파이썬으로 배우는 데이터 구조

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학습 목표

LinkedList의 ADT를 이해하고

Node Class를 구현할 수 있다

Data Structures in Python
Chapter 3 - 3

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

Agenda

- Linked List
  - Introduction
  - The Node class
  - The Linked List ADT
  - Comparing Implementations

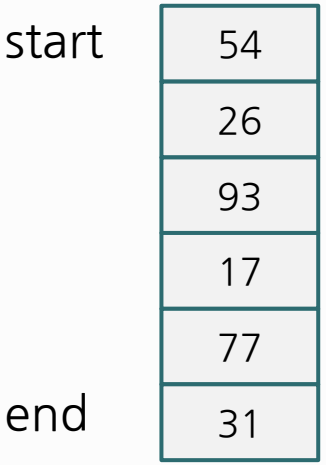
Review

- The `list` in Python is a powerful, yet simple, collection mechanism that provides the programmer with a wide variety of operations.
  - We may use Python `list` to implement both Stack and Queue.

- A Python `list` stores each element in **contiguous memory** if possible.
  - It is an array-based sequence.
  - This makes it possible to access any element in O(1) time.
  - However, insertion or deletion elements at the beginning of the list takes O(n).

Linked List

- An **array** provides the more **centralized** representation, with one large chunk of memory capable of accommodating references to many elements.

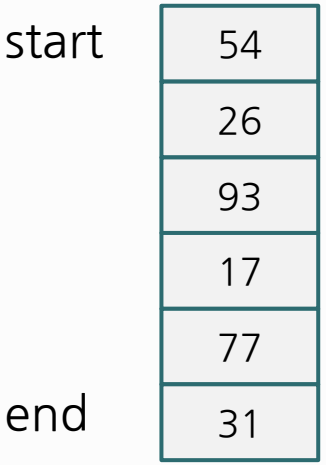


An array-based collection

A Linked List

Linked List

- An **array** provides the more **centralized** representation, with one large chunk of memory capable of accommodating references to many elements.
- A **linked list** relies on a more **distributed** representation in which a lightweight object, known as a **node**, is allocated for each element.
  - Each node maintains a **reference** to its element and one or more references to neighboring nodes in order to collectively represent the linear order of the sequence.



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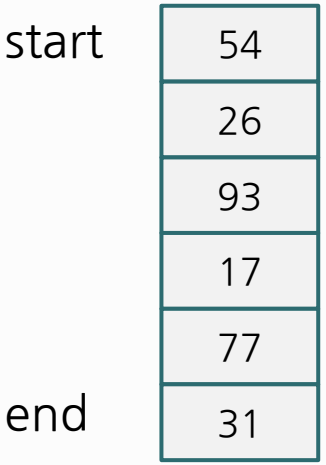

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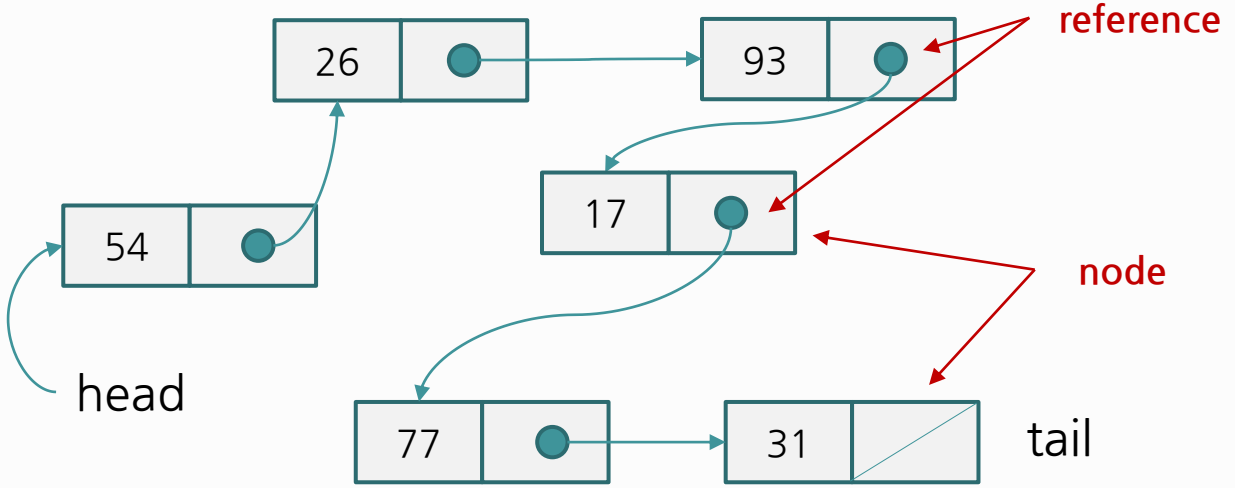
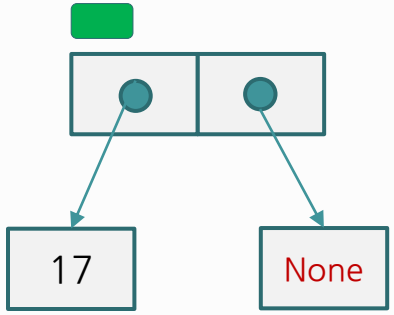


A Linked List

A Node

- A **node** is the basic building block of a linked list.
- It contains the **data** as well as a **link** to the **next node** in the list.
- The node's element references an arbitrary object that is an element of the sequence (17 in this example), which the next references the subsequent node the linked list or None.



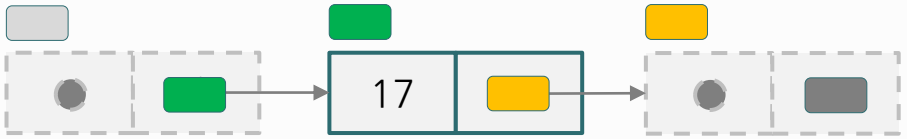
a node in memory

a compact representation of a node

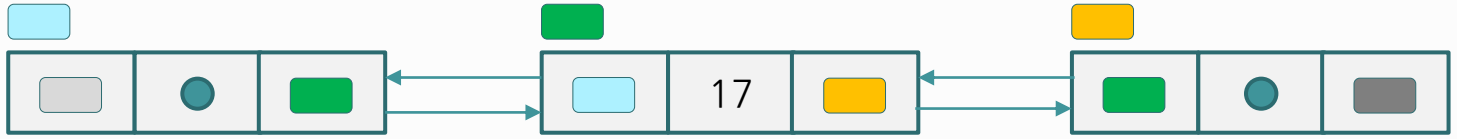
Singly Linked Lists vs Doubly Linked List

- An example of a node instance that forms part of a linked list.
- Each node maintains a reference to its element and **one or more references** to neighboring nodes in order to collectively represent the linear order of the sequence.

A Singly Linked List



A Doubly Linked List

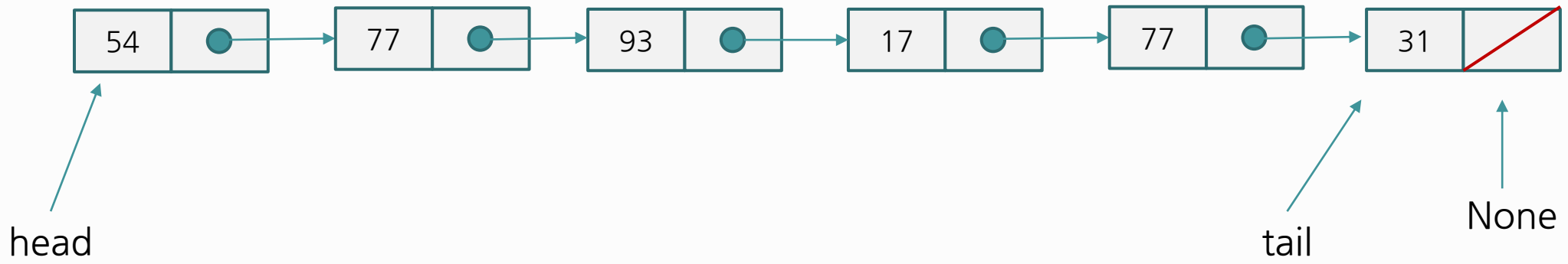


Terminology

- **head and tail:**
  - The first and last node of a linked list are known as the **`head`** and **`tail`** of the list, respectively.
- **traverse**
  - By starting at the head and moving from one node to another by following each node's next reference, we can reach the tail of the list.
  - We can identify the tail as the node having None as its next reference. This process is commonly known as **traversing** the linked list.

Terminology

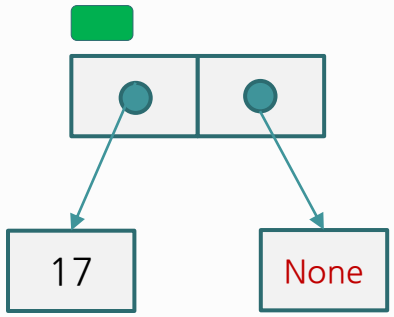
- An example of a singly linked list whose elements are number.
  - The list instance maintains a member named **`head`** that identifies the first node of the list, and another member named **`tail`** that identifies the last node of the list.
  - The **None** object is denoted as a slash.



For a compact illustration of a singly linked list, with elements embedded in the nodes.

The Node class

- A **node** is the basic building block of a linked list.
- It contains the **data** as well as a **link** to the **next node** in the list.
- The node's element references an arbitrary object that is an element of the sequence (17 in this example), which the next references the subsequent node the linked list or None.



a node in memory

a compact representation of a node

The Node class

- A **node** may be defined as shown below:

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

node = Node(17)
```

an implementation of a node

The Node class

- A **Node** class may be defined as shown below:

```
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

    def set_data(self, data):
        self.data = data

    def set_next(self, next):
        self.next = next

if __name__ == "__main__":
    node = Node(17)
```

getting the next node linked; it may be None.

setting the data of the current node

setting the next of the current node
namely, linking the next node

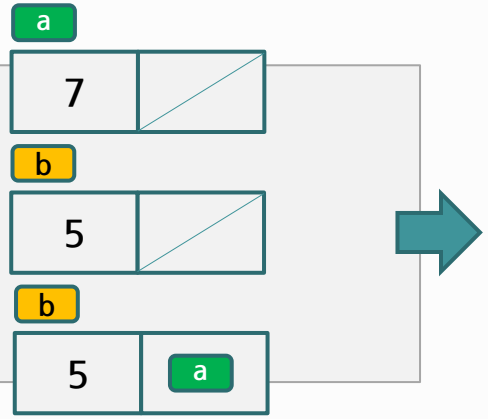
The Node class - Chain of nodes

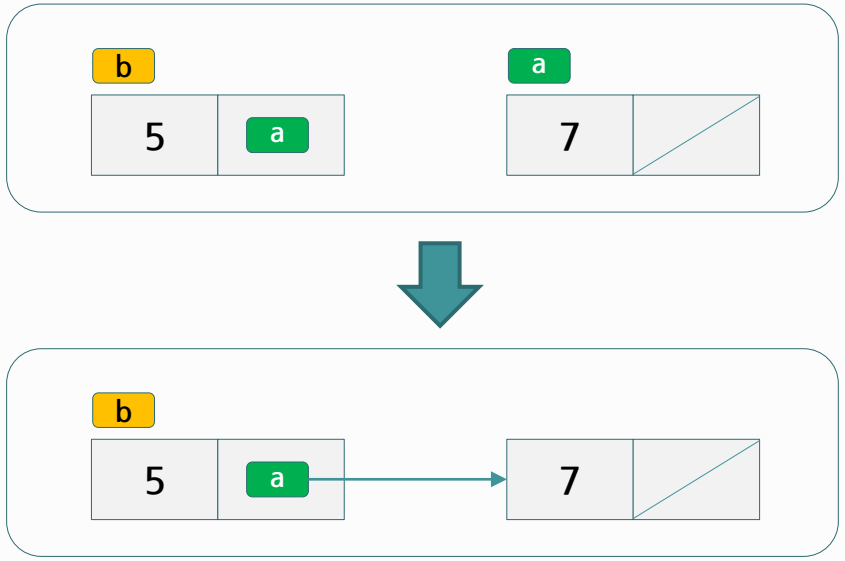
- Chain of nodes:

```
a = Node(7)

b = Node(5)

b.set_next(a)
```





The node reference **'a'** is stored in **b.next**;
Now, we just keep the node reference of **'b'** which is called the head of the linked list.

The Node class - Chain of nodes

- Change the data of two nodes to 55 and 77 in the linked list, respectively. The head of the list, b is given.

- Step 1:

```
b.set_data(55)
```

- Step 2:

```
x = b.get_next()
x.set_data(77)
```

using a temporary name, x

```
b.get_next().set_data(77)
```

without using a temporary name

Exercise 1

- Step 1: Draw a linked list diagram. Which one is the first node of the list?

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

a = Node(15)
b = Node(26)
c = Node(37)
d = Node(48)

b.set_next(a)
c.set_next(d)
d.set_next(b)
```

(1) Create nodes.

(2) Link nodes.

(3) Linked list

(1) Create nodes.

(2) Link nodes.

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```

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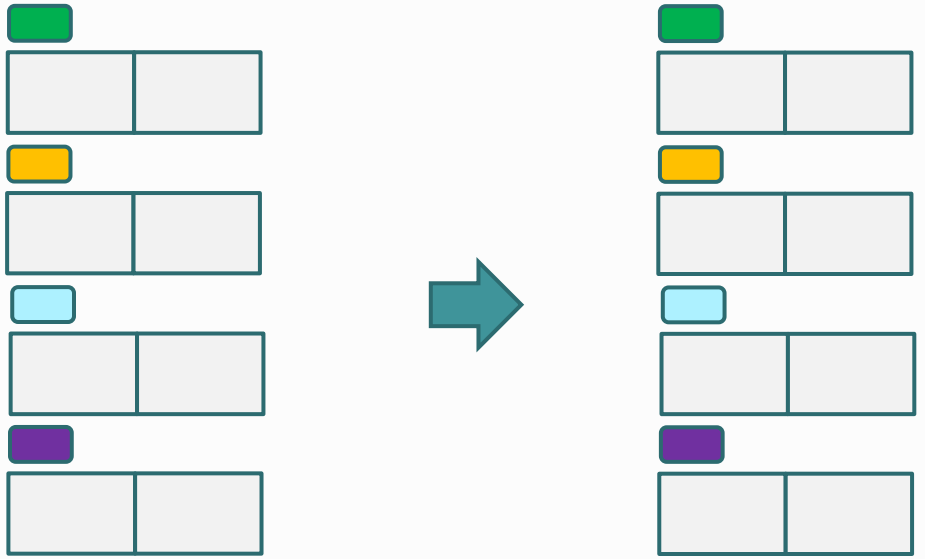

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Exercise 1 - Solution

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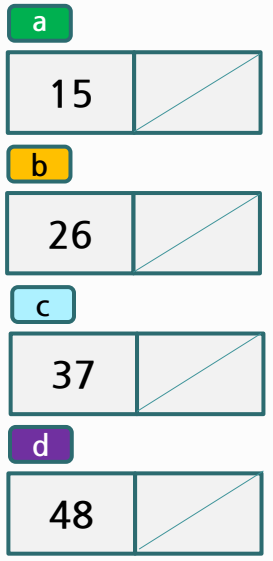

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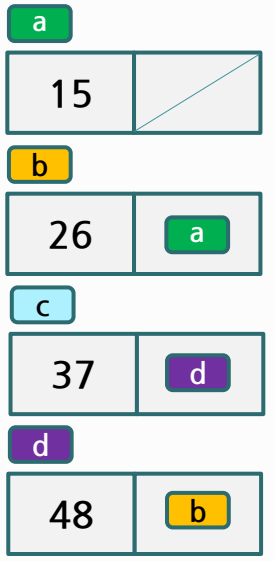
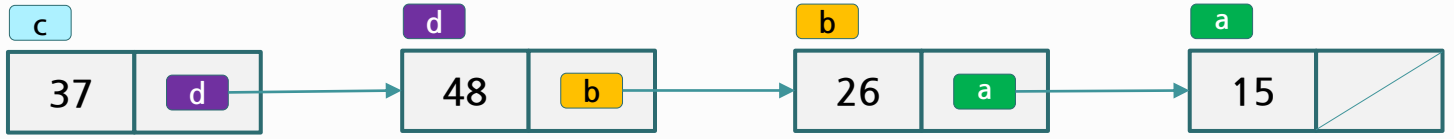


(2) Link nodes.

(3) Linked list



Exercise 1

- Step 2: What is the output of the following program?

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

a = Node(15)
b = Node(26)
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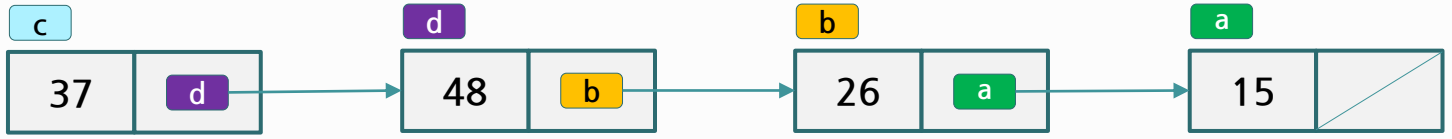
b.set_next(a)
c.set_next(d)
d.set_next(b)
```

```
print_chain(a)
print()
print_chain(b)
print()
print_chain(c)
```

(3) Linked list



Exercise 1 - Solution

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d.set_next(b)
```

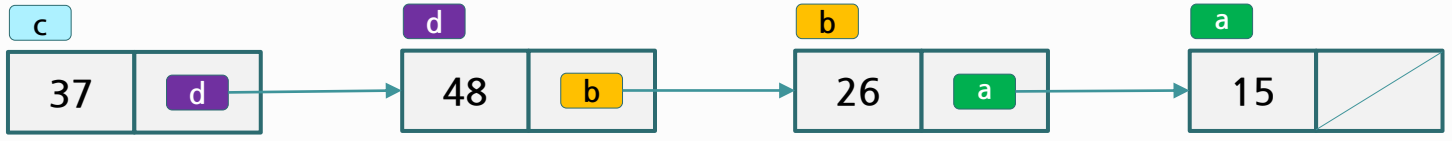
```
print_chain(a)
print()
print_chain(b)
print()
print_chain(c)
```

```
15

26 15

37 48 26 15
```

(3) Linked list



Exercise 1 Observation

- Step 2: What is the output of the following program?

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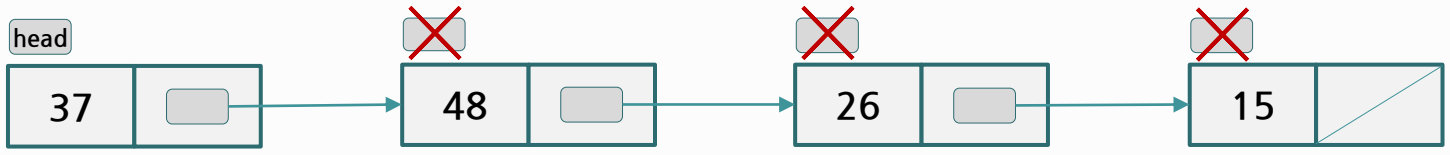
b.set_next(a)
c.set_next(d)
d.set_next(b)
```

```
print_chain(a)
print()
print_chain(b)
print()
print_chain(c)
```

- Notice that only one reference is passed to the function, and others are unknown in the function.
- You may `traverse` **the whole list** if the first node reference or the `head` is known.

(3) Linked list



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_front(), pop(data)`
  - Removes the node with data from the list.
- `find(data)`
  - Finds for the data in the list and **returns** a Boolean value.

Summary

- Reference variables can be used to implement the data structure known as **a linked list.**
- Each reference, "next", in a linked list is a reference to the next node in the list.
- Any element in a list can be accessed, however, you must traverse a linked list to access a particular node using the **head** node available.

학습 정리

1) List자료형은 연속적인 메모리를 필요로 하지만, LinkedList는 노드(node) 객체를 연결시켜 분산된 메모리 형태를 가진다

2) LinkedList의 첫번째 node는 head, 마지막 node는 tail이라고 부른다

3) 인덱스(index)로 접근했던 기존 list자료형과는 다르게 LinkedList는 head node를 이용해 접근할 수 있다

파이썬으로 배우는 데이터 구조

수고했습니다
곧 다음 시간에
다시 뵙겠습니다