Data Structures in Python
Chapter 3

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

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Agenda

- Linked List - Review
- ListUnsorted Implementation
  - ADT
  - Constructor
  - Traversal
  - push(), pop(), find()

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)`
  - Pushes a new node with the data to the list.
- `pop(data)`
  - Removes the node from the list.
- `find(data)`
  - Searches for the data in the list and **returns** a Boolean value.

abstract methods

The ListUnsorted Class - ADT

- `ListUnsorted(): __init__()`
  - Creates a new list that is empty and returns an empty list.
- `push(data)`
  - Pushes a new node to the list at the front.
- `pop(data)`
  - Removes the node with data from the list.
- `find(data)`
  - Searches for the data in the list and returns a Boolean value.

The ListUnsorted Class - ADT

- The linked list is built from a collection of nodes, each linked to the next by explicit references.
  - It must maintain a reference to the first node (head).
  - It is commonly known as a **linked list**.
- Examples:
  - An Empty List:

```
mylist = ListUnsorted()
```

The ListUnsorted Class - Constructor

- To use the abstract methods, import The constructor contains
  - A **head** reference variable
    - References the list's first node
    - Always exists even when the list is empty

```
from abc import ABC, abstractmethod

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

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

```
if __name__ == '__main__':
    mylist = ListUnsorted()
```

The ListUnsorted Class

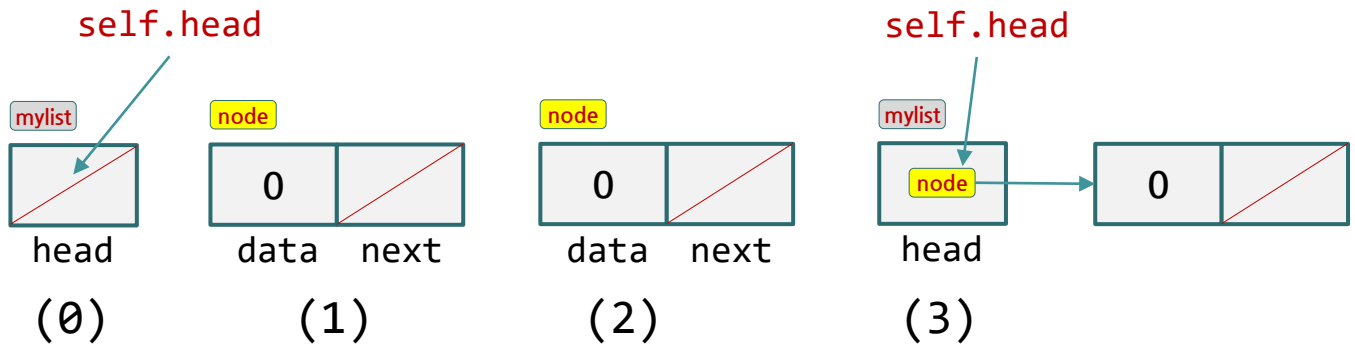
- Example: a linked list of integers

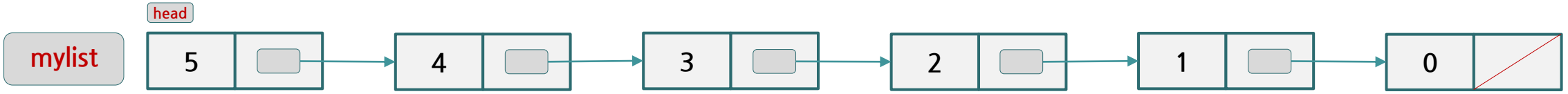
```
class ListUnsorted(LinkedList):
    ...

    def push(self, data):
        node = Node(data)
        node.set_next(self.head)
        self.head = node
    ...
```

(1)
(2)
(3)

```
if __name__ == '__main__':
    mylist = ListUnsorted()
    for i in range(6):
        mylist.push(i)
```

(0)





The ListUnsorted Class

- Example: a linked list of integers

```
class ListUnsorted(LinkedList):
    ...

    def push(self, data):
        node = Node(data)
        node.set_next(self.head)
        self.head = node
    ...
```

(1) (2) (3)

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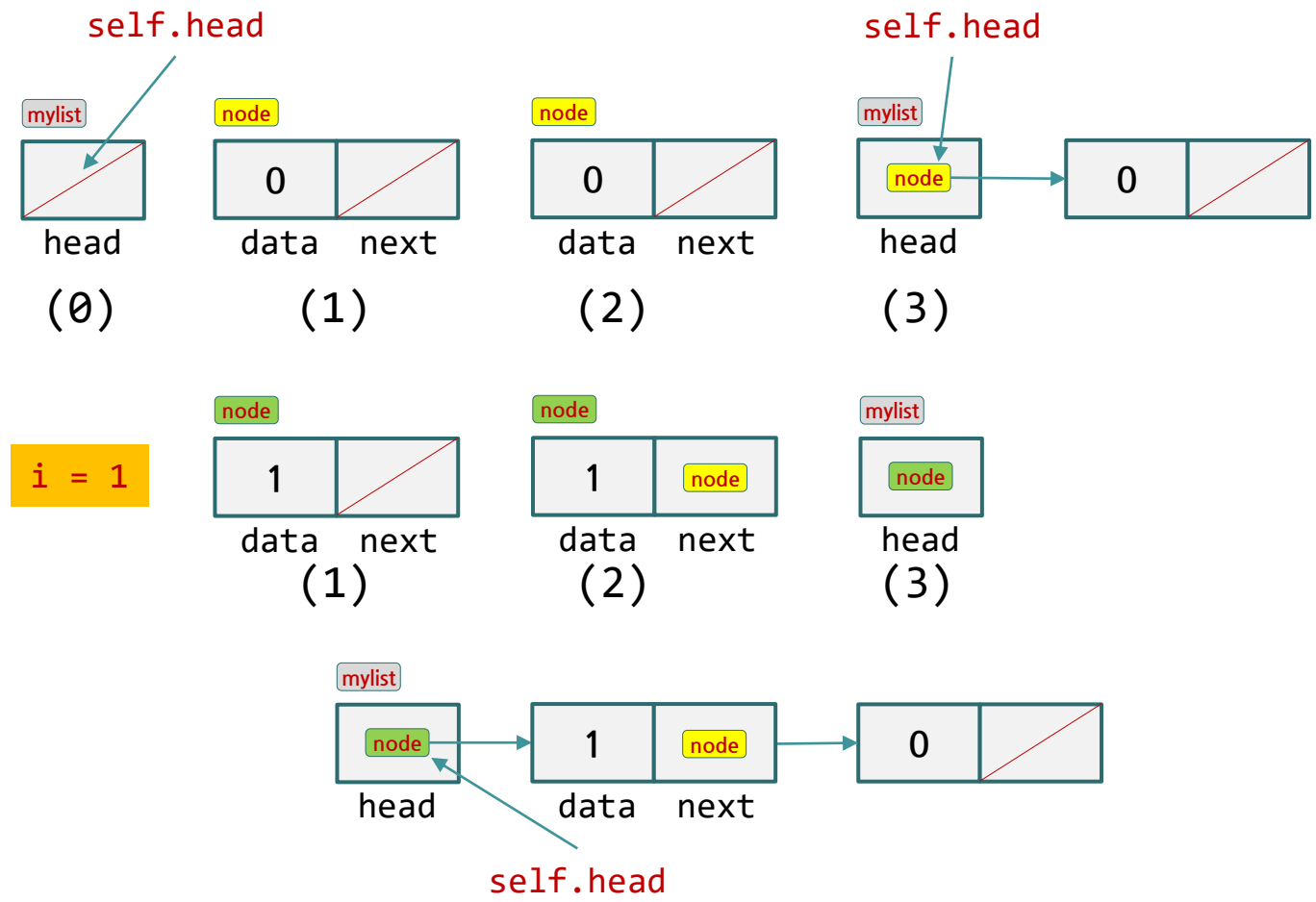
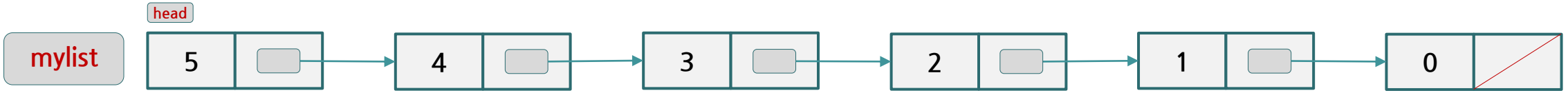
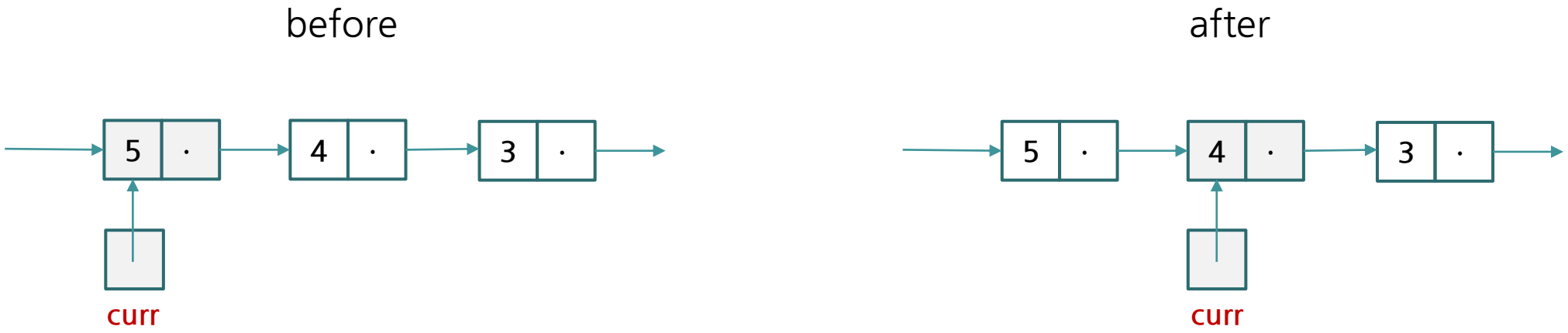




The ListUnsorted Class - Traversals

- To traverse a linked list, set a pointer to be the same address as **head**, process the data in the node, move the pointer to the **next** node, and so on.



The ListUnsorted Class - Traversals

- Loop stops when the next pointer is **None**
  - Use a reference variable: curr
    - References the current node
    - Initially references the first node (head)

```
curr = self.head
```

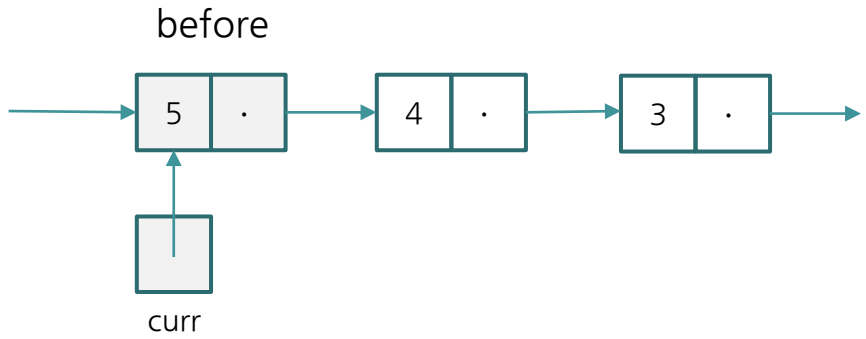
    - To advance the current position to the next node

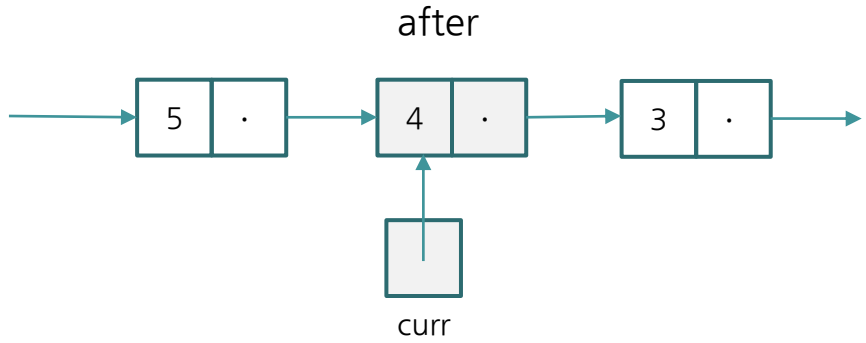
```
curr = curr.get_next()
```

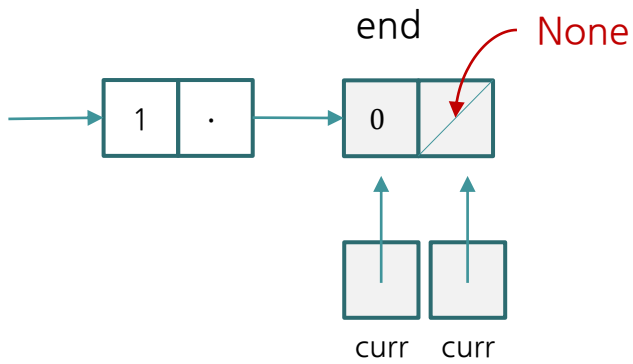
    - Loop

```
curr = self.head
while not curr == None:
    ...
    curr = curr.get_next()
```

after while loop, curr == None







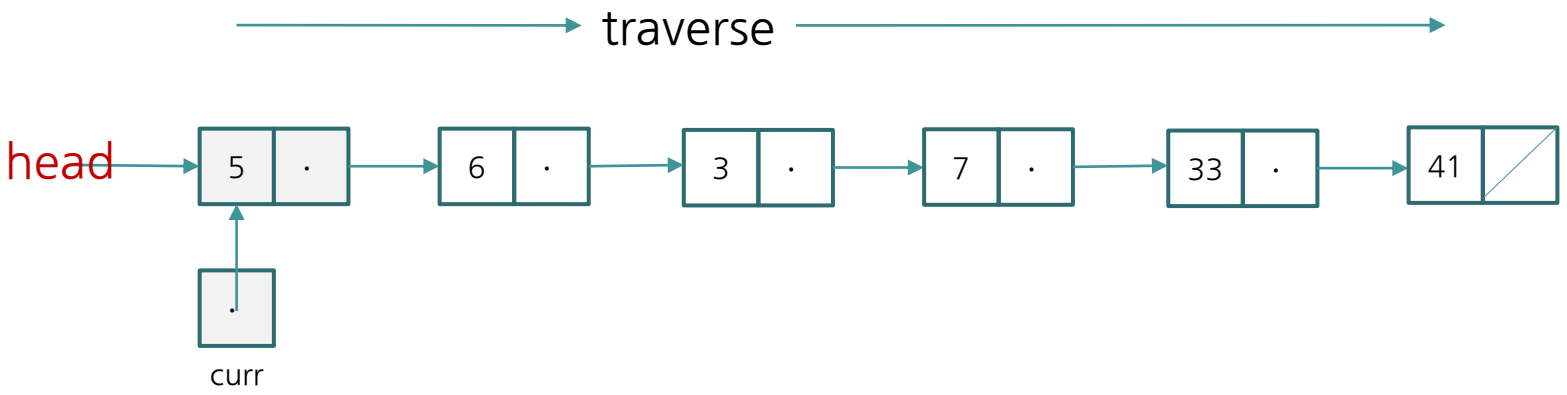
The ListUnsorted Class - Displaying the Contents

- Traversing the Linked List from the **head** to the **tail**
  - Use a reference variable: **curr**
  - This functionality may be implemented in **LinkedList.__str__()**

```
curr = self.head
while curr != None:
    print(curr.get_data(), end=' ')
    curr = curr.get_next()
```

```
5 6 3 7 33 41
```

after while curr == None



The ListUnsorted Class - is_empty() & size()

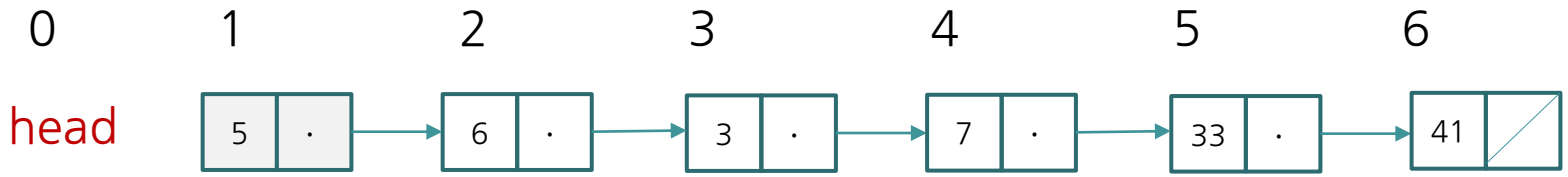
These methods may be implemented in `LinkedList` class.

- `is_empty()` - Tests to see whether the list is empty.

```
return self.head == None
```

- `size(), __len__()`
  - Returns the number of nodes in the list.
  - Traverses the list and counts the number of nodes.

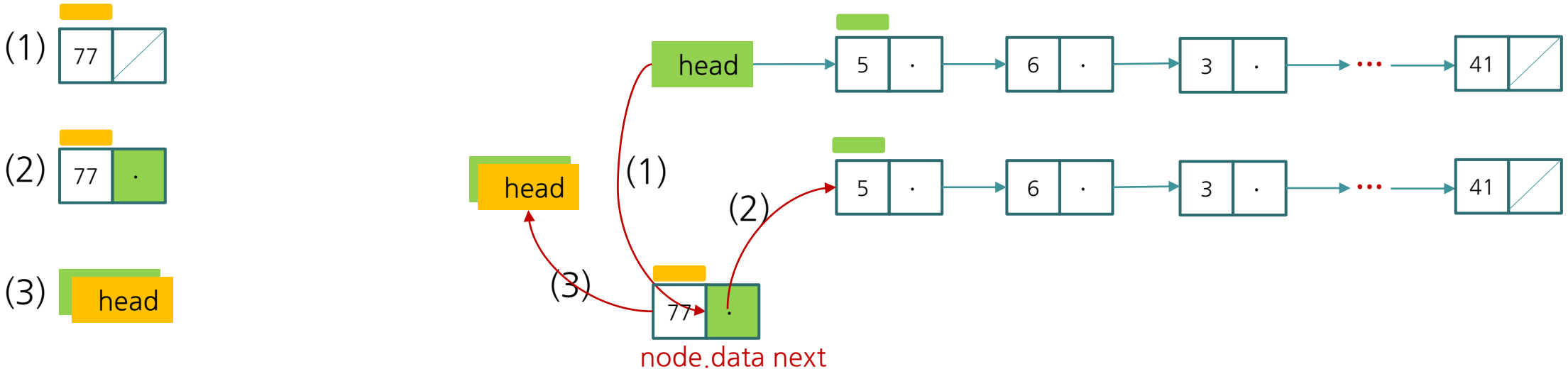
```
curr = self.head
count = 0
while curr != None:
    count = count + 1
    curr = curr.get_next()
```



The ListUnsorted Class - push()

- Push(data) inserts a node with data at the beginning of a linked list
  - Create a new Node and store the new data into it.
  - Connect the new node to the linked list by changing references.
    - Change the next reference of the new node to refer to the old first node of the list.
    - Modify the head of the list to refer to the new node.

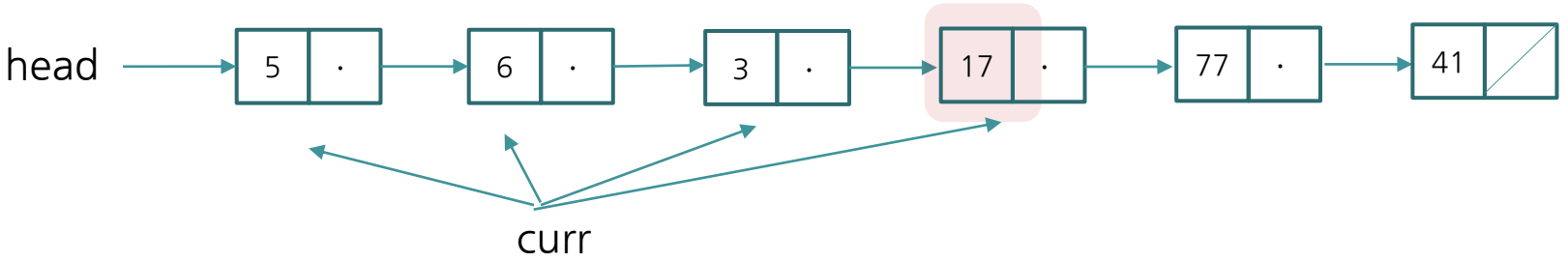
```
(1) node = Node(77)
(2) node.set_next(self.head)
(3) self.head = node
```



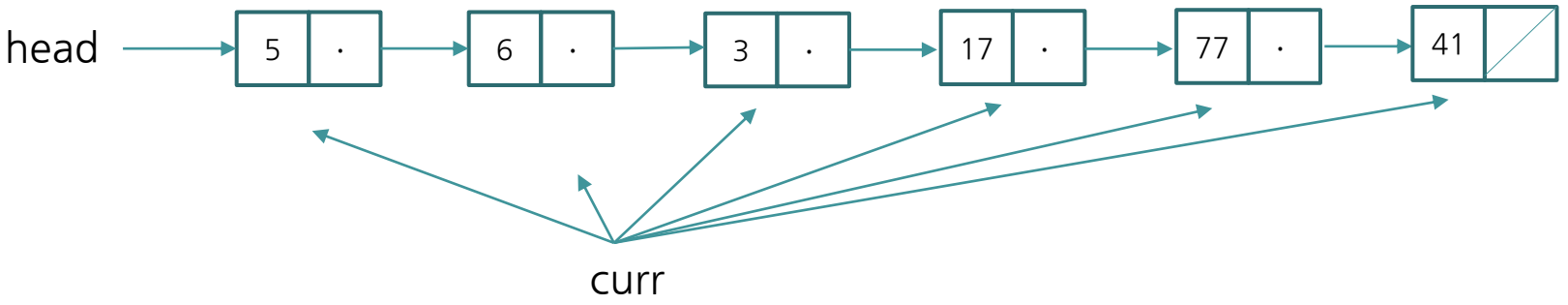
The ListUnsorted Class - find()

- find(data) searches for a node with data in the list and returns a Boolean.
- Examples:

```
print(mylist.find(17))
```




```
print(mylist.find(19))
```



The ListUnsorted Class - find()

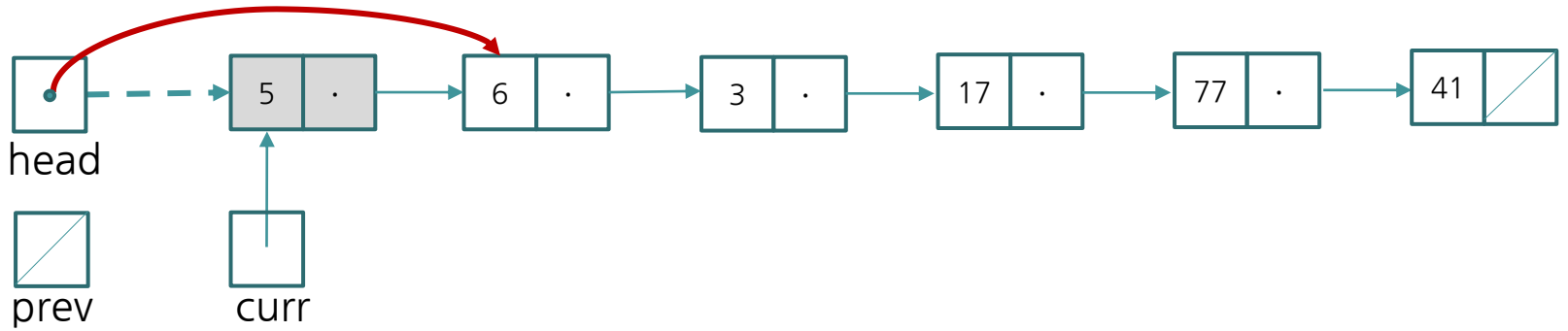
- To find a node in a linked list:
  - Set a pointer to be the same address as head.
  - Process the data in the node, move the pointer to the next node, and so on.
  - Loop stops either
    - The data is found.
    - The next pointer is None.

```
def find(self, data):
    curr = self.head
    while curr != None:
        if curr.get_data() == data:
            return True
        curr = curr.get_next()
    return False
```

The ListUnsorted Class - pop()

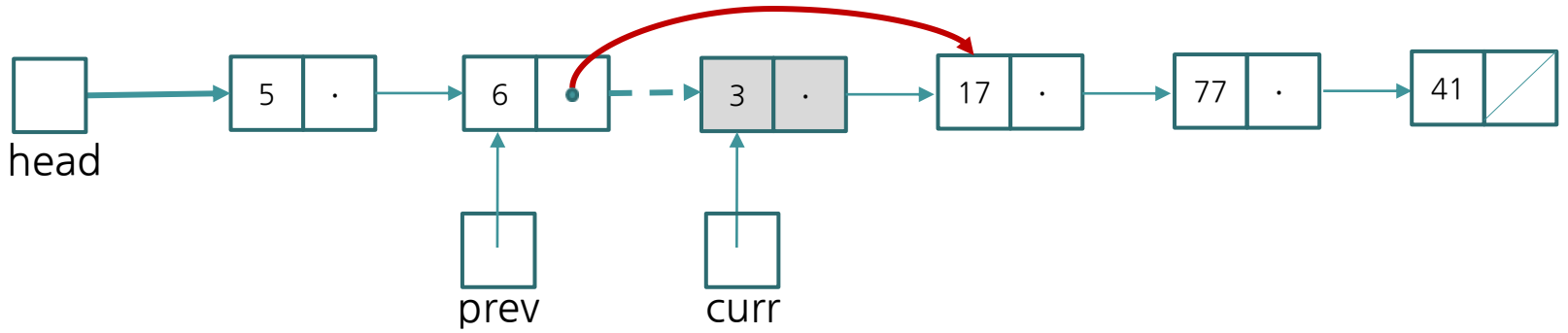
- pop(data) removes a node with data from the list.
  - Assume the node to pop is present in the list.
- Examples:
  - Delete the first node.

```
mylist.pop(5)
```



  - Delete a node in the middle of the list with **prev** and **curr** references.

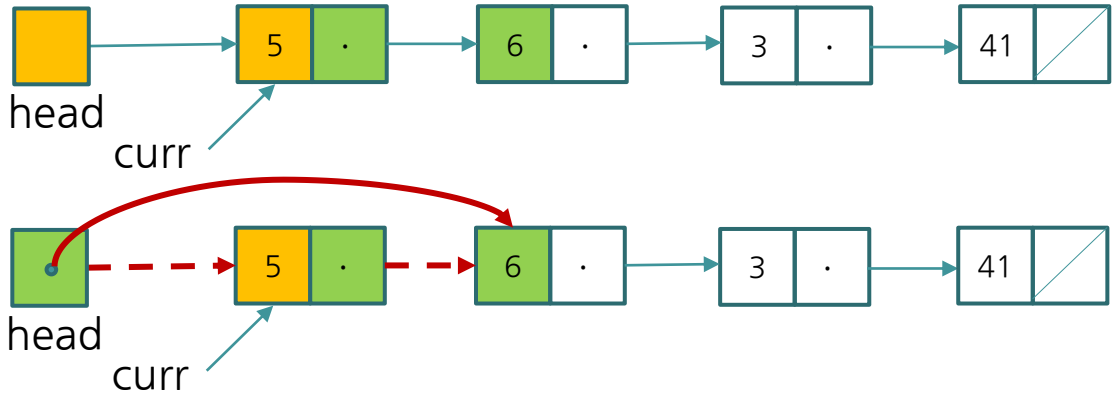
```
mylist.pop(3)
```



The ListUnsorted Class - pop()

- To delete a node from a linked list
  - Locate the node that you want to delete (**curr**)
  - **Disconnect** this node from the linked list by changing references.
- Two situations:
  - (1) To delete the **first** node,
    - Modify head to refer to the node after the current node

```
self.head = curr.get_next()
```



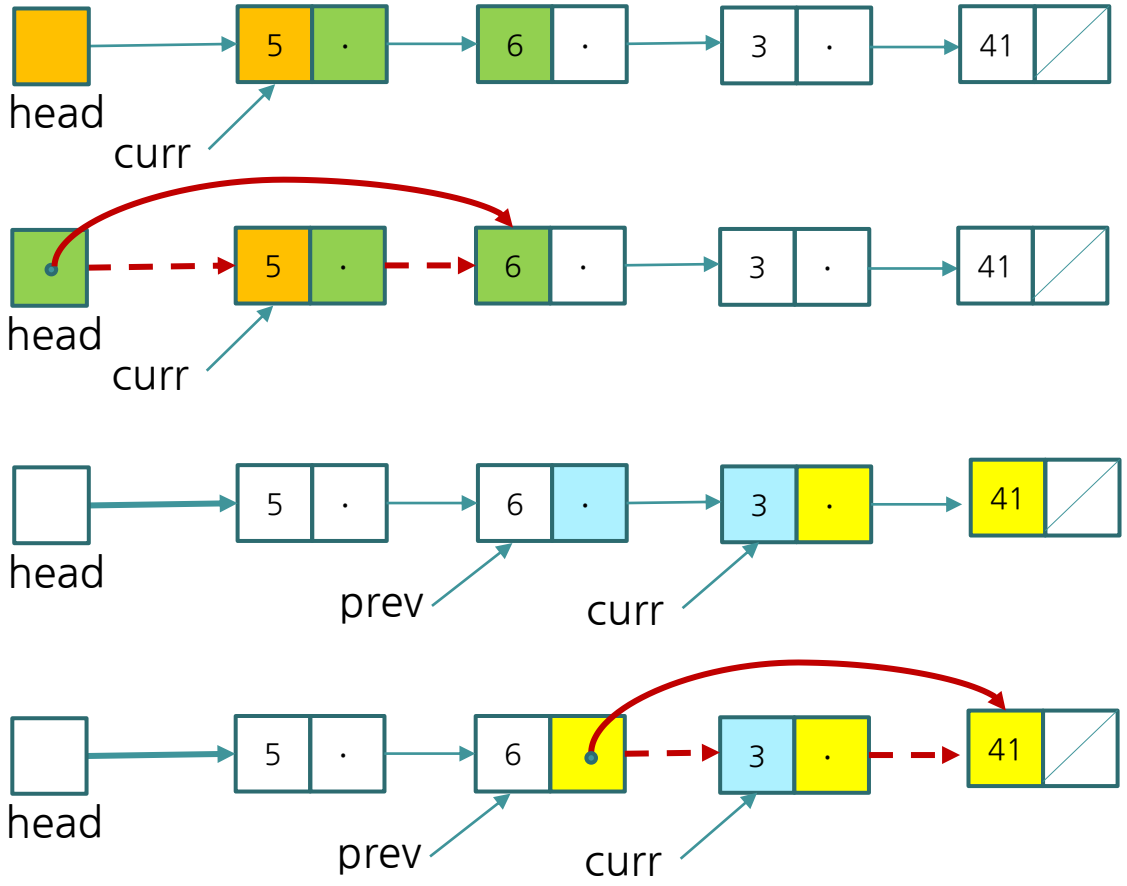
The ListUnsorted Class - pop()

- To delete a node from a linked list
  - Locate the node that you want to delete (**curr**)
  - **Disconnect** this node from the linked list by changing references.
- Two situations:
  - (1) To delete the **first** node,
    - Modify head to refer to the node after the current node

```
self.head = curr.get_next()
```

  - (2) To delete a node in the **middle,**
  - Set next of the **prev** node to refer to the node **after the current node.**

```
prev.set_next(curr.get_next())
```



The ListUnsorted Class - Example

- Example:

```
def TestListUnsorted():
    mylist = ListUnsorted()
    number_list = [31, 77, 17, 93, 26, 54]
    for num in number_list:
        mylist.push(num)

print (mylist.size())
print (mylist.find(17))
print (mylist.find(1))
mylist.pop(31)
mylist.pop(54)
print (mylist.size())
```

```
6
True
False


4
```

Summary

- Any element in a list can be accessed; however, you must traverse a linked list to access a particular node.
- A node can be inserted into and deleted from a reference based linked list without shifting nodes.