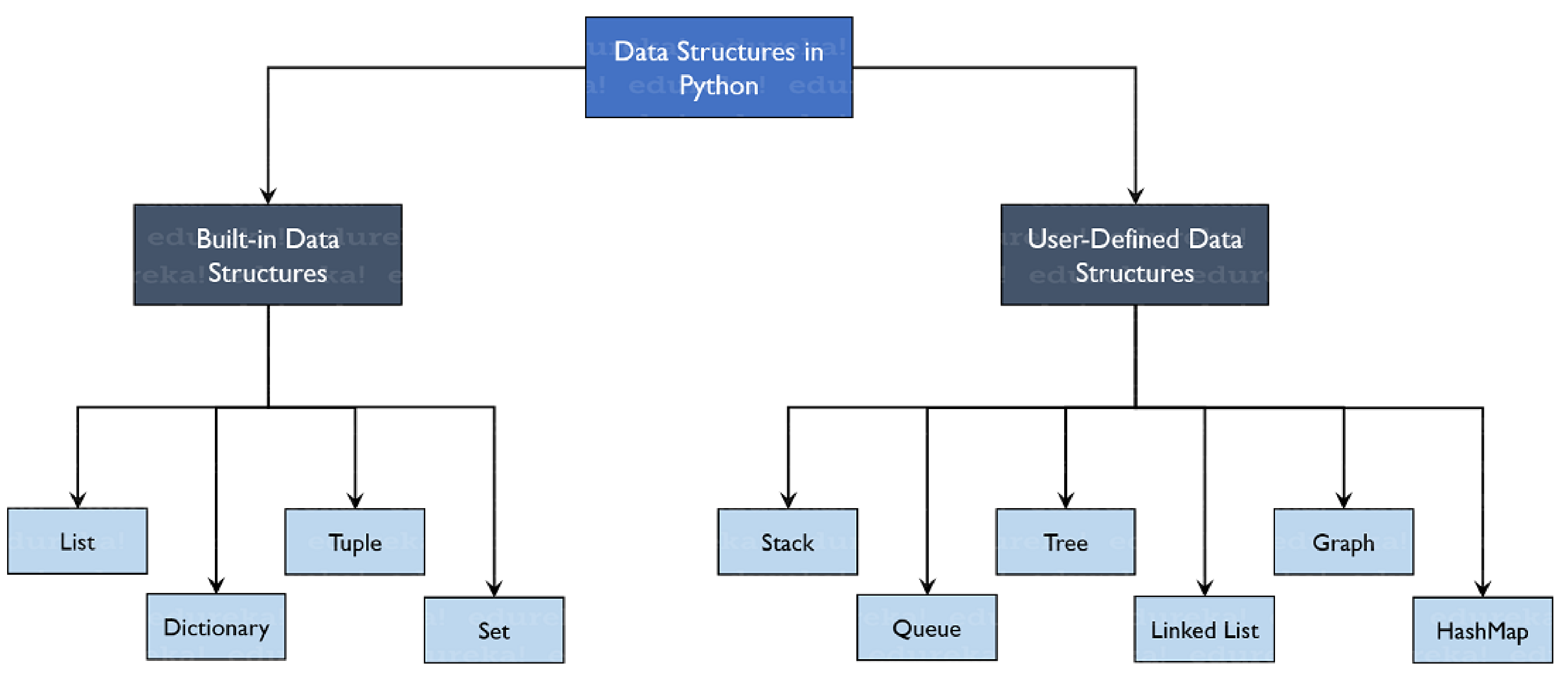
Data Structures in Python



User-Defined Data Structure

- **Stack:** Linear LIFO (Last-In-First-Out) Data structure
- **Queues:** Linear FIFO (First-In-First-Out) data structure
- **Linked Lists:** Linear data structures that are linked with pointers
- **Trees:** Non-Linear data structures having a root and nodes
- **Graphs:** Store a collection of points or nodes along with edges
- **Hash Maps:** In Python, Hash Maps are the same as Dictionaries

Stack

A stack is a linear data structure that stores items in a Last-In/First-Out (LIFO) or First-In/Last-Out (FILO) manner. In stack, a new element is added at one end and an element is removed from that end only. The insert and delete operations are usually called push and pop.

Python's built-in data structure list can be used as a stack. Instead of push(), append() is used to add elements to the top of stack while pop() removes the element in LIFO order.

Implementation of Stack using List

In [ ]:
```
MyStack = list()

MyStack.append("Abdul Mateen")
MyStack.append("Lab Instructor")
MyStack.append("FOIT")

display(MyStack)

MyStack.pop()
```

Queue

Like stack, queue is a linear data structure that stores items in First In First Out (FIFO) manner. With a queue the least recently added item is removed first.

Python's built-in data structure List can be used as a queue. Instead of enqueue() and dequeue(), append() and pop() function is used.

Implementation of Queue using List

In [ ]:
```
MyQueue = list()

MyQueue.append("Abdul Mateen")
MyQueue.append("Lab Instructor")
MyQueue.append("FOIT")

display(MyQueue)

MyQueue.pop(0)
```

Linked List

Linked List is a linear data structure. Unlike arrays, linked list elements are not stored at a contiguous location; the elements are linked using pointers.

In [ ]:
```
class Node:
    def __init__(self, Value=None):
        self.DataValue = Value
        self.NextValue = None
class MyLinkedList:
    def __init__(self):
        self.HeadValue = None
    def Insert(self, NewValue):
        NewNode = Node(NewValue)
        if self.HeadValue is None:
            self.HeadValue = NewNode
            return
        LastValue = self.HeadValue
        while(LastValue.NextValue):
            LastValue = LastValue.NextValue
        LastValue.NextValue=NewNode
    def Remove(self, Removekey):
        HeadValue = self.HeadValue
        if (HeadValue is not None):
            if (HeadValue.DataValue == Removekey):
                self.HeadValue = HeadValue.NextValue
                HeadValue = None
                return
        while (HeadValue is not None):
            if HeadValue.DataValue == Removekey:
                break
            Previous = HeadValue
            HeadValue = HeadValue.NextValue
        if (HeadValue == None):
            return
        Previous.NextValue = HeadValue.NextValue
        HeadValue = None
    def LLprint(self):
        PrintValue = self.HeadValue
        while PrintValue is not None:
            print (PrintValue.DataValue)
            PrintValue = PrintValue.NextValue

MyLinkList = MyLinkedList()
MyLinkList.Insert("Abdul Mateen")
MyLinkList.Insert("Lab Instructor")
MyLinkList.Insert("FOIT")

MyLinkList.Remove("Lab Instructor")


MyLinkList.LLprint()
```

Trees

Tree represents the nodes connected by edges. It is a non-linear data structure. It has the following properties.

- One node is marked as Root node.
- Every node other than the root is associated with one parent node.
- Each node can have an arbiatry number of chid node.

In [ ]:
```
class Node:
    def __init__(self, Value):
        self.Left = None
        self.Data = Value
        self.Right = None
class Tree:
    def CreateNode(self, Data):
        return Node(Data)
    def Insert(self, Node , Data):
        #if tree is empty , return a root node
        if Node is None:
            return self.CreateNode(Data)
        # if data is smaller than parent , insert it into left side
        if Data < Node.Data:
            Node.Left = self.Insert(Node.Left, Data)
        elif Data > Node.Data:
            Node.Right = self.Insert(Node.Right, Data)
        return Node
    def Treeprint(self, Root):
        if Root is not None:
            self.Treeprint(Root.Left)
            print(Root.Data)
            self.Treeprint(Root.Right)
Root = None
MyTree = Tree()
Root = MyTree.Insert(Root, 10)
MyTree.Insert(Root, 20)
MyTree.Insert(Root, 30)
MyTree.Insert(Root, 40)
MyTree.Insert(Root, 70)
MyTree.Insert(Root, 60)
MyTree.Insert(Root, 80)
MyTree.Treeprint(Root)
```

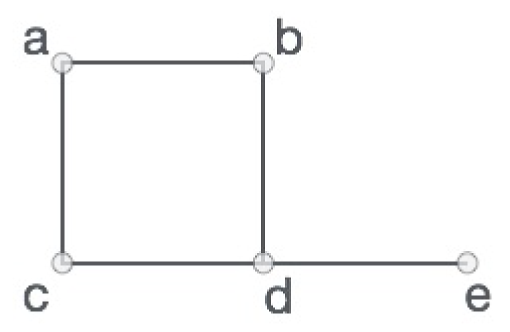
In [ ]:
```
from anytree import Node, RenderTree

CC = Node("Imran Arshad")
Teacher1 = Node("Mohsin Abbas", parent=CC)
Teacher2 = Node("Freeha Iqbal", parent=CC)
Teacher3 = Node("Madiha Yousaf", parent=CC)
LI = Node("Samman Ashraf", parent=Teacher1)
LI = Node("Abdul Mateen", parent=Teacher1)
LI = Node("Samman Ashraf", parent=Teacher2)
LI = Node("Abdul Mateen", parent=Teacher2)
LI = Node("Samman Ashraf", parent=Teacher3)
LI = Node("Abdul Mateen", parent=Teacher3)

for pre, fill, node in RenderTree(CC):
    print("%s%s" % (pre, node.name))
```

Graphs

A graph is a pictorial representation of a set of objects where some pairs of objects are connected by links. The interconnected objects are represented by points termed as vertices, and the links that connect the vertices are called edges.



In [ ]:
```
# Vertices = {a, b, c, d, e}
# Edges = {ab, ac, bd, cd, de}
MyGrapgh = {"a" : ["b","c"],
            "b" : ["a", "d"],
            "c" : ["a", "d"],
            "d" : ["e"],
            "e" : ["d"]
           }
MyGrapgh.update({"f" : ["b"]})
Vertices = MyGrapgh.keys()
Edges = MyGrapgh.values()
print(Vertices)
print(Edges)
print(MyGrapgh)
MyGrapgh.pop("f")
print(MyGrapgh)
```

Hash

Hash tables are a type of data structure in which the address or the index value of the data element is generated from a hash function. That makes accessing the data faster as the index value behaves as a key for the data value.

In Python, the Dictionary data types represent the implementation of hash tables. The Keys in the dictionary satisfy the following requirements.

- The keys of the dictionary are hashable i.e. the are generated by hashing function which generates unique result for each unique value supplied to the hash function.
- The order of data elements in a dictionary is not fixed.

In [ ]:
```
MyHash = {'Name': 'Abdul Mateen', 'Designation': 'Lab Instructor', 'Department': 'FOIT'}
MyHash.update({'Subject' : 'AI'})
print(MyHash.keys())
print(MyHash.values())
print(MyHash)
MyHash.pop('Subject')
print(MyHash)
```