Data Structures in Python
Chapter 3

- Linked List
- **Inheritance - OOP**
- ListUnsorted Class
- ListSorted Class
- Iterator
- Doubly Linked List

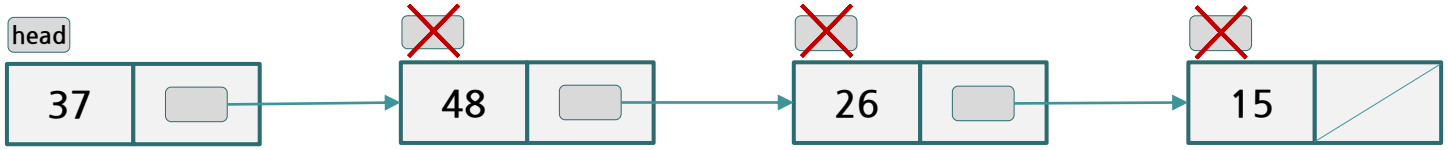
Prof. Youngsup Kim, idebtor@gmail.com, CSEE Dept., Grace School Rm204 Handong Global University

Agenda

- Linked List - Review
- ListUnsorted vs. ListSorted
- Superclass and Subclasses
  - Inheritance
  - Abstract Base Classes

Linked List - Review

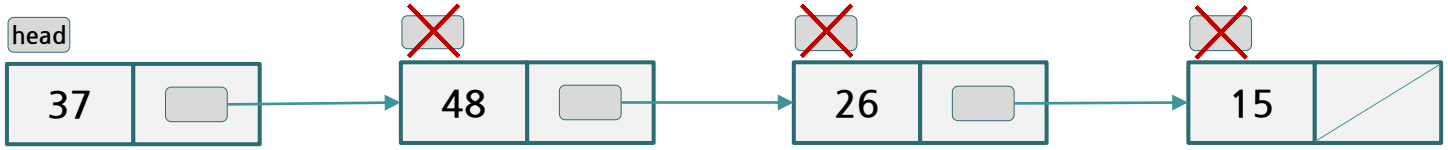
- Step 1: Code a singly linked list. The first node is called `'head'`.




```
class Node:
    def __init__(self, data):
        self.data = data
        self.next = None









if __name__ == '__main__':
```

Linked List - Review

- Step 1: Code a singly linked list. The first node is called `'head'`.




```
class Node:
    def __init__(self, data):
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if __name__ == '__main__':
    head = Node(37)
    head.next = Node(48)
    head.next.next = Node(26)
    head.next.next.next = Node(15)
```
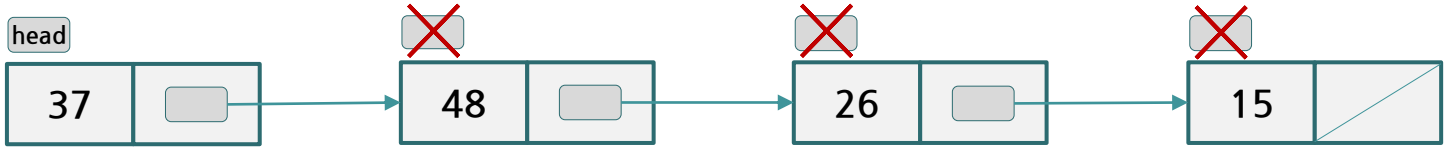

Linked List - Review

- Step 2: `Traverse` **the whole list** if the first node reference or the `head` is known.




```
class Node:
    def __init__(self, data):
        self.data = data
        self.next = None

    def get_data(self):
        return self.data

    def get_next(self):
        return self.next

if __name__ == '__main__':
    head = Node(37)
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```
def print_chain(head):
```

```
37 48 26 15
```

Linked List - Review

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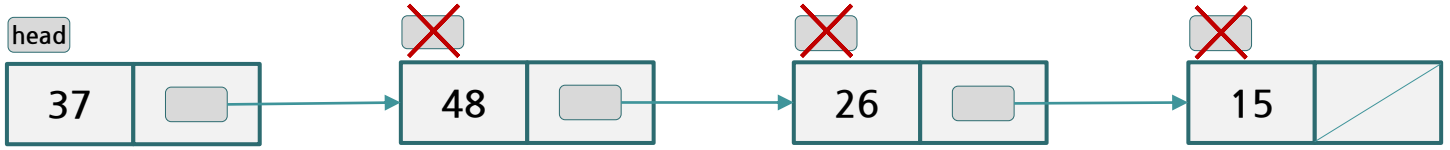


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if __name__ == '__main__':
    head = Node(37)
    head.next = Node(48)
    head.next.next = Node(26)
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```

```
def print_chain(head):
    while not head == None:
        print(head.get_data(), end = " ")
        head = head.get_next()
```

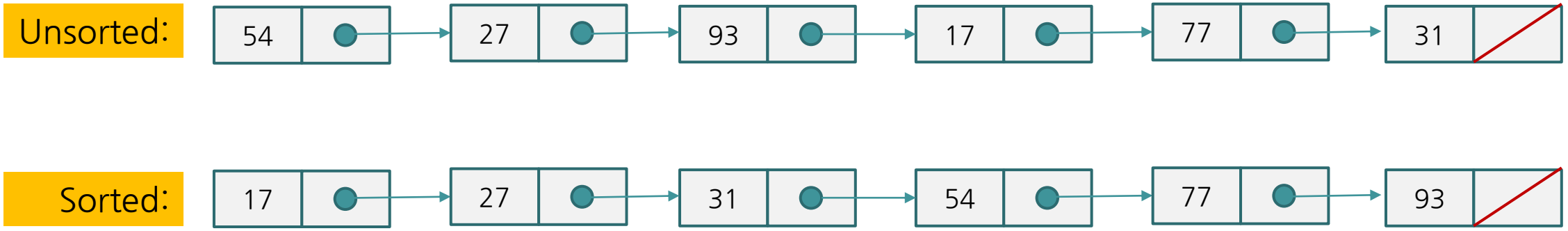
```
37 48 26 15
```

Linked List ADT

- `LinkedList()`
  - Creates a new list that is empty and returns an empty list.
- `is_empty()`
  - Tests to see whether the list is empty and **returns** a Boolean value.
- `size()` and `__len__()`
  - Returns the number of nodes in the list.
- `__str__()`
  - Returns contents of the list in human readable format.
- `push(data), push_back(data)`
  - Pushes a new node with data to the list.
- `pop(data)`
  - Removes the node with data from the list.
- `find(data)`
  - Searches for the data in the list and **returns** a Boolean value.

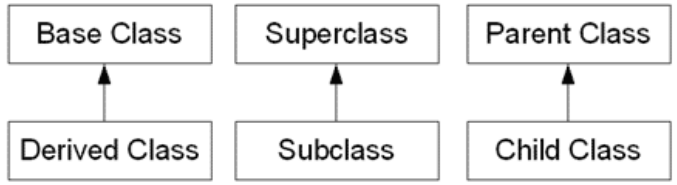
ListUnsorted vs. ListSorted

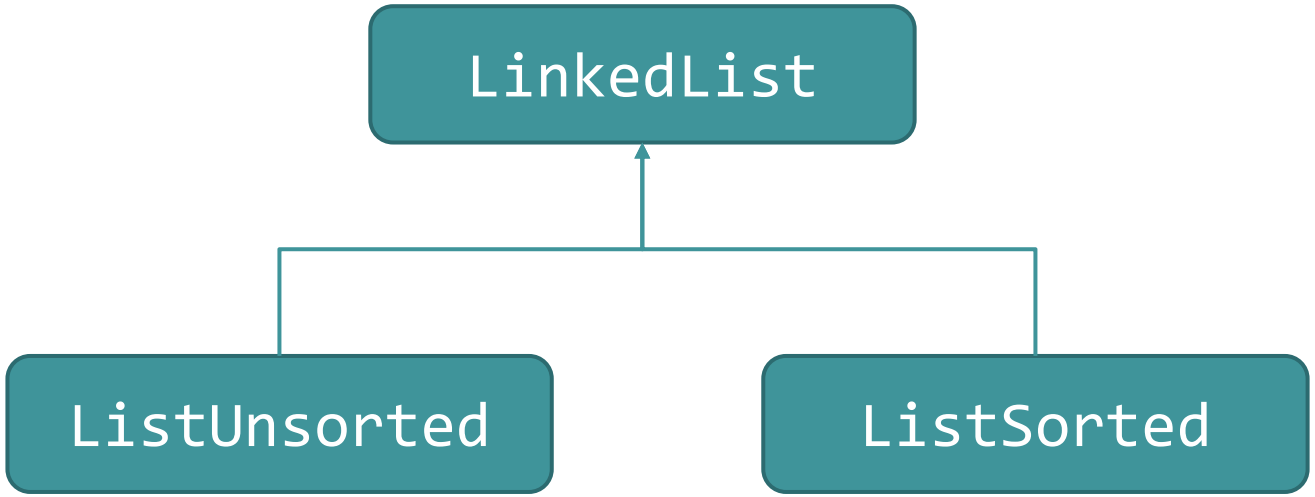
- In general, a linked list is formed as each node with data is provided.
- Let us suppose that the user wants to create two different kinds of linked lists, either sorted or unsorted.
  - Then, we must design two different classes: ListUnsorted and ListSorted
  - If we create two different classes as requested, many parts of the code between two classes will be identical and violating the DRY coding principle.



Superclass and Two Subclasses

- Goals: Two Different Kinds of Linked Lists
  - Create a superclass: `LinkedList`
  - Create two subclasses: `ListUnsorted` and `ListSorted`
  - Use the inheritance of Object-Oriented Programming.





LinkedList ADT
LinkedList()
is_empty()
size()
push(data), push_back(data)
pop(data)
find(data)
__len__()
__str__()

Superclass and Two Subclasses

- Determine the methods not to implement at the level of LinkedList
  - Those methods become **abstract methods** in LinkedList.
  - The **subclasses** of LinkedList must implement those methods, respectively.

LinkedList ADT
LinkedList()
is_empty()
size()
push(data)
push_back(data)
pop(data)
find(data)
__len__()
__str__()

LinkedList ADT
LinkedList()

ListUnsorted ADT
ListUnsorted()
push_back(data)

ListSoted ADT
ListSorted()

Superclass and Two Subclasses

- Determine the methods not to implement at the level of LinkedList
  - Those methods become **abstract methods** in LinkedList.
  - The **subclasses** of LinkedList must implement those methods, respectively.

LinkedList ADT
LinkedList()
is_empty()
size()
push(data)
push_back(data)
pop(data)
find(data)
__len__()
__str__()

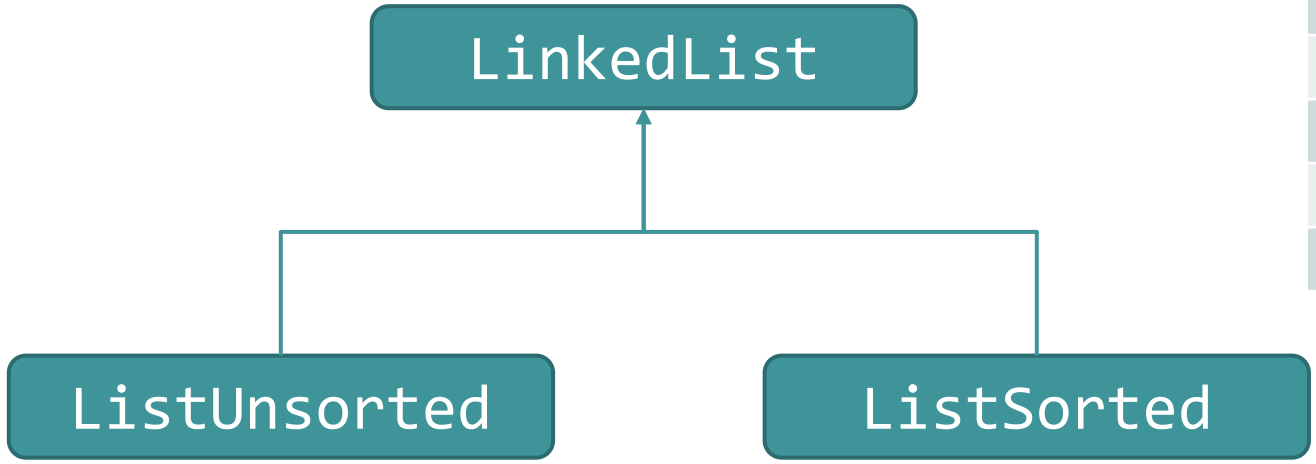
LinkedList ADT
LinkedList()
is_empty()
size()
__len__()
__str__()

ListUnsorted ADT
ListUnsorted()
push(data)
push_back(data)
pop(data)
find(data)

ListSoted ADT
ListSorted()
push(data)
n/a
pop(data)
find(data)

Superclass and Two Subclasses

- Identify some necessary methods that the subclasses must implement to make LinkedList to work properly.



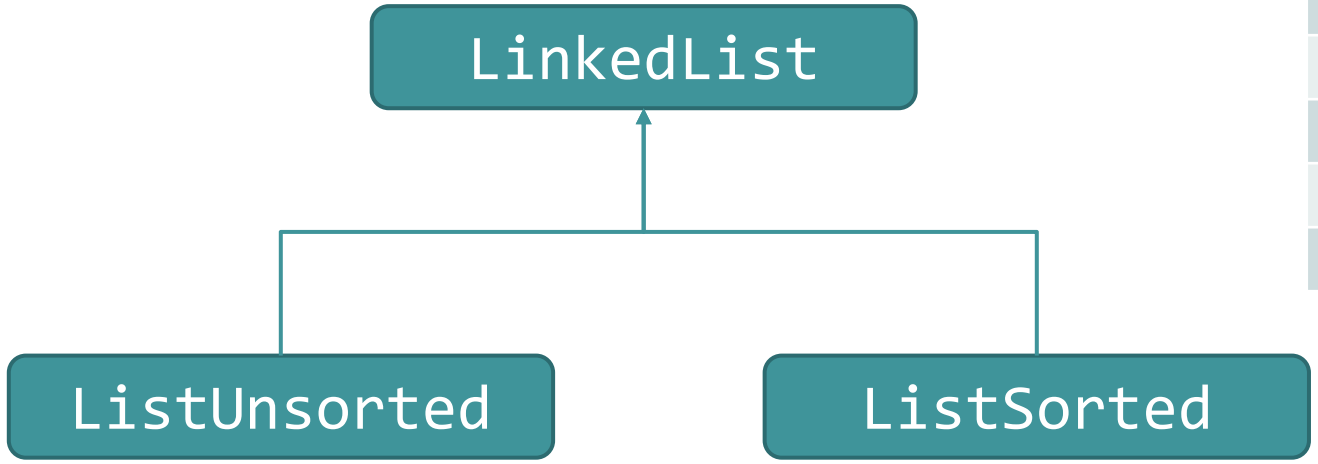
LinkedList ADT
LinkedList()
is_empty()
size()
__len__()
__str__()

LinkedUnsortedADT
LinkedList()
push(data), push_back(data)
pop(data)
find(data)

LinkedSortedADT
LinkedListUnsorted()
push(data)
pop(data)
find(data)

Superclass and Two Subclasses

- Identify some necessary methods that the subclasses must implement to make LinkedList to work properly.



LinkedList ADT
LinkedList()
is_empty()
size()
__len__()
__str__()

LinkedUnsortedADT
LinkedList()
push(data), push_back(data)
pop(data)
find(data)

LinkedSortedADT
LinkedListUnsorted()
push(data)
pop(data)
find(data)

Superclass and Two Subclasses

- As a superclass of the view, it would be better if there is a way to **force the subclasses to implement** those necessary methods.

Superclass and Two Subclasses

- As a superclass of the view, it would be better if there is a way to **force the subclasses to implement** those necessary methods.

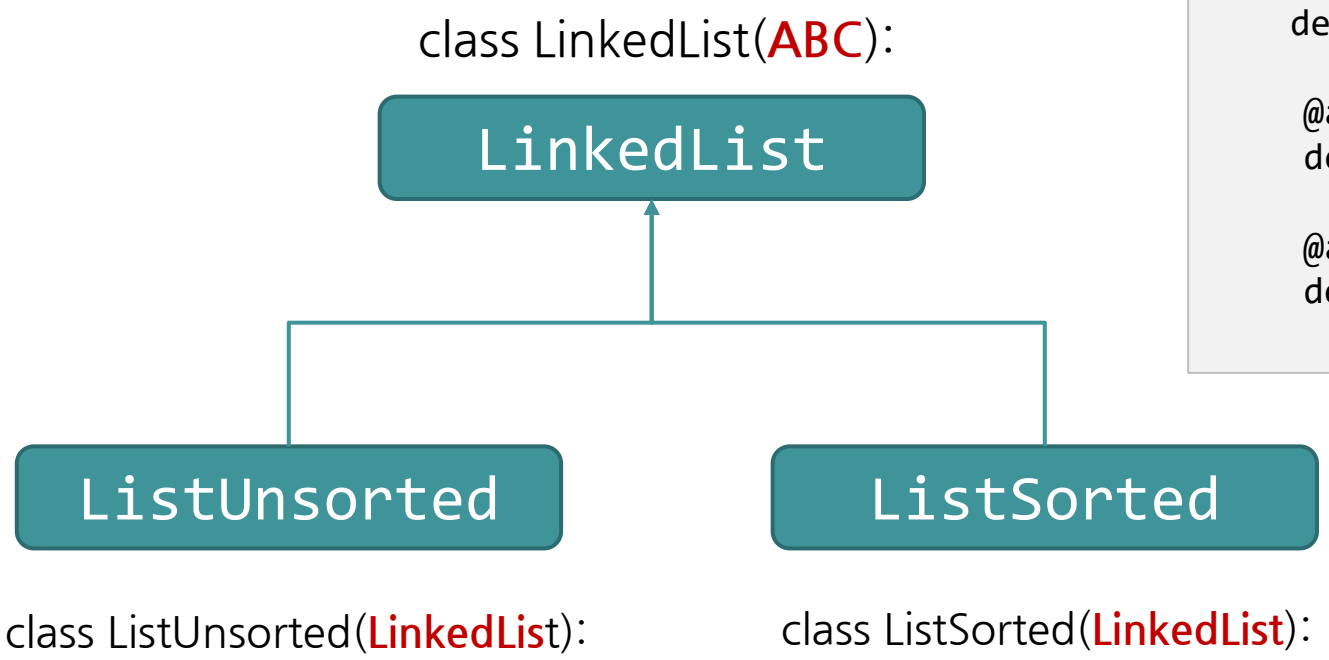
- In Python, **abstract base classes (i.e., superclass)** provide a blueprint for **concrete classes (i.e., subclass)**.
- The superclass do not contain implementation.
  - Instead, It provides an interface and make sure that derived concrete classes (subclasses) are properly implemented.
- **Abstract base classes cannot be instantiated**.
  - Instead, they are inherited and extended by the concrete subclasses.
- Subclasses derived from a specific abstract base class **must implement the methods** and properties provided in that abstract base class. Otherwise, an error is raised during the object instantiation.

Superclass and Two Subclasses

- Use '**abc**' module in the to define abstract base class.
  - Define abstract methods in LinkedList class and it becomes an abstract base class.

```
from abc import ABC

class LinkedList(ABC):
    ...
    @abstractmethod
    def push(self, data):
        pass
    @abstractmethod
    def pop(self, data):
        pass
    @abstractmethod
    def find(self, data):
        pass
```



Superclass and Two Subclasses

- The '**abc**' module in the Python library provides the infrastructure for defining custom abstract base classes. To use abstract base classes, `from abc import ABC`.

```
from abc import ABC, abstractmethod

class LinkedList(ABC):
    def __init__(self):
        self.head = None
    ...

    @abstractmethod
    def push(self, data):
        pass

    @abstractmethod
    def pop(self, data):
        pass

    @abstractmethod
    def find(self, data):
        pass
```

```
class ListUnsorted(LinkedList):
    def __init__(self):
        LinkedList.__init__(self)
    ...

    def push(self, data):
        pass

    def pop(self, data):
        pass

    def find(self, data):
        pass
```

```
class ListSorted(LinkedList):
    def __init__(self):
        LinkedList.__init__(self)
    ...
    ...
```

Summary

- We may use **OOP inheritance** to prevent from duplicating the code and to maximize the reusability of the code.
- The '**abc**' module in the Python library provides the infrastructure for defining custom abstract base classes.