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Python Programming: Introduction & Installation

❖ **General Purpose Language:**
- ❑ Machine Learning AI
- ❑ GUI, Web, Software Dev

❖ **Download Install & Run:**
- ❑ https://www.python.org
- ❑ Start > Python IDLE
- ❑ Write a line of code

  e.g. 2+3 OR print("Hello World")

❖ **Python Features:**
- ❑ Interpreted
- ❑ Object oriented
- ❑ High Level
- ❑ Dynamically typed
- ❑ Current version 3.x

❖ **Community version of PyCharm IDE:**
- ❑ https://www.jetbrains.com/pycharm/download
- ❑ Install 64 bit (depending on system)
- ❑ Start > PyCharm > Create New Project > filename.py
- ❑ print("Hello World")
- ❑ Run the file

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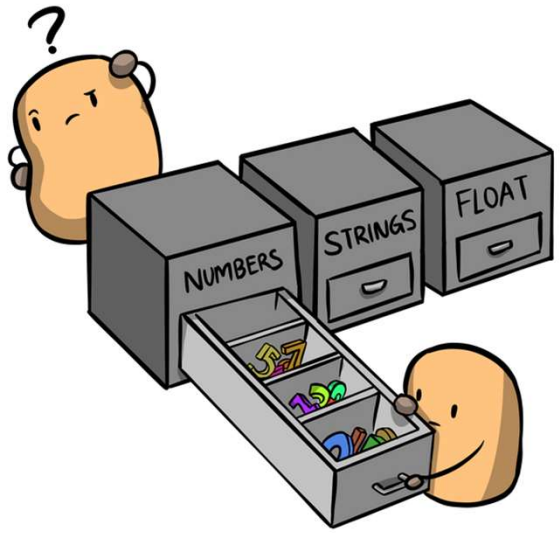
PYTHON PROGRAMMING: VARIABLES & STRINGS



❖ **Types:**

- ❑ **int** e.g. 4, 1000, -34 etc.
- ❑ **float** e.g. 33.4, -0.0005
- ❑ **string** e.g. 'My friend Tom', 'cricket' etc.

❖ **Assignment:**

- ❑ x = 2
- ❑ name = 'Rupa'

❖ **Strings:**

A	n	o	d	i	a	m		R	o	c	k	s	
0	1	2	3	4	5	6	7	8	9	10	11	12	→index
-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	

Strings are immutable:

str1 = "My Name"

str1[3] = 'n' **# Error**

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Python Programming: Lists, Tuples & Sets

❖ **Lists: [ ]**

- ❑ Mutable
- ❑ E.g.: myList = [23, 91, 9, 507]
- ❑ Functions used in List:
  - ➢ append()
  - ➢ insert()
  - ➢ remove()
  - ➢ pop()
  - ➢ clear()
  - ➢ extend()
  - ➢ max(list)
  - ➢ min(list))
  - ➢ sum(list))
  - ➢ sort()
  - ➢ sort(reverse=True)

❖ **Tuples: ( )**

- ❑ Immutable
- ❑ Iteration is faster than list
- ❑ E.g.: myTuple = (23, 91, 9, 507)

❖ **Sets: { }**

- ❑ Like mathematical sets: do not consider repetition
- ❑ E.g.: mySet = {23, 91, 9, 507, 91}
- ❑ Uses hashing for performance
- ❑ No index for sets
- ❑ Mutable
- ❑ Functions used in Set:
  - ➢ add()
  - ➢ remove()
  - ➢ set1.update(set2)

	Mutable	Ordered	Indexing / Slicing	Duplicate Elements
List	✓	✓	✓	✓
Tuple	✗	✓	✓	✓
Set	✓	✗	✗	✗

Python Programming: Dictionaries

Student [List of Dictionaries]					
Rupa {List of Dictionaries}	Eng	Math	Science	SST	AI
	87	96	94	84	99
Sangita {List of Dictionaries}	Eng	Math	Science	SST	AI
	93	100	85	79	98
Thomas {List of Dictionaries}	Eng	Math	Science	SST	AI
	81	98	78	82	100
Sanjay {List of Dictionaries}	Eng	Math	Science	SST	AI
	82	99	95	95	91

- **Dictionaries: { key : value }**
  - Key must be unique and immutable
  - Key can ne numeric or non-numeric
  - Access values through key/get( ) function
  - Can zip 2 lists (key-list & value-list) to form a dictionary
  - Real Life dictionaries can have nested lists, tuples, sets & other dictionaries inside

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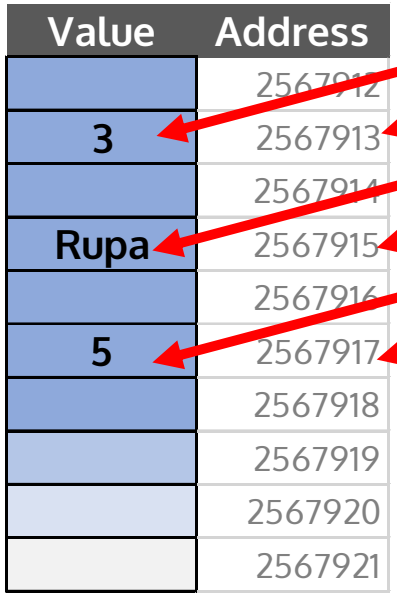
PYTHON PROGRAMMING: VARIABLES



❖ **Variables Trivia:**

- ❑ num = 3
- ❑ id(num)
- ❑ name = 'Rupa'
- ❑ id(name)
- ❑ Two variables assigned same values: a = 5, b=5
- ❑ id(a) will therefore point to the same memory as id(b)

❖ **Constants:**

Actually variables with names in CAPS e.g. PI = 3.14

❖ **Garbage Collection:**

Unused objects and variables are garbage collected by Python

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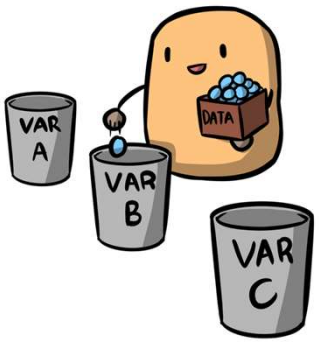
Python Programming: Data Types & Operators



❖ Data Types:

- ❑ **None:** var not assigned (null)
- ❑ **Numeric:**
  - ➢ **Int**
  - ➢ **Float**
  - ➢ **Complex** e.g. 6+4.5j
  - ➢ **Bool** True, False
- ❑ **List**
- ❑ **Tuple**
- ❑ **Set**
- ❑ **String**
- ❑ **Range**

Sequence

- ❑ **Dictionary**

** Character data type absent in Python

❖ Types of Operators :

- ❑ **Arithmetic** e.g. + - * / % etc.
- ❑ **Assignment** assigning values (=)
- ❑ **Relational** compare two variables (">" "<" "==" ">=" "<=" "!=")
- ❑ **Logical** "AND" "OR" "NOT"
- ❑ **Unary** negating a value
- ❑ **Bitwise** "XOR" "<<" ">>" etc.

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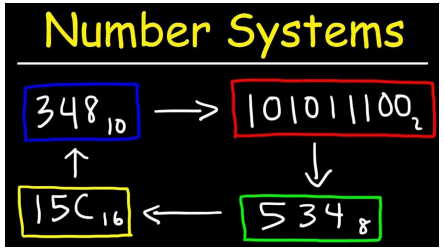

NUMBER SYSTEM

SYSTEM	DIGITS	BASE	PYTHON LITERALS
Binary	0, 1	2	0b
Octal	0, 1, 2, 3, 4, 5, 6, 7	8	0o
Decimal	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	10	None
HexaDecimal	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F	16	0x

- **print(num)** Decimal to Binary
- **print(bin(num))** Binary to Decimal
- **print(oct(num))** Decimal to Octal
- **print(hex(num))** Decimal to HexaDecimal

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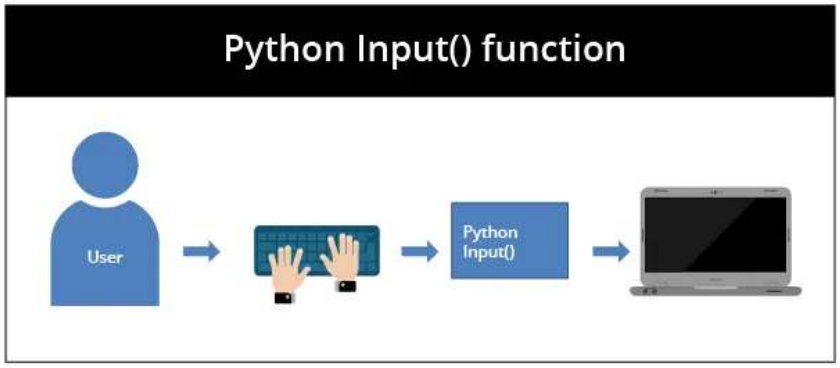
PYTHON PROGRAMMING: USER INPUT

- **input():** Delays the execution of program and asks user for input
  - Strings, Integers, Floats, Characters and Expressions can be asked from the user by passing proper functions inside input()
- **eval():** Evaluates any mathematical expression



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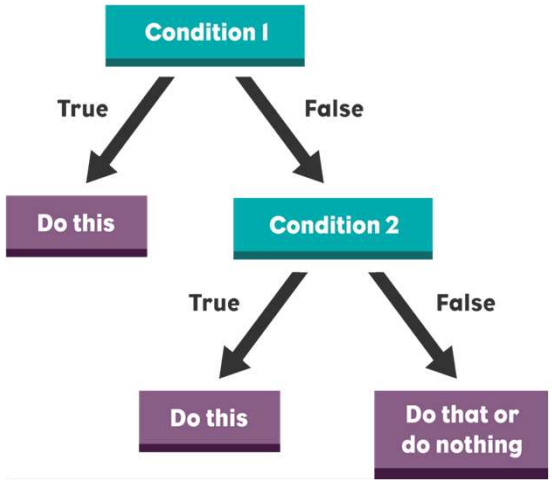
PYTHON PROGRAMMING: IF ELSE STATEMENT



- **If Statement:** Uses if keyword followed by condition
- **If-Else Statement:** Used to execute both the true part and the false part of a condition. If true, the if block code is executed. If false, the else block code is executed
- **Nested If:** One or more statements present inside another if statement. Used when a variable has to be processed multiple times
- **If-Elif-Else:** It checks the if statement condition. If false, the elif statement is executed. If elif is false, the else statement is executed

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Python Programming: For & While Loops

- **For:** Definite iteration. Iterates predefined number of times
- **While:** Indefinite Iteration. Keeps iterating until the condition is false
- **The Else Clause:** Python exclusive
  - **For Else**
  - **While Else**
- **Loop Control Statements:**
  - **Break –** Terminates the loop
  - **Continue –** Forces to execute the next iteration of loop
  - **Pass –** Null operation

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PYTHON PROGRAMMING: ARRAY

TYPECODE	CHARACTER TYPE	PYTHON TYPE	MINIMUM SIZE IN BYTES
b	Signed Char	int	1
B	Unsigned Char	int	1
u	Py_UNICODE	unicode character	2
h	Signed Short	int	2
H	Unsigned Short	int	2
i	Signed int	int	2
I	Unsigned int	int	2
l	Signed Long	int	4
L	Unsigned Long	int	4
f	Float	float	4
d	Double	float	8

❖ **Array:**

- ❑ Array can be one dimensional or multi dimensional
- ❑ Import array module to work with arrays
- ❑ All elements of an array should be of same type
- ❑ Can take inputs from user to form an array

❖ **Functions:**

- ❑ typecode()
- ❑ buffer_info()
- ❑ array()
- ❑ extend()
- ❑ append()
- ❑ pop()

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❖ **Numpy:**

- ❑ general purpose array-processing package
- ❑ Used mainly for multidimensional arrays
- ❑ Efficient even with 1D array. For e.g.- mentioning typecode is not necessary

❖ **Array Creation:**

- ❑ array() – array with given data
- ❑ linspace() – array of range divided in specified number of parts
- ❑ logspace() – array of range divided in parts but log values
- ❑ arange() – like linspace but breaks the range in a progressive series
- ❑ Zeros() – array of 0's
- ❑ Ones() – array of 1's

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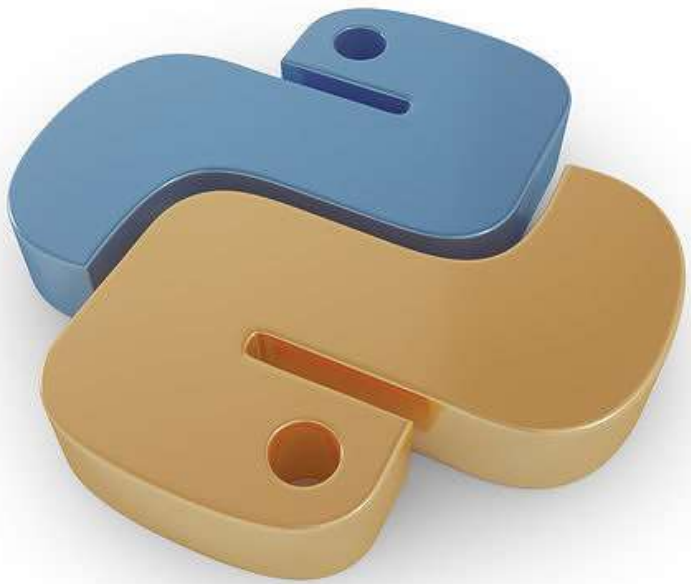
Python Programming: More On Array



- **Array Addition:**
  - Any variable can be added with each element
  - **sum():** Sum of all the array elements
  - Arrays support various types of mathematical operations
- **Copying Array:**
  - **Aliasing:** Assigning an existing array to a new one stored at same address
  - **Shallow Copy:** view() function copies the array to form a new but dependent one at different address
  - **Deep Copy:** copy() function does the sane but the arrays stay independent

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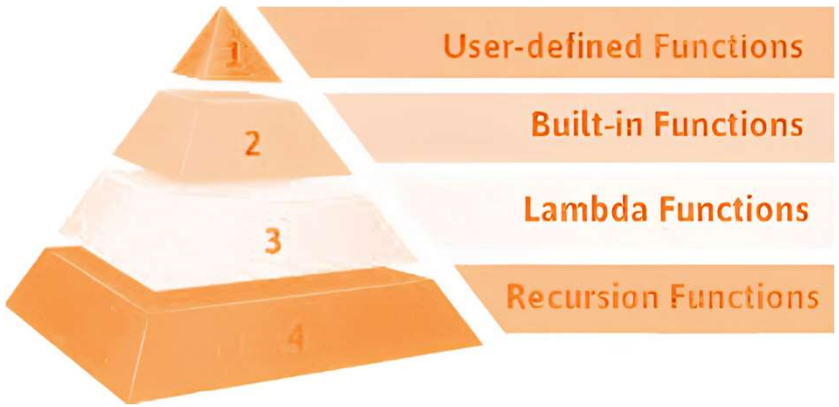
PYTHON PROGRAMMING: FUNCTIONS



- **Function** is a block of code which only runs when called
- **Creating New Function:**
  - **def** keyword creates a new function
  - Can assign many functions/statements
  - Can be called anywhere and anytime
  - Saves time and space in coding
  - Nested functions
- **Return Statement:** Used inside a function or method to send the result back to caller
- **Parameters** are variables inside the parentheses in a defined function. e.g. fn(x, y)
- **Arguments** are values sent to the function when it is called. e.g. fn(2, 3)

  ****Python's argument passing is neither "pass by value" nor "pass by reference" but "pass by object reference"**

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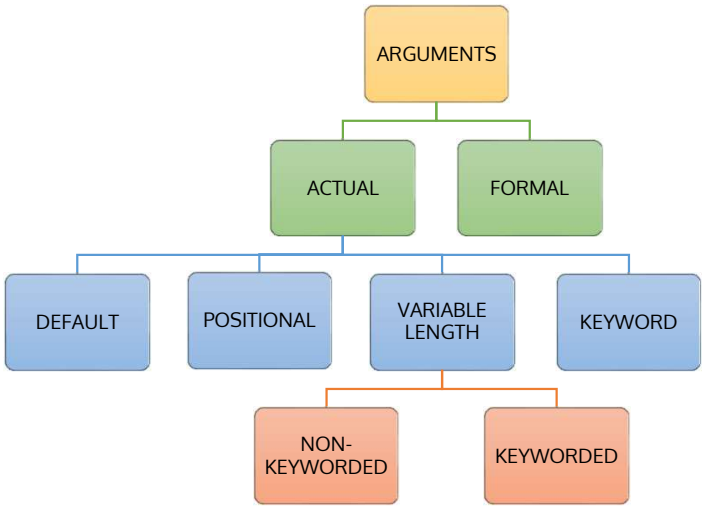
PYTHON PROGRAMMING: ARGUMENTS



- ❖ **Formal** arguments are parameters passed while defining a function
- ❖ **Actual** arguments are the values passed to the function when called
  - ❑ **Default** arguments are the values assigned while defining a function
  - ❑ **Positional** arguments must be specified in the proper order
  - ❑ **Keyworded** arguments use keys to assign values even if they are not sorted in order
  - ❑ **Variable Length** arguments are used when the number of values is unknown

    e.g. **input()** where user might give multiple values

    ***args** used for passing a variable number of arguments to a function

    ****kwargs** used for the same as *args but with keys assigned to each of them

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Python Programming: Global Keyword & Recursion

- **Global** variables have a global scope and assigned outside functions
- **Local** variables have a local scope only inside the function they are assigned to
- **Global Keyword** lets access and modify the global variable even inside a function
- **globals():** function returns the dictionary of current global symbol table
  - Changes a global variable without affecting local ones if called inside a function
- **Recursion** is a process where a function calls itself

  e.g. Program to find factorial of a number
  - **sys.getrecursionlimit():** default limit of recursion is 1000
  - **sys.setrecursionlimt(n):** changes the limit of recursion to desired value "n"

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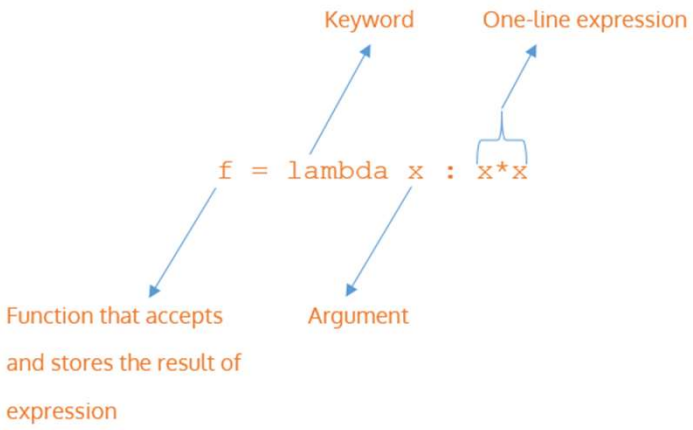
PYTHON PROGRAMMING: ANONYMOUS FUNCTIONS



- **Lambda** aka anonymous functions are functions without names
  - Used when a small, one-time-use function is required
  - Initiated with the keyword **"lambda"** instead of "def"
- **Limitations:**
  - Limited to a single expression.
  - They are often less readable than named functions
  - No proper names or docstrings make it harder to understand their purpose

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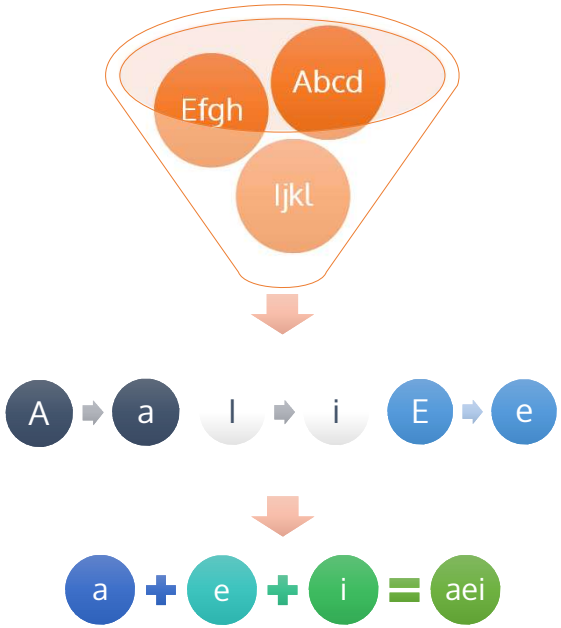
PYTHON PROGRAMMING: FILTER MAP & REDUCE



❖ **filter()** is an in built function used for fetching elements from a collection (e.g. list or array) based on a set condition

```
filter(function, iterable)
```

❖ **map()** function transforms each element in a collection using a given function by applying it to each element

```
map(function, iterable)
```

❖ **reduce()** aggregates elements in a collection to produce a single result by repeatedly applying a binary function to them

```
from functools import reduce

reduce(function, sequence, initial)
```

** initial can be assigned with a value to be aggregated with the passed sequence

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PYTHON PROGRAMMING: DECORATORS

- **Decorators** can modify functions (or methods) and classes without changing the source code
- Functions are **first-class citizens** in python, which means they can be:
  - passed as arguments to other functions
  - returned as values to other functions
  - defined within other functions
- The above properties validate decorators
- Example – "**@timeit**" decorator measures execution time of a code

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PYTHON PROGRAMMING: SPECIAL VARIABLES

- **Special Variables** can provide details on the context, behavior or state of a code in Python
  - Always defined using double underscores (e.g. "**__name__**")
  - They are also known as dunder or magic methods
- **Examples:**
  - **__name__** contains the name of current module
    - __name__ shows '__main__' if the current script is running
    - If imported as a module into another script, __name__ shows the module's name
  - **__init__** is called when an object is created from a class and used to initialize the object's attributes
  - **__del__** is called for destroying an object and sending it for garbage collection
  - **__str__** is called by the str() function to generate a string that represents the object's state
  - **__call__** allows instances of a class to be called like functions
  - **__iter__** and **__next__** are used to define iterators for custom objects

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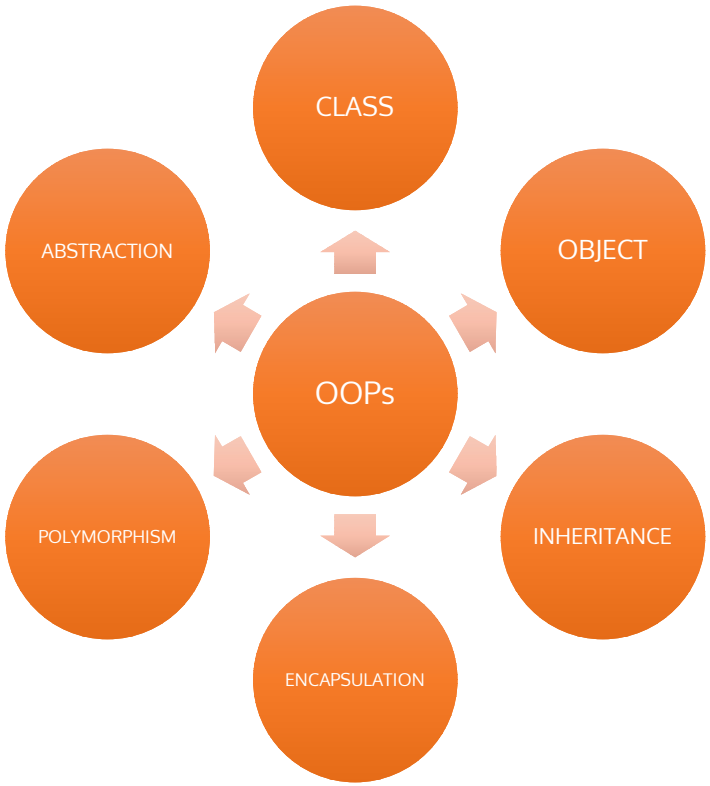

- **OOPs** is a programming prototype that enables problem solving in a real world approach
  - Shows how versatile Python is, based on programming spectrum
  - Strings, Integers, Floats, Lists, Sets etc. are examples of built-in objects
  - To define an object, declaring a class is necessary
  - Classes contain **attributes** and **behaviors** of objects

Python Programming: Objects & Classes

- **Class** offers a blueprint for user-defined objects
  - Contains attributes(variables) and behaviors(methods) for the objects
  - Provides a way to organize code by grouping related data and behavior together
  - Keyword for creation is **class**
  - By convention class name should be typed in camel-case
- **Object** is an entity with **attributes** and **behaviors**
  - For example, an object **Parrot** has
    - **attributes** - age, color
    - **behavior** - flying, singing

    which belongs to the **class** "**Parrot**"
  - Objects are instances created from the class

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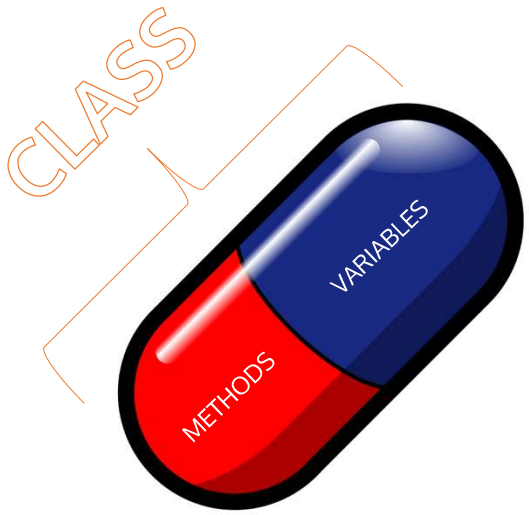
PYTHON PROGRAMMING: CONSTRUCTORS & ENCAPSULATION



- **Constructors** initialize objects and allocate memory (in Heap Memory) to them
  - **__init__** method lets the class assign attributes for objects
  - **self** keyword (by convention) represents an instance (object) of the given class
  - Constructors are generally of two types
    - **Default** (Non-parameterized) does not accept any arguments except from **self**
    - **Parameterized** accepts arguments aside from **self**
- **Encapsulation** is a OOPs concept that ensures a conventional restriction of data
  - Wraps the variables and the methods together as a single unit
  - The idea is ensuring the variables can be accessed only through the methods of their current class
  - Constructors can be used for achieving encapsulation

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Python Programming: OOPs Variable Types

- **Instance Variables (Attributes)** are specific to an instance of a class
  - Stores unique data to each object created from the class
  - Object level
- **Class Variables (Static Variables)** are shared by all instances of a class
  - Defined within the class but outside of any instance methods
  - Same for all instances of the class (Class level)
  - Can be accessed using the class name or any instance of the class
- **Local Variables** are defined within methods or functions (Method level)
  - Only accessible within those
  - They have no connection to the class or its instances

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PYTHON PROGRAMMING: OOPS METHOD TYPES

- ❖ **Instance Methods** are meant to access the instance attributes
  - ❑ Takes **self** as parameter
  - ❑ The most commonly used method
  - ❑ **Accessors** fetch (get) the value and **Mutators** modify (set) the value
- ❖ **Class Methods** are usually used to access class variables
  - ❑ Can be called using the class name itself
  - ❑ Takes **cls** as parameter
  - ❑ Declared by **@classmethod** decorator
- ❖ **Static Methods** are not associated with either of the class or instance variables
  - ❑ Takes no parameters
  - ❑ Declared by **@staticmethod** decorator
  - ❑ Can be accessed using the class name as well as class objects

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PYTHON PROGRAMMING: INNER CLASS

```
class OuterClass:
    def __init__(self, outer_var):
        self.outer_var = outer_var

    class InnerClass:
        def __init__(self, inner_var):
            self.inner_var = inner_var
```

❖ **Inner Classes** or nested classes are basically one defined inside the other

- ❑ Useful for grouping two related classes
- ❑ Better privacy of code
- ❑ Inner classes are of two types, as follows
  - ➢ **Multiple:** The class contains one or more variables
  - ➢ **Multilevel:** The class contains an inner class which contains another inner class

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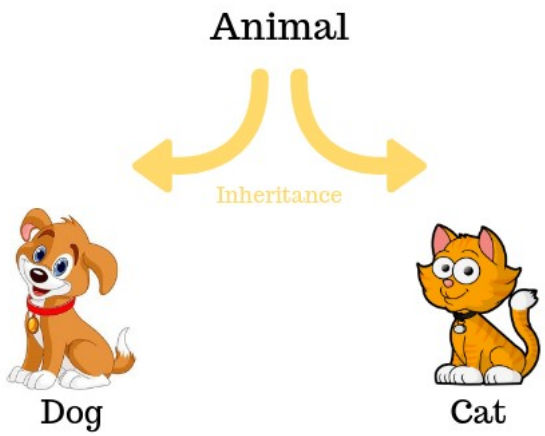
PYTHON PROGRAMMING: INHERITANCE



❖ **Inheritance** is a OOPs concept that allows a class to inherit attributes and behaviors from another class

- ❑ Provides reusability of the code and increases its performance
- ❑ **Parent Class (Super Class)** is the class whose properties are inherited by the new one
- ❑ **Child Class (Sub Class)** derives its properties from its parent class aside from having its own

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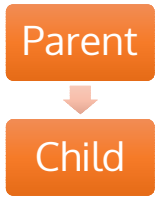
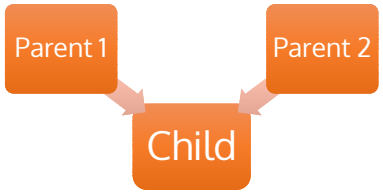
PYTHON PROGRAMMING: INHERITANCE TYPES

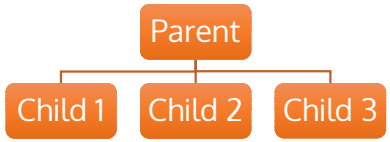
SINGLE LEVEL



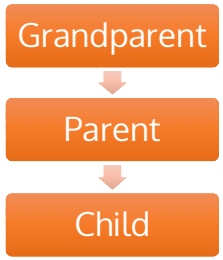
MULTIPLE



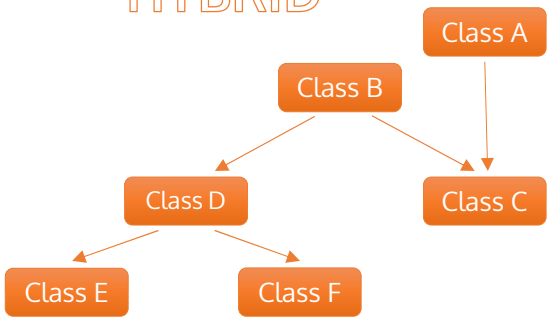
HIERARCHICAL



MULTILEVEL



HYBRID



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Python Programming: Method Resolution Order

- **MRO** is an order in which classes are searched when looking for a method or attribute in an inheritance hierarchy
  - Modern Python uses C3 Linearization algorithm over the old school DLR
  - **Example:** In Case of A(B,C) – MRO dictates that the code will first search A itself, then go to B and then C
  - **Left to Right**
- **Super()** is a built-in function which allows access to the parent's methods and attributes in the child class
  - Follows MRO

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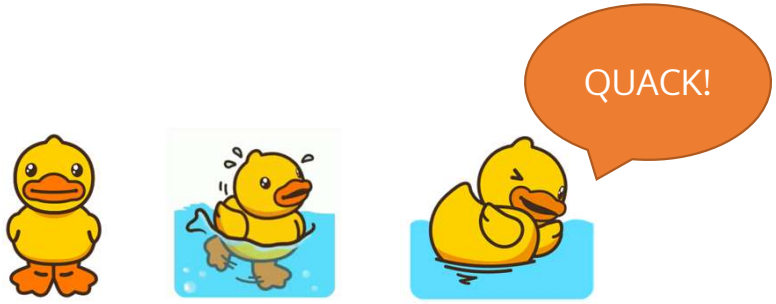
Python Programming: Polymorphism

- **Polymorphism** means having multiple forms in general
  - Provides code flexibility and reusability
  - **len()** is an in-built polymorphic function
  - Functions or methods with same name make different objects behave in similar pattern

Python Programming: Duck Typing

"If it looks like a duck, swims like a duck and quacks like a duck, then it probably is a duck"



- **Duck Typing** is an idea of assigning types to classes based on similar methods
  - Python is a dynamically typed language which dictates:
    - The type or class of an object is determined by its behavior
    - Declaring the type of an object explicitly is unnecessary

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PYTHON PROGRAMMING: OPERATOR OVERLOADING

❖ **Operator Overloading** lets us define how operators behave for objects of custom classes

- ❑ Operators in python actually calls certain special methods behind the scene
  - ➢ " + " calls **__add__**
  - ➢ " - " calls **__sub__**
  - ➢ " * " calls **__mul__**
- ❑ Custom operations can be defined by modifying those special methods
  - ➢ For e.g. adding two objects by inducing new addition logic to **__add__**

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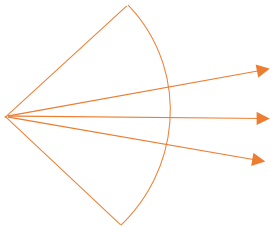
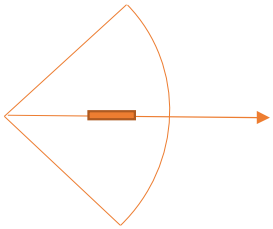
Python Programming: Method Overloading & Overriding



OVERLOADING



OVERRIDING

- **Method Overloading** defines multiple methods with the same name but different parameters
  - **Compile time** Polymorphism
  - Is implemented within the same class
  - Python does not support this by default which makes the latest definition valid for the overloaded method
- **Method Overriding** defines a new implementation for a method in a subclass that already exists in the parent class
  - **Run time** Polymorphism
  - Works within at least two classes (or more) related via inheritance
  - Methods must have same name and parameters

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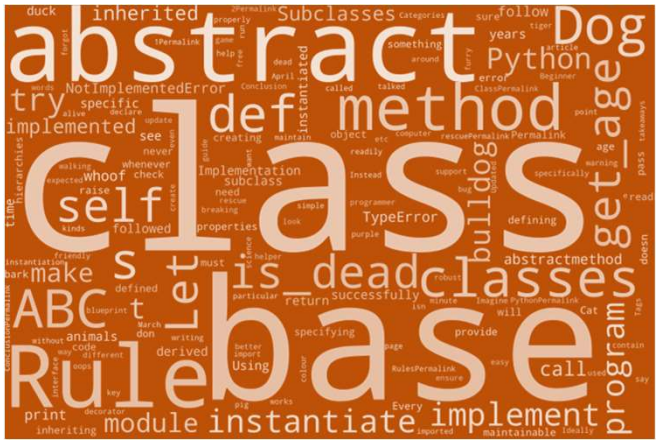
Python Programming: Abstract Methods & Classes



- **Abstract Methods** are declared but not implemented
  - Defined using **@abstractmethod** decorator
  - Need to import **ABC** (Abstract Base Classes) module
  - Python does not support this by default
- **Abstract Classes** are classes that contain at least one abstract method
  - Used for building **API** (Application Program Interface)
  - Serves as a blueprint for other classes
  - Objects can not be created from them