello", "Ahmed")`
 - Change the default values of print() function.
`print("Hello", "Ahmed", sep="000")`
`print("Hello", "Ahmed", end="1111")`



DATA TYPES IN PYTHON

- Almost variable is a reserved memory location to store values.
- Python is a type-less language.

```
X = 10
```

```
X = "Hello world"
```

- The variable name refers to the memory location where its value store.
 - The id() function is used to get the memory location.

```
I = 10
```

```
print( id( I ) )
```



DATA TYPES IN PYTHON

Cont'd

- A variable name must begin with either a **letter** or an **underscore** (_).
- It contains any number of letters, digits, or other underscores.
- Variable names are **case sensitive**.

X = 10

x = 10

- Variable name could be unicode.

س=5



DATA TYPES IN PYTHON

Cont'd

- The type() function is used to know variable type:

```
X = 10
```

```
print( type( X ) )
```

- Escape sequences are characters used to express special characters as literals.

ESCAPE SEQUENCE	MEANING
\b	Backspace
\n	Newline
\t	Horizontal tab
\\	The \ character
\'	Single quotation mark
\"	Double quotation mark



ARITHMETIC EXPRESSIONS IN PYTHON

Cont'd

Name	Meaning	Example	Rresult
+	Addition	15+20	35
-	Subtraction	24.5-3.5	21.0
*	Multiplication	15*4	60
/	Float Division	4/5	0.8
//	Integer Division	4//5	0
**	Exponentiation	4**2	16
%	Remainder	27%4	3



ARITHMETIC EXPRESSIONS IN PYTHON

Cont'd

Operator	Name	Example	Equivalent
<code>+=</code>	Addition assignment	<code>x += 4</code>	<code>x = x + 4</code>
<code>-=</code>	Subtraction assignment	<code>x -= 2</code>	<code>x = x - 2</code>
<code>*=</code>	Multiplication assignment	<code>x *= 5</code>	<code>x = x * 5</code>
<code>/=</code>	Division assignment	<code>x /= 5</code>	<code>x = x / 5</code>
<code>//=</code>	Integer division assignment	<code>x //= 5</code>	<code>x = x // 5</code>
<code>%=</code>	Remainder assignment	<code>x %= 5</code>	<code>x = x % 5</code>
<code>**=</code>	Exponent assignment	<code>x **= 5</code>	<code>x = x ** 5</code>



ARITHMETIC EXPRESSIONS IN PYTHON

Cont'd

- Rule of **priority**, that is some operator has highest priority than others.
 1. `()`
 2. `**`
 3. Unary operator
 4. `*`, `/`, `//`, `%`
 5. `+`, `-`
- Rule of **associativity**, evaluate expression of similar priority from left to right.



FUNCTIONS WITH NUMERIC DATA TYPES

- Numeric functions:

```
print( bin(50) )  
print( oct(50) )  
print( hex(50) )  
print( int(0x32) )  
print( abs(-5) )  
print( pow(2, 3) )  
print( max(4, 5) )  
print( min(4, 5) )  
print( round(3.7) )
```



GETTING INPUTS IN PYTHON

- Almost all programs **interact with the user** through giving data to the program to process it and display other data.

- Use the input() function.

```
input( )
```

```
input( "Enter your name: " )
```

```
name = input( "Enter your name: " )
```

- Change the type of the value given from the user.

```
stdCount = int( input( "Enter the number of students: " ) )
```

```
stdAge = float( input( "Enter student age: " ) )
```





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Control and Iteration Statements

Lecture 3

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Lecture

03

BOOLEAN DATA TYPE AND COMPARISON OPERATORS

- Boolean data type consists of two values **TRUE** and **FALSE**.
- The **"is"** operator is used to test if two variables refer to the same value.
- The **"is not"** operator is used to compare if the objects are pointing to the same memory location or not.

COMPARISON OPERATOR	MEANING
==	Equals
!=	Not equals
<	Less than
>	Greater than
<=	Less than or equal
>=	Greater than or equal

Lecture

03

COMPOUND BOOLEAN EXPRESSIONS

- The logical operators:
 - The **not** operator.
 - The **and** operator.
 - The **or** operator.

A	not A
True	False
False	True

A	B	A and B
True	True	True
True	False	False
False	True	False
False	False	False

A	B	A or B
True	True	True
True	False	True
False	True	True
False	False	False

PROGRAM FLOW

Cont'd

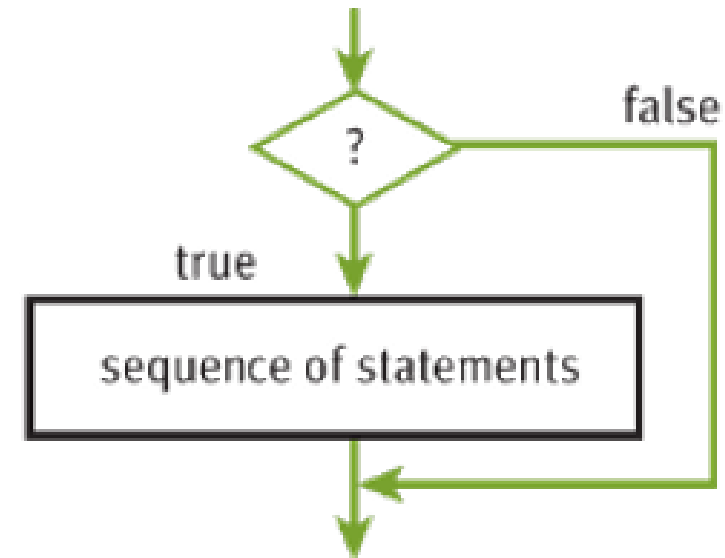
- A program's flow is the order in which the program's code executes.
- **The sequential flow:** a set of statements whose execution process happens in a sequence.
- **The conditional flow:** allows a program to test several conditions and execute instructions based on which condition is true.
- **The looping flow:** used to repeat a group (block) of programming instructions.

Lecture

03

THE CONDITIONAL FLOW STATEMENTS

- The basic-selection statement (If statement).
 - Syntax:
if <condition> :
 <statement(s)>
 - Example:
 x = 5
 if x == 6 :
 print("Yes")



THE CONDITIONAL FLOW STATEMENTS

Cont'd

- The two-way selection statement (If...else statement).

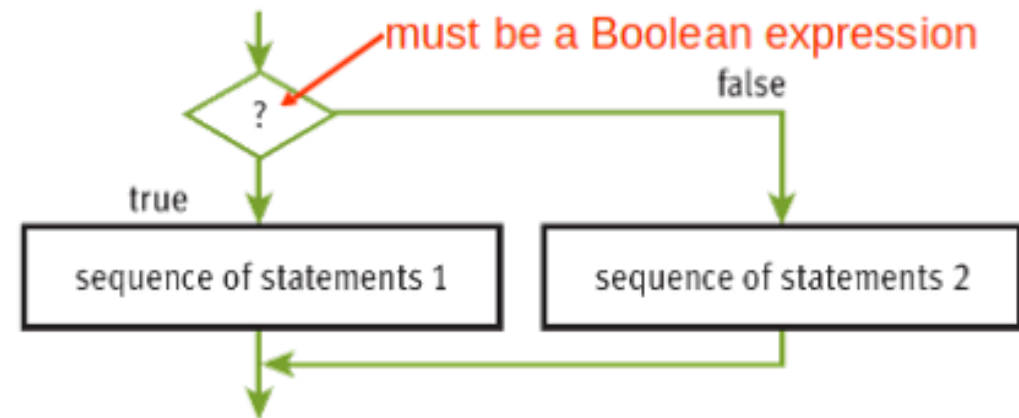
- Syntax:

```
if <condition> :  
    <true statement(s)>
```

```
else:  
    <false statement(s)>
```

- Example:

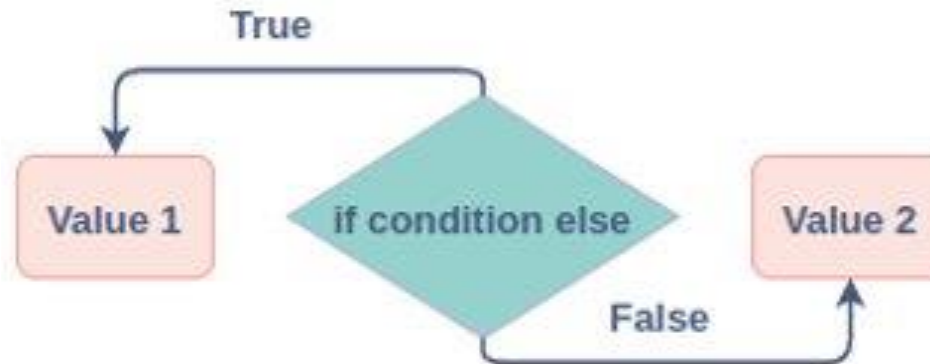
```
x = 5  
if x == 6 :  
    print( "Yes")  
else:  
    print("No")
```



THE CONDITIONAL FLOW STATEMENTS

Cont'd

- The ternary operator statement (If...else statement).
 - Syntax:
`<variable> = <true statement> if <condition> else <false statement>`



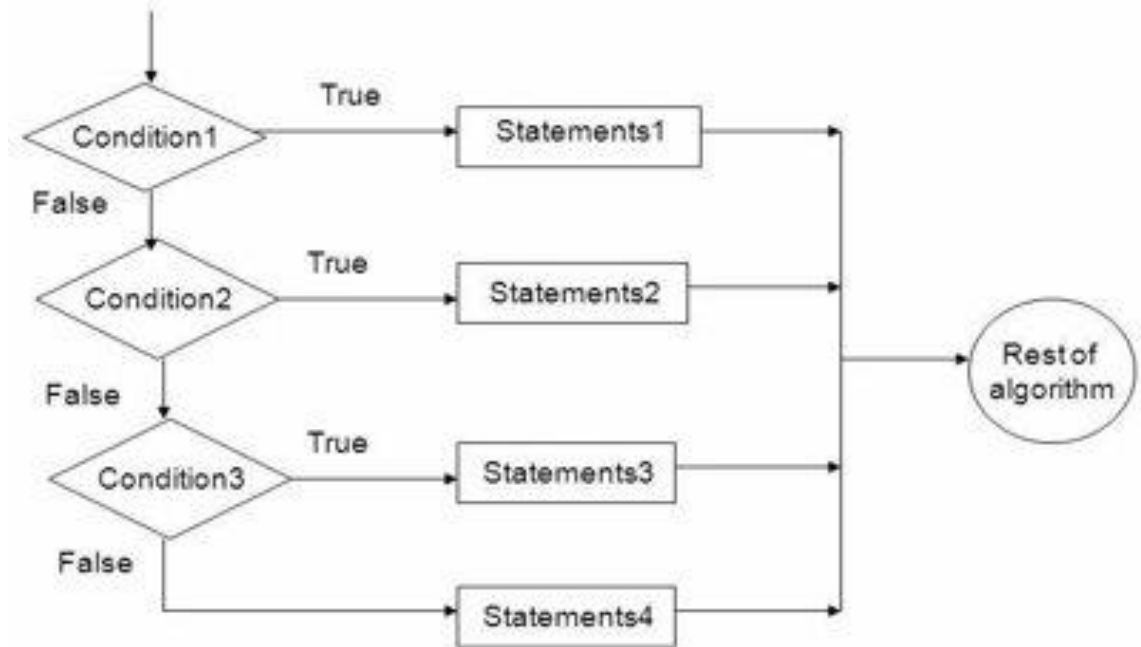
THE CONDITIONAL FLOW STATEMENTS

Cont'd

- The multi-way selection statement (If...elif statement).

- Syntax:

```
if <condition_1> :  
    <true cond_1 statement(s)>  
elif <condition_2> :  
    <true cond_2 statement(s)>  
else:  
    <otherwise statement(s)>
```



THE CONDITIONAL FLOW STATEMENTS

Cont'd

- The nested selection statement (If...if statement).

- Syntax:

if <condition1>:

if <condition2>:

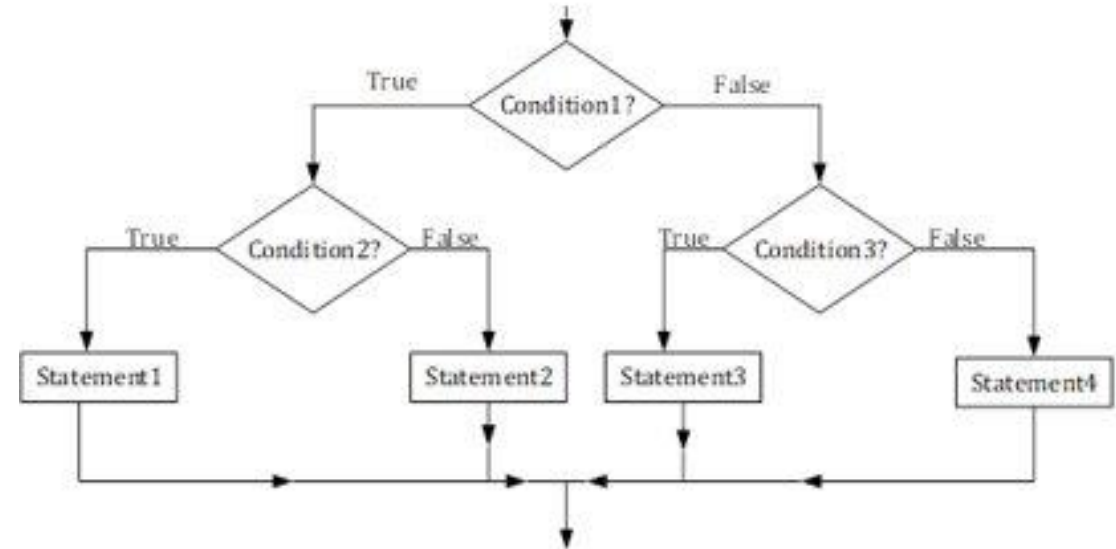
 <true cond2_statement(s)>

else:

 <otherwise statement(s)>

else:

 <otherwise statement(s)>



ITERATION/LOOPING STATEMENTS

- An **iteration statement**, or loop, repeatedly executes a statement, known as the loop body, until the controlling expression is False.
- The **while statement** evaluates the **control expression** before executing the loop body.
- The **for statement** is used to repeat the execution of a set of statements for every element of a **sequence**.

ITERATION/LOOPING STATEMENTS

Cont'd

- The `range` function returns a sequence of numbers between the given range.
 - Examples:
`range(10)`
`range(-10)` #empty sequence
`range(2, 10)`
`range(-2, 10)`
`range(10, 2)` #empty sequence
`range(1, 10, 2)`
`range(10, 1, -1)`

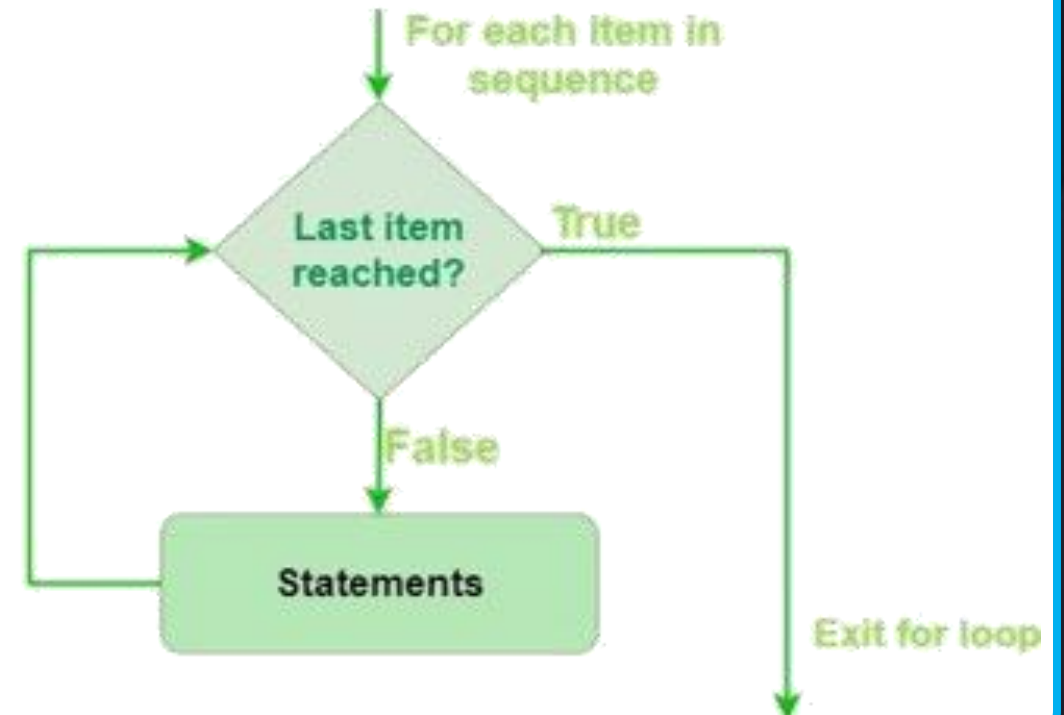
ITERATION/LOOPING STATEMENTS

Cont'd

- The **for** statement:

- Syntax:

```
for <variable> in <sequence> :  
    <statement 1>  
    .....  
    <statement n>
```

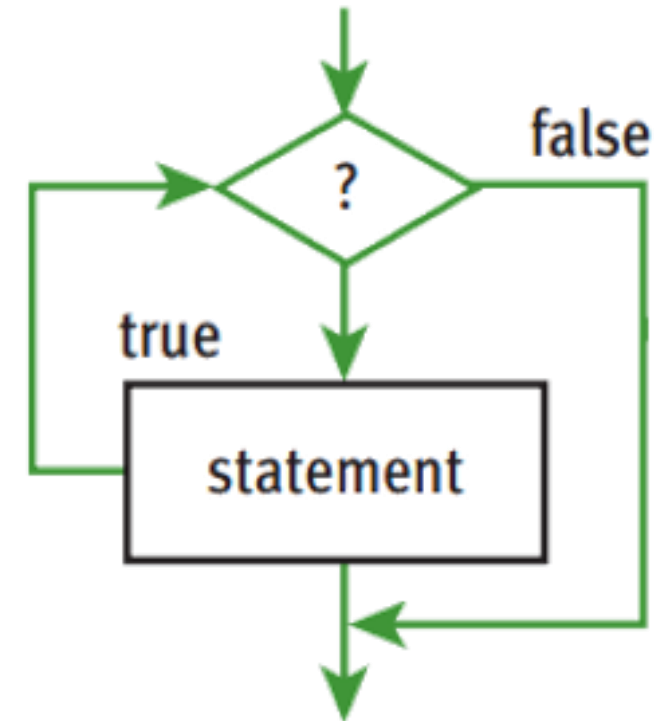


ITERATION/LOOPING STATEMENTS

Cont'd

- The **while** statement:
 - Syntax:
while <condition> :
 <statement 1>

 <statement n>





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String Data Type

Lecture 4

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STRING DATA TYPE

- String declaration.
 - Using double quotes marks " "
 - `S1 = " this is a string "`
 - Using single quotes marks ' '
 - `S2 = ' this is a string '`
 - Using `str( )` function
 - `S3 = str('this is a string')`

STRING DATA TYPE

Cont'd

- When the string itself contains single or double quotes.

`S1 = "He said that "I am from Egypt""` **#syntax error**

- Solutions:

- Using the scape character

`S1 = "He said that \"I am from Egypt\""`

- Using three-double/single quotes. Also, it used to write a string in multiple lines.

`S1 = """ He said that "I am from Egypt """`

`S2 = ''' He said that
I am from Egypt '''`

STRING DATA TYPE FEATURES

- Immutable: we can not change its content in the same location.
- Subscript operator [] is useful when you want to use the position/index to get the element in this position, as we done in strings to get the character in a specific position.

STRING DATA TYPE FEATURES

Cont'd

- Immutable description.

```
s1 = "Hello"
```

```
s1[2] = 'x' #get run-time error
```

```
print( id( s1 ) )
```

```
s1 += " world"
```

```
print( id( s1 ) ) #get a new memory location
```

STRING OPERATORS

- The + operator means **concatenation**.

```
s1 = "Hello"
```

```
s2 = 'World'
```

```
print( s1 + s2 )
```

- The * operator means **repeatation**.

```
s1 = "Hello World"
```

```
print( s1 * 3 )
```

STRING FUNCTIONS

- **ord('character'):** to get the ASCII code for the given character.
`print( ord( 'A' ) )`
- **chr(number):** to get the character corresponds to the given number.
`print( chr( 95 ) )`
- **len(string):** to get the string length.
`s1 = "Hello"`
`print( len( s1 ) )`

STRING FUNCTIONS

Cont'd

- **isalpha()**: to check if the string contains **only** alphabetic.
`s1 = "Hello123"`
`print(s1.isalpha())`
- **isdigit()**: to check if the string contains **only** numbers.
`s1 = "123"`
`print(s1.isdigit())`
- **isalnum()**: to check if the string contains alphabetic and number.
`s1 = "Hello123"`
`print(s1.isalnum())`

STRING FUNCTIONS

Cont'd

- **islower():** to check if the string is written in lower case.

```
s1 = "ESU"  
print(s1.islower())
```
- **isupper():** to check if the string is written in upper case.

```
s1 = "ESU"  
print(s1.isupper())
```
- **isspace():** to check if the string contains whitespaces.

```
s1 = "   "  
print(s1.isspace())
```

STRING FUNCTIONS

Cont'd

- **startswith(substring):** to check if the string begins with the given substring.
`s1 = "ESU"`
`print(s1.startswith("H"))`
- **endswith(substring):** to check if the string ends with the given substring.
`s1 = "ESU"`
`print(s1.endswith("U"))`



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List, Tuple, and Dictionary Data Types

Lecture 5

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NEW PYTHON DATA TYPES

- A **list** allows the programmer to manipulate a **dynamic** sequence of data values of any types.
- A **tuple** is a special case of lists which allows the programmer to manipulate a **fixed** sequence of data values of any types.
- A **dictionary** organizes **dynamic** data values by association with other data values rather than by sequential position.

LIST FEATURES

- A list literal consists of a comma-separated list of items, enclosed in a pair of square brackets [].
- Each item in a list has a **unique index** that specifies its position.
 - Zero-based indexing: from 0 to length – 1
- Lists are mutable, means it can be changed after they are created.
- List item values can be duplicated and any data types.

CREATING LISTS

- Empty list

`L1 = [ ]`

`L2 = list()`

- Same data type.

`L3 = [1, 2, 3]`

- Different data types.

`L4 = [1, True, "ESU"]`

`L5 = list( [1, True, "ESU"] )`

`L6 = list( "ESU" )` #What about this?

ACCESSING LIST ITEMS

Cont'd

- Access items example:

```
Numbers = [1, 2, 3, 4, 5]
print( Numbers[5] )
print( Numbers[-1] )
print( Numbers[10] )
Numbers[2] = 15
print( Numbers[2] )
Numbers[ 0 : 2 ] = [ 6, 7 ]
print( Numbers )
```

Lecture

05

LIST SLICING

Cont'd

- Using this form [start : stop].
- The slicing generate a new list.

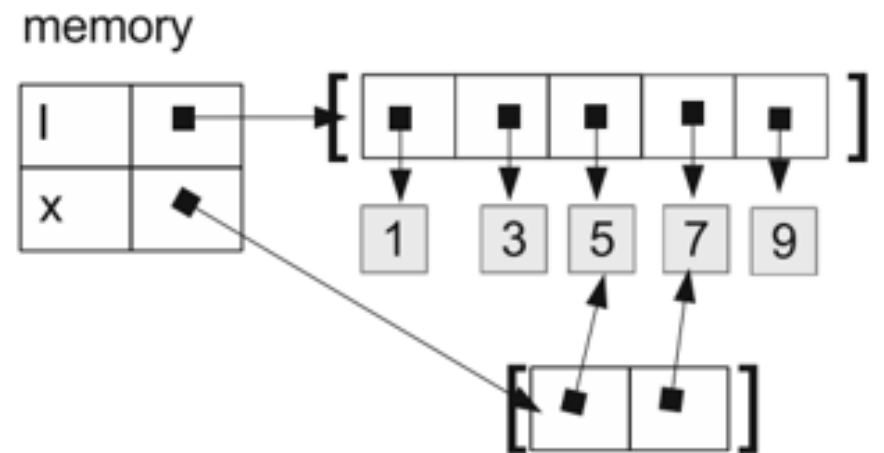
```
L1 = [1, 2, 3, 4, 5, 6, 7, 8, 9]
```

```
print( L1[ 3 :    ] )
```

```
print( L1[    : 5 ] )
```

```
print( L1[ 2 : 5 ] )
```

```
l = [1, 3, 5, 7, 9]
x = l[2:4]
```



LIST OPERATORS

- The list type supports operations including `+`, `*`, `in`, and `not in`.

```
L1 = [1, 2, 3, 4]
```

```
L2 = L1 + [5, 6]
```

```
print( L2 )
```

```
L2 = L1 * 2
```

```
print( L2 )
```

```
print( 1 in L1 )
```

```
print( 1 not in L1 )
```

LIST FUNCTIONS

- **len(list):** to get the list length.

```
L1 = [1, 2, 3, 4, 5]  
print( len( L1 ) )
```
- **min(list):** to get the minimum value in a list.

```
print( min( L1 ) )
```
- **max(list):** to get the maximum value in a list.

```
print( max( L1 ) )
```

LIST FUNCTIONS

Cont'd

- **append(element):** to add the element to the end of a list.
`L1.append(6)`
- **insert(index, element):** to insert element at specified index.
`L1 = [1, 2, 3, 4, 5]`
`L1.insert( 6, 2 )`
- **index(element):** to get the index of an element.
`L1 = [1, 2, 3, 4, 5]`
`L1.index( 2 )`
- **remove(element):** to remove the first occurrence of the element.
`L1.remove(3)`

DICTIONARY DATA TYPE/STRUCTURE

- A **dictionary** organizes elements between curly braces { }.
- Data structures organized by association are also called **tables** or **association lists**.
- In Python, a dictionary associates a set of **keys** with **data values**.
 - Keys must be immutable type (i.e., number, string, tuple)
 - Keys are unique.
 - Values can be of any type.

DICTIONARY DATA TYPE/STRUCTURE

Cont'd

- A dictionary creation/declaration.

```
dict0 = {}
```

```
dict1 = dict() #empty dictionaries
```

```
dict2 = { 1 : 123 , "a" : 456 , 2 : True }
```

```
dict3 = dict( [ (1 , 123), ("a" , 456), (2 , True) ] )
```

Lecture

05

ACCESSING DICTIONARY ELEMENTS

- Using the index operator/subscript operator `[]` with element associated key.

```
friends = { 'Mohamed': 30, 'Ahmed': 25, 'Ali': 40 }  
print(friends)  
print(friends[1]) #error: elements are not accessed by numerical index.  
print(friends['Mohamed'])  
print(friends['Abdulrahman']) #error: keyerror 'Abdulrahman'
```



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Functions in Python

Lecture 6

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FUNCTIONS AS AN ABSTRACTION MECHANISM

- Functions serve as abstraction mechanisms.
- Functions are the re-usable pieces/block of code which help us to organize structure of the code and do a task.
- Functions allow us to run a specific statements multiple times without repeating these statements.
 - This achieve the concept of "DRY" **don't repeat yourself**.

BUILT-IN VS. USER-DEFINED FUNCTIONS

- The built-in functions: the functions provided by python language.

`print()`
`input()`
`popitem()`

- The user-defined functions: the functions that the user creates it to do a specific task.

`getUserAccount()`
`updateStudentAddress()`

FUNCTION CREATION

Cont'd

- Code:

```
def sayHello( ):
    print("Hello to Python from ESU")
```

```
def Mysum( ):
    X = 4
    Y = 5
    print("Sum = ", X + Y)
```

Lecture

06

FUNCTION CALLING

- The `def` statement only creates/declares a function but does not call it.
- After creating the function, you can call (run) the function by adding parentheses after the function's name.

```
sayHello( )
```

```
Mysum( )
```

```
mysum( ) #NameError
```

FUNCTION PARAMETERS AND ARGUMENTS

- A parameter is a **variable** in a function definition. It is a placeholder and hence does not have a concrete value.

```
def Mysum(x, y):  
    print("Sum = ", x + y)
```

- An argument is a **value** passed during function calling.
Mysum(2, 3)

RETURNING VALUES FROM FUNCTIONS

- Any function may return a computed value or the default value **None**.
- A function can return a value using **the return statement**.
- Unlike C, C++ or Java, multiple values can be returned by a python function.

Lecture

06

IDENTIFIER SCOPES

- Identifier scope refers to the **accessibility** of identifiers in different parts of code; it is an important concept related to functions.
- The **local scope** refers to the variable defined and used inside a block of code, (i.e., function).

```
def testLocal():  
    a = "Hello im a local variable :)"  
    print(a)
```

```
print(a)
```

IDENTIFIER SCOPES

Cont'd

- The **global scope** refers to the variable not belongs to a specific block and used inside the whole program.

```
a = "Hello im a global variable :)"  
def testGlobal():  
    print(a)  
  
testGlobal()
```

IDENTIFIER SCOPES

Cont'd

- If you modify a global scope variable inside a function, this will throw an error called **UnboundLocalError**.

```
a = "Hello im a global variable :)"  
def testGlobal():  
    print(a)    # will throw an error  
    a = "Hello"  #this means a new variable  
    print(a)
```

```
testGlobal()
```

IDENTIFIER SCOPES

Cont'd

- If you need to modify a global scope variable, you need to use the **global** reserved word.

```
a = "Hello im a global variable :)"
```

```
def testGlobal():
```

```
    global a
```

```
    print(a)
```

```
    a = "Hello"
```

```
    print(a)
```

```
testGlobal()
```



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Functions and Modules

Lecture 7

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FUNCTION NAMES

Cont'd

- Function names are references to functions and that we can assign multiple names to the same function.
- Functions are stored in variables like everything else.

```
def increment(x):  
    return x + 1  
Myincrease = increment  
print(Myincrease)  
print(increase(5))
```

FUNCTION WITH DEFAULT ARGUMENTS

Cont'd

- Following the required arguments are one or more default arguments.

```
def function(y = 5, x): #SyntaxError  
    pass
```

- When function is called with these arguments, default values are **overridden** by caller's values.

```
function(2)  
function(2, 3)
```

FUNCTION WITH DEFAULT ARGUMENTS

Cont'd

- Example2:

```
def greet(name, desc="Mr."):
    print("Hello,", desc, name)
```

```
greet("Ahmed")
greet("Ahmed", "Dr.")
```

FUNCTION KEYWORD ARGUMENTS

Cont'd

- Example3:

```
def accessArguments(x, y = 1, z = 2):  
    print("X= ", x, "Y= ", y, "Z= ", z)
```

```
accessArguments(3)
```

```
accessArguments(3, 10)
```

```
accessArguments(3, z = 5)
```

```
accessArguments(3, z = 4, y = 6)
```

FUNCTION WITH ARBITRARY ARGUMENTS

Cont'd

- Sometimes, we **do not know** in advance the number of arguments that will be passed into a function.
- In the function definition, we use an asterisk `*` before the parameter name to denote this kind of argument.
- The `*args` syntax allows a function to receive any number of positional arguments as a **tuple**.

FUNCTION WITH ARBITRARY ARGUMENTS

Cont'd

- Example4:

```
def greet(*names):  
    for name in names:  
        print("Hello," , name)
```

```
greet("Ahmed", "Mohamed")  
greet("Ahmed", "Mohamed", "Aly")  
greet("Ahmed", "Mohamed", "Aly", "Mahmoud")
```

ANONYMOUS FUNCTIONS

Cont'd

- An anonymous function is a function that is defined **without a name**.
- Anonymous functions are defined using the **lambda** keyword.
- Lambda functions can have any number of arguments but **only one expression**.

`lambda arguments: expression`

ANONYMOUS FUNCTIONS

Cont'd

- Example11:

```
double = lambda x: x * 2  
print(double(5))
```

- This function has no name. It returns a **function object** which is assigned to the identifier **double**. We can now call it as a normal function.

MODULES IN PYTHON

Cont'd

- Modules are assemblies of code that provide specific functionalities and constants for **reuse**.
- Adding a module to your program helping you doing some tasks to save time and effort, where you can add/call multiple modules.
- Constants and functions defined in a module can be accessed by using the module name and **the dot (.) operator**.
`<module>.<identifier>`

MODULES IN PYTHON

Cont'd

- Calling modules in a program:

```
import module_name1, module_name2, .....
```

- Example16.

```
import random  
print(random)  
print(random.random())  
print(dir(random))
```



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Object-Oriented Programming

Lecture 8

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POP: FEATURES

- The main concern in POP is **doing things**.
- Depend on the built-in and user-defined **functions**.
- Based on local and global variables in parameter passing.
- **Modularity**: means splitting the program into parts where the top-down design can be applied.

PRIMITIVE DATA TYPES

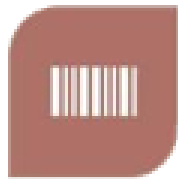
- **Primitive data types**, a.k.a. basic or fundamental data types, are the simplest and most basic building blocks in a programming language. It store single simple value.
- The primitive data types vary between programming languages, but some common ones include:
 - Integer, Short, and Long.
 - Floating-point, Double.
 - Character.
 - Boolean.
 - String.

COMPLEX/CUSTOMER DATA TYPES

Cont'd



Customer



Product



Post



Name, address, payment method



Name, **description**, is it in stock?



User, **post text**, date

OBJECT-ORIENTED PROGRAMMING

- Object-Oriented Programming (OOP) is a programming paradigm that organizes code into objects, which can encapsulate data and behavior.
 - Program is divided into classes and objects.
 - The main concern on **data**.
 - Strong modeling to real world problems.
 - It is easy to maintain program even if it is too complex.
 - Provide strong data security.
 - It is highly extensible programming paradigm.
 - Unit of programming is **class**.
 - Ex: Python, Java, C#.

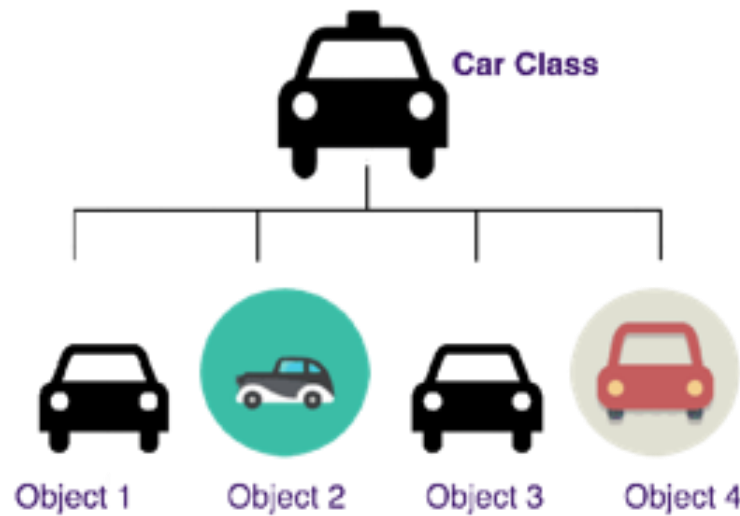


OOP: CLASS

- **Classes:** the user-defined data types that act as the blueprint for individual objects, attributes and methods.
 - **Attributes:** are defined in the class template and represent the state of an object. Class attributes belong to the class itself.
 - **Methods:** are functions that are defined inside a class that describe the behaviors of an object.

OOP: OBJECT

- **Objects:** are **instances** of classes and represent real-world entities. They encapsulate data (attributes) and behavior (methods) related to those entities.



CLASS DEFINITION

- All class definitions start with the `class` keyword, which is followed by the name of the class and a **colon**.
- Any code that is **indented** below the class definition is considered part of the class's body.

```
class className :  
    #class body
```

Lecture

08

INSTANCE ATTRIBUTES

- Instance attributes are the **properties** that all objects must have and defined inside the method called `__init__()`.
- When a new object is created, `__init__()` sets **the initial state** of the object by assigning the values of the object's properties.
- If you change the attributes of an instance, it won't affect other instances.
- The `__init__()` can take any number of parameters, but the first parameter will always be a variable called **self**.

INSTANCE ATTRIBUTES

Cont'd

- Example:

```
class Student:  
    def __init__(self, name, age):  
        self.name = name  
        self.age = age
```

- Both **name** and **age** are called instance attributes.

CLASS ATTRIBUTES

- The class attributes are properties that have **the same value** for all class instances.
- Class attributes are defined directly **under the line of the class name**, outside the `__init__()` function.
- You can access the class attribute via **instances** of the class or via the **class name**.

Lecture

08

DEALING WITH INSTANCE AND CLASS ATTRIBUTES

- When you access an attribute via an **instance of the class**, Python searches for the attribute in **the instance attribute list**.
- If the instance attribute list doesn't have that attribute, Python continues looking up the attribute in **the class attribute list**.
- However, if you access an attribute via **the class name**, Python directly searches for the attribute in **the class attribute list**.

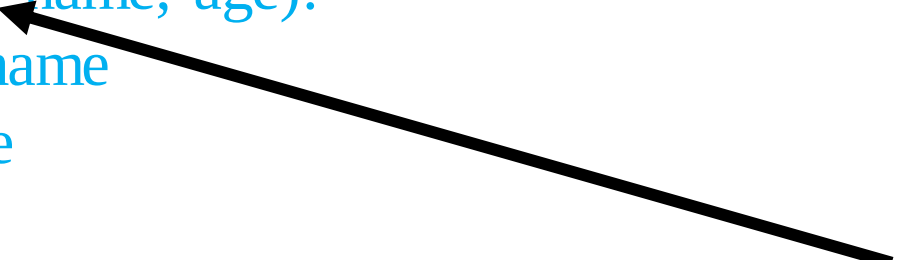
INSTANTIATING OBJECTS

Cont'd

- Example:

```
class Student:  
    def __init__(self, name, age):  
        self.name = name  
        self.age = age
```

`std1 = Student("Ahmed", 20)` → The object **std1** is automatically passed where self is referring to the object **std1**





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Object-Oriented Programming II

Lecture 9

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THE GETTER AND SETTER METHODS

- **getattr(obj, 'paramName')**: returns the current value of this parameter.
- **setattr(obj, 'paramName', value)**: allows you to set/change the value of an attribute.
- **hasattr(obj, 'Name')**: checks whether the object has this attribute or not.
- **isinstance(obj, className)**: returns True if the specified object is of the specified type, otherwise False .

THE OPERATOR OVERLOADING

- Example:

```
class Point:
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y
p1 = Point(1, 2)
p2 = Point(2, 3)
print(p1+p2)
```

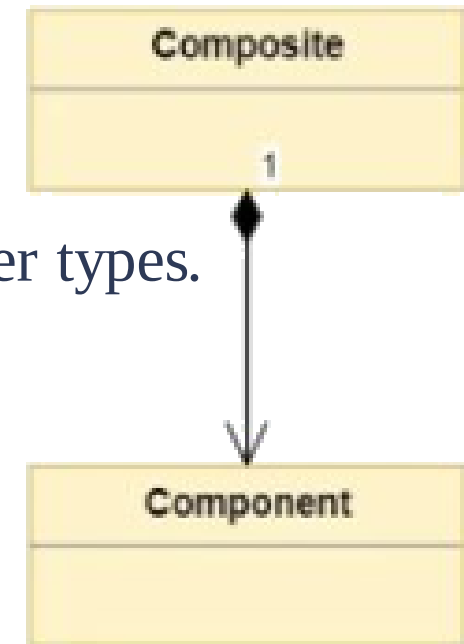
THE OPERATOR OVERLOADING

Cont'd

- Among the special functions for operators are:
 - + by overloading `__add__(self, otherObj)` for **obj1 + obj2**
 - - by overloading `__sub__(self, otherObj)` for **obj1 - obj2**
 - * by overloading `__mul__(self, otherObj)` for **obj1 * obj2**
 - / by overloading `__div__(self, otherObj)` for **obj1 / obj2**
 - % by overloading `__mod__(self, otherObj)` for **obj1 % obj2**
 - ** by overloading `__pow__(self, otherObj)` for **obj1 ** obj2**

CLASS COMPOSITION

- **Composition:** is a concept that models a **has a** relationship.
- It enables creating complex types by combining objects of other types.
- This means that a class Composite can contain an object of another class Component.
- A composition relationship occurs if one class has an **instance attribute** which is an object from the other class (car has wheels).



CLASS COMPOSITION

Cont'd

- Example:

```
class Course:
    def __init__(self, name):
        self.cname = name;    self.hours = 3

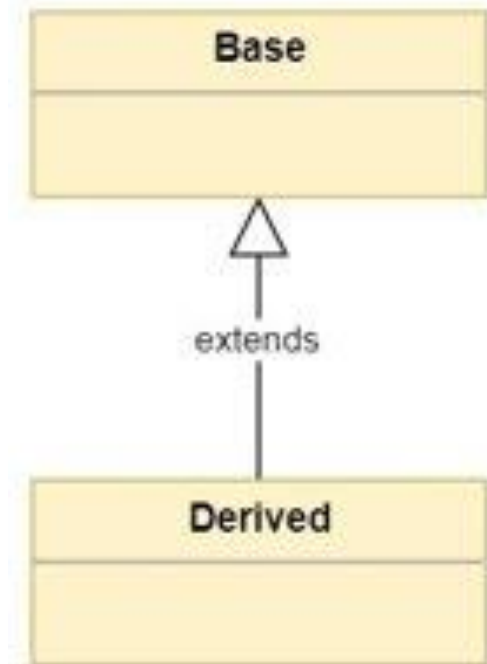
class Student:
    def __init__(self, name):
        self.course = Course("OOP")
        self.name = name

s = Student("ahmed")
print( s.course.cname )
```

INHERITANCE

- **Inheritance:** models what is called an **is a** relationship.
- A class can inherit **all** the methods and attributes of another class. These methods and attributes become available to the new class without the need to redefine them from scratch.
- A **derived class** that inherits from a **Base class**.

```
class DrivedClassName(BaseClassName):  
    # body
```



POLYMORPHISM

- Polymorphism is taken from the Greek words **Poly** (many) and **morphism** (forms).
- it means that the methods with **the same name** can be executed on **many** objects or classes.
- There are two ways to perform polymorphism:
 - Using functions.
 - Using class methods.

CLASS POLYMORPHISM

- Polymorphism defines methods in **the child class** that have the same name as the methods in the parent class.
- The inherited child class method will modify the parent's implementation with an implementation that suitable for the child class.
- This process of re-implementing a method in the child class is known as **Method Overriding**.



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File Handling and Graphical User Interface

Lecture 10

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FILES

- Since RAM is volatile (which loses its data when the computer is turned off).
- **Files** are named locations on disk to store related information.
- They are used to permanently store data in a non-volatile memory (e.g. hard disk).



Lecture

10

FILE OPENING

- The syntax of opening a file is:
`File_object_name = open(filename, mode)`
- The "filename" is a **string** argument which specify filename along with its path.
- The mode is a **string** argument which used to specify how file will be used.
 - The reading mode represented by "r".
 - The writing mode represented by "w".
 - The appending mode represented by "a".

Lecture

10

FILE CLOSING

- When we are done with performing operations on the file, we need to properly close the file.
- Closing a file will free up the resources that were tied with the file.
- The syntax for closing a file is:

```
File_object_name.close()
```

Lecture

10

FILE READING DATA

- We must open the file in reading **r** mode.
- To read data back from the file you need one of these methods:
 - **read([number])**: return specified number of characters from the file.
 - If the number is omitted, it will read the entire content.
 - **readline()**: returns the next line of the file.
 - **readlines()**: read all the lines as a list of strings.
- **FileNotFoundError** is the error generated if the file you try to read is not exists.

FILE WRITING DATA

Cont'd

- We need to open it in write w, append a or exclusive creation x mode.
- We need to be careful with the w mode, as it will overwrite into the file if it already exists.
- Code:

```
import os
os.chdir("/path/to/the/folder/")
with open("myfile.txt", "w") as f:
    f.write("My Name: Hamada I.")
    f.write("I'm a teacher at \n" )
```

Lecture

10

FILE RENAMING AND DELETING

- The os module provides methods that help to perform file-processing operations, such as renaming and deleting.
- To rename an existing file, rename() method is used.
- It takes two arguments, current file name and new file name.
- Syntax:

`os.rename(current_file_name, new_file_name)`

`os.remove(filename)`

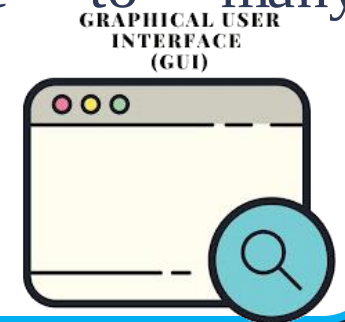
COMMAND LINE INTERFACE

- **The command-line interface (CLI):** takes input from the user via text commands entered in a terminal or console window.
- **CLI features:**
 - Based on commands a user inputs in the terminal.
 - More efficient and faster since it doesn't require much memory or processing power as the entire interaction is performed in a terminal window.
 - Requires memorizing commands, which sometimes have complex syntax and many arguments.
 - Takes input from the keyboard.
 - Users cannot change CLI's appearance.



GRAPHICAL USER INTERFACE

- **The graphical-user interface (GUI) version:** based on graphics and visual elements, allowing users to interact with the system using a keyboard and a mouse.
- **GUI features:**
 - Based on visual elements such as icons, buttons, windows, dialog boxes, etc.
 - Requires more memory and processing power due to many graphical components that need to be loaded.
 - Icons method reduces the required knowledge level.
 - Takes input from the mouse and keyboard.
 - Appearance can be modified to suit the users' needs.

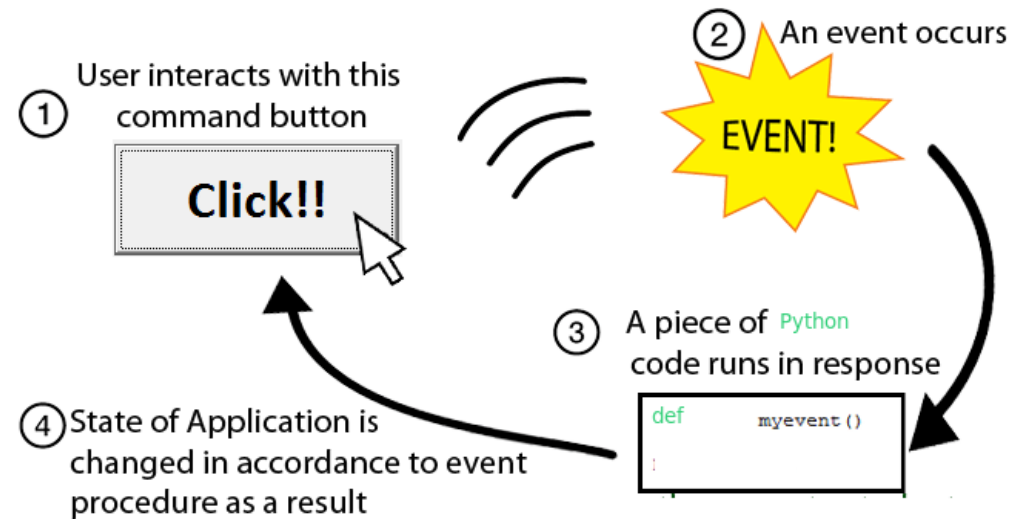


Lecture

10

EVENT-DRIVEN PROGRAMMING

- In GUI, the user-generated events (i.e., mouse clicks, button clicks) trigger operations in the program to respond by pulling in inputs, processing them, and displaying results.



TKINTER MESSAGE BOXES

Cont'd

- Code:

```
from tkinter import messagebox

messagebox.showinfo("title","Information")
messagebox.showwarning("title","Warning")
messagebox.showerror("title","Error")
messagebox.askquestion("title", "Do you love GUI?")
response = messagebox.askyesnocancel("title", "Do you love GUI?")
print(response)
```

TKINTER FRAME

Cont'd

- Code:

```
from tkinter import *
```

```
mainFrame = Tk()
```

```
mainFrame.title("The main frame title")
```

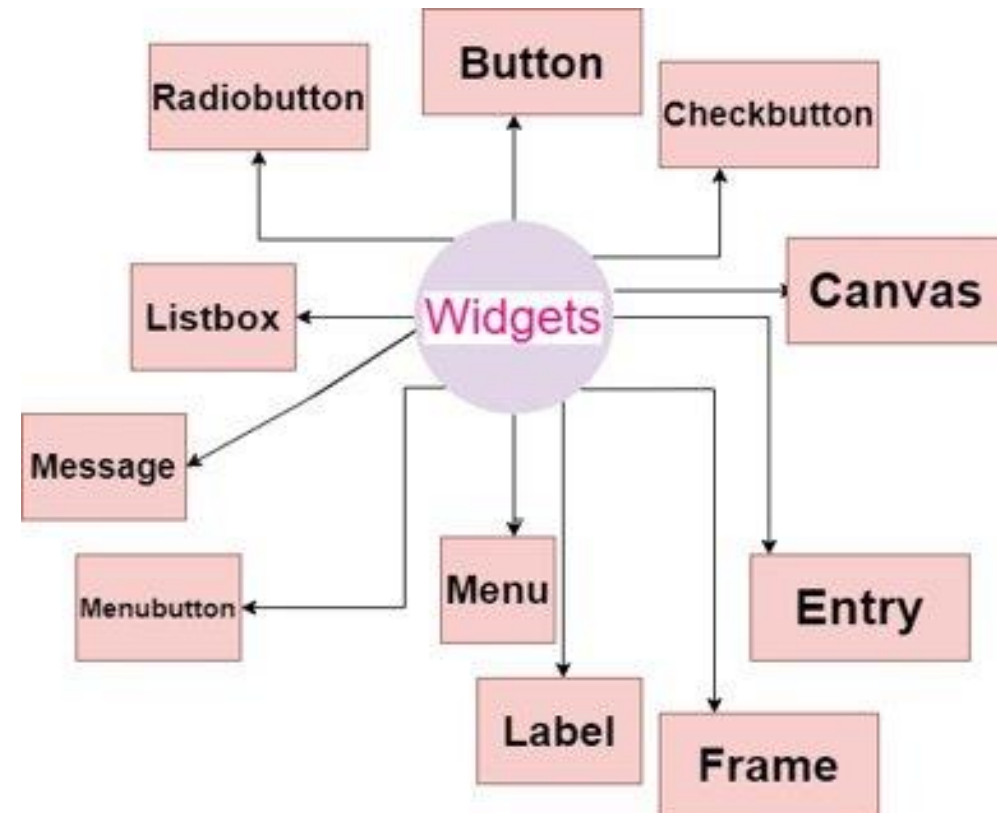
```
mainFrame.geometry("300x300")
```

```
mainFrame.mainloop() #listens for events
```

Lecture

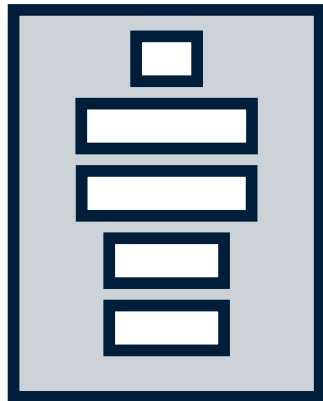
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TKINTER WIDGETS



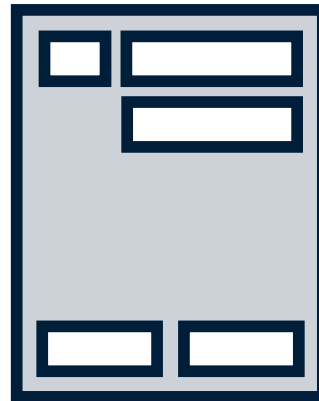
TKINTER GEOMETRY MANAGER

- The geometry measurements allow you to organize the widgets and throughout the parent frames or parent widget area.



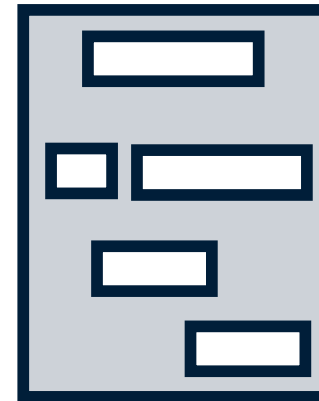
Pack

One after another,
vertically or horizontally



Grid

Assigned to grid cells,
using rows and columns



Place

Put stuff anywhere,
using coordinates



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Thank You

