

# 파이썬으로 배우는 데이터 구조



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# 학습 목표

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Doubly-linked List를 다루는 다양한  
메소드들을 구현할 수 있다

## **Data Structures in Python**

### **Chapter 3 - 4**

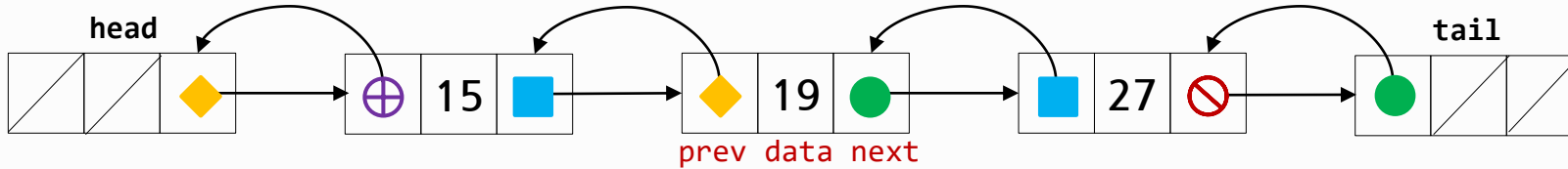
- Doubly Linked List - Structures
- **Doubly Linked List - Operations**
- Doubly Linked List - DequeCircular

# Agenda

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- **DoublyLinked** Class ADT
  - Basic Operations:
  - Key Operations:
  - Other Operations

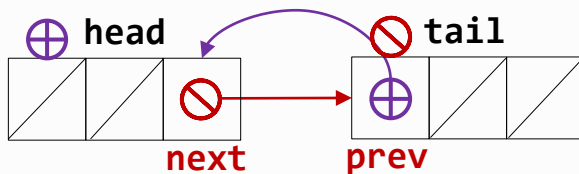
# DoublyLinked Class ADT



- Basic Operations:
  - `__init__()`, `__str__()`,
  - `begin()`, `end()`, `is_empty()`, `size()`, `find()`, `clear()`
- Key Operations:
  - `remove()`
  - `insert()`
- Other Operations: (left as coding exercise)
  - `reverse()`
  - `__iter__()`

## Basic Operations: `begin()` and `end()`

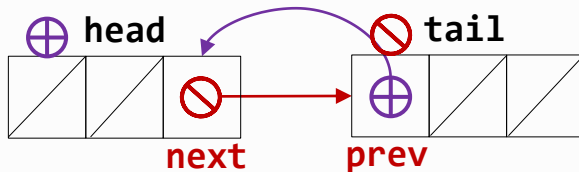
- **`begin()`** returns 1<sup>st</sup> node (reference) that the head's **`next`** points to. It may return the **`tail`** node.
- **`end()`** returns the **`tail`** node (reference).



```
def begin(self):  
    return self.__head.next  
  
def end(self):  
    return self.__tail
```

## Basic Operations: is\_empty()

- **is\_empty()** returns True if the list is empty, False otherwise.
- The list must be empty if what **begin()** returns is the same what **end()** returns.
- For easy coding, it is recommended to use **begin()** and **end()** rather than head and tail. That is a reason we use **\_\_head** and **\_\_tail**.



```
alist = DoublyLinked()
```

```
print(alist.begin())  
print(alist.end())  
print(alist.is_empty())
```

```
<__main__.Node object at 0x000001B3D089AB80>  
<__main__.Node object at 0x000001B3D089AB80>  
True
```



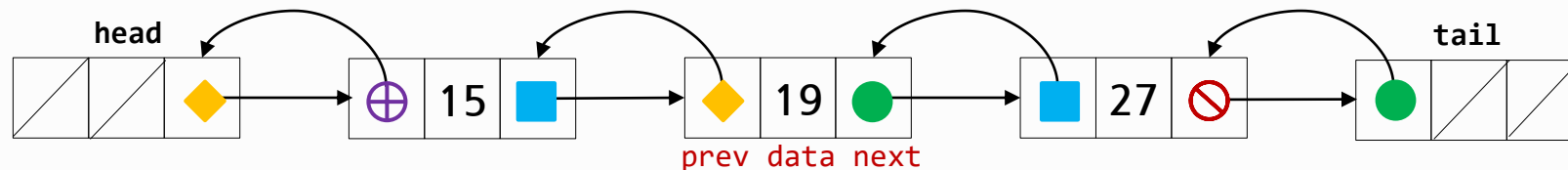
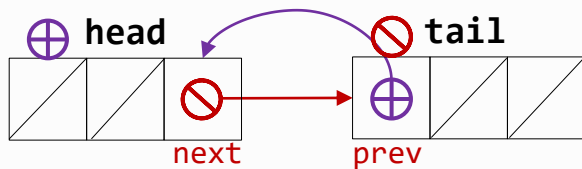
```
def begin(self):  
    return self.__head.next  
  
def end(self):  
    return self.__tail  
  
def is_empty(self):  
    return self.begin() == self.end()
```

# Basic Operations: size()

- **size()** returns the number of node in the list.
  - The two sentinel nodes are **not** counted for the size of the list.

```
def size(self):  
    count = 0  
    curr = self.begin()  
    while curr != self.end():  
        count = count + 1  
        curr = curr.next  
    return count
```

- initialize **count**
- **curr** is set to the 1<sup>st</sup> node
- loop through the list
- increment count by 1
- go for the next
- return **count**



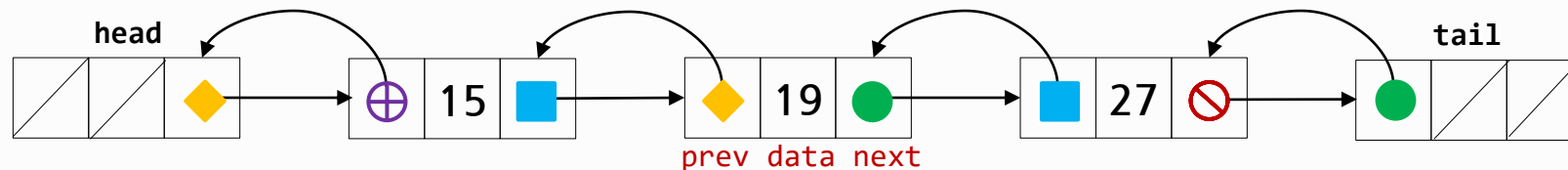
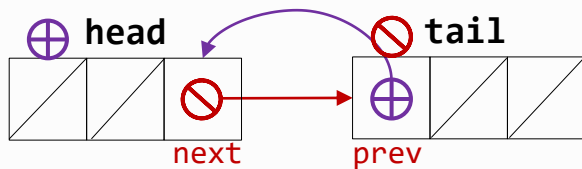


## Basic Operations: find(data)

- **find()** returns the node (reference) with the **data**, **None** if not found.
  - One method fits for all cases. No special case is needed.
  - Pay attention that we cannot use the expression such as "**while curr:**" since **self.end()** does not return **None** but the **tail** node (reference).

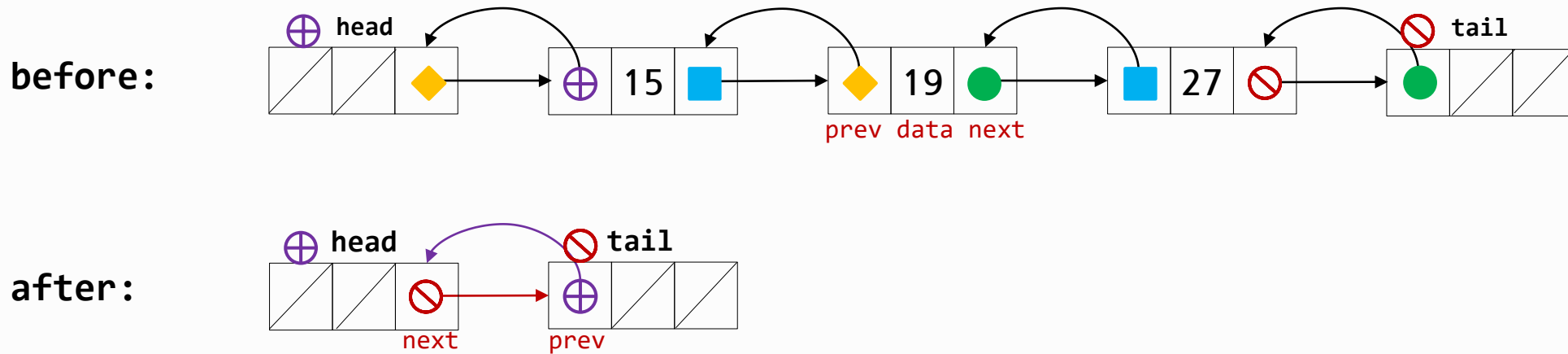
```
def find(self, data):  
    curr = self.begin()  
    while curr != self.end():  
        if curr.data == data:  
            return curr  
        curr = curr.next  
    return None
```

- **curr** is set to the 1<sup>st</sup> node
- loop through the list
- check for the matching
- return **curr** matched
- go for the next since no match
- return **None** since not found



## Basic Operations: clear()

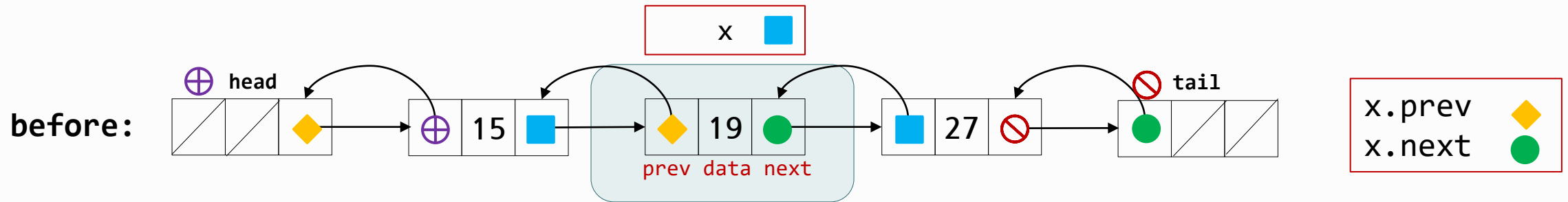
- **clear()** removes all the nodes in the list and becomes an empty list.
  - The following two statements make no nodes in the list be referenced. Then the Python garbage collector, **gc.collect()**, kicks in automatically.
  - To invoke it by yourself, import **gc**.



```
def clear(self):  
    self.__head.next = self.__tail  
    self.__tail.prev = self.__head  
    #gc.collect()    # unnecessary
```

## Key Operations: remove(x)

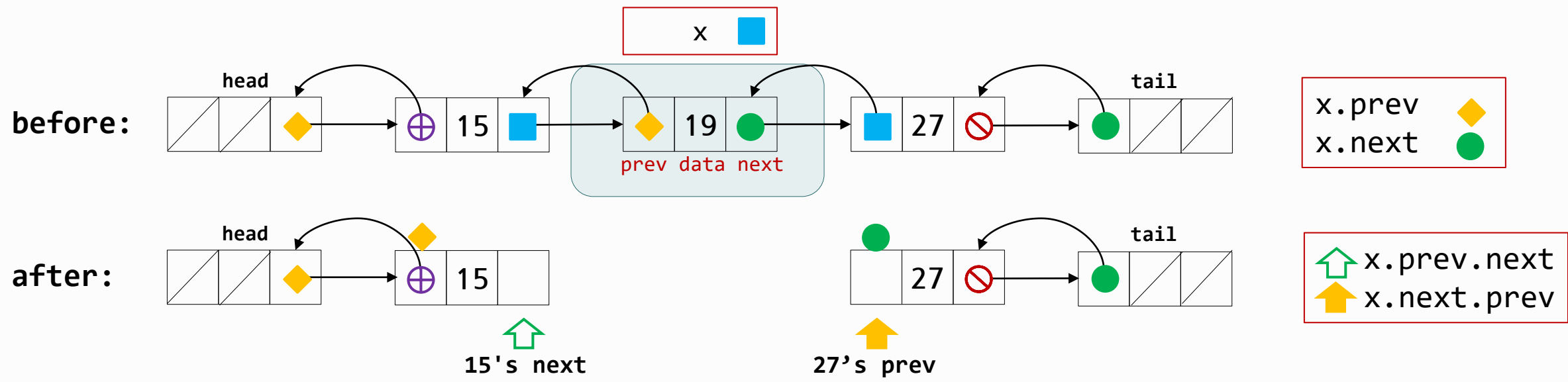
- **remove()** removes the node **x** only if **x** is a node in the list. If not, return **None**.



- Concept:
  - Using given the node **x**, remove by itself, but keep the links alive.
  - The node **15's next** must set to the **node 27**, the green circle. The node **27's prev** must set to the **node 15**, the orange diamond. as shown in the following figure.

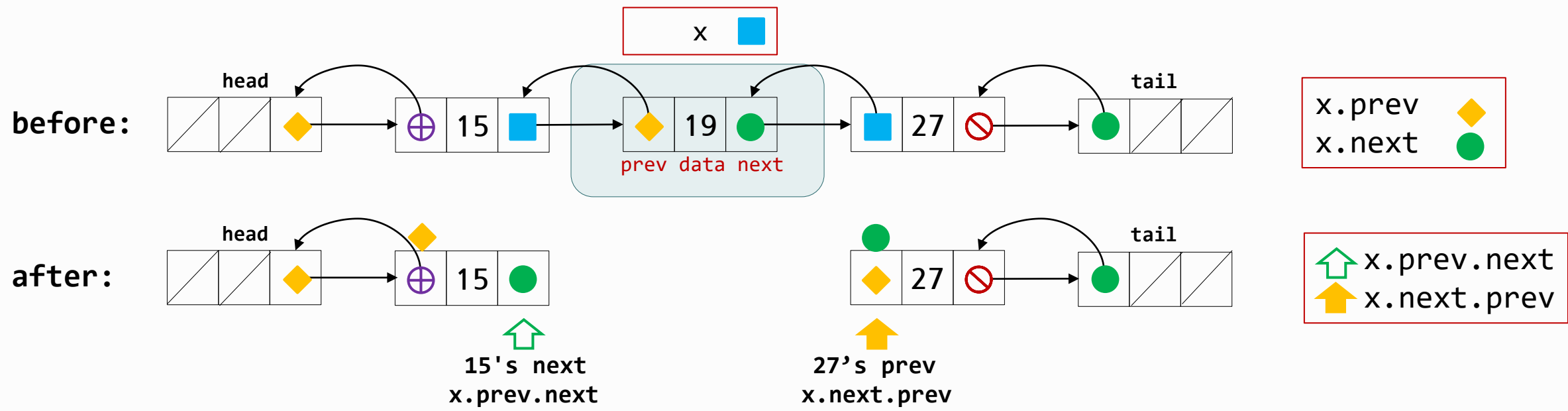
# Key Operations: remove(x)

- remove() removes the node x only if x is a node in the list. If not, return None.



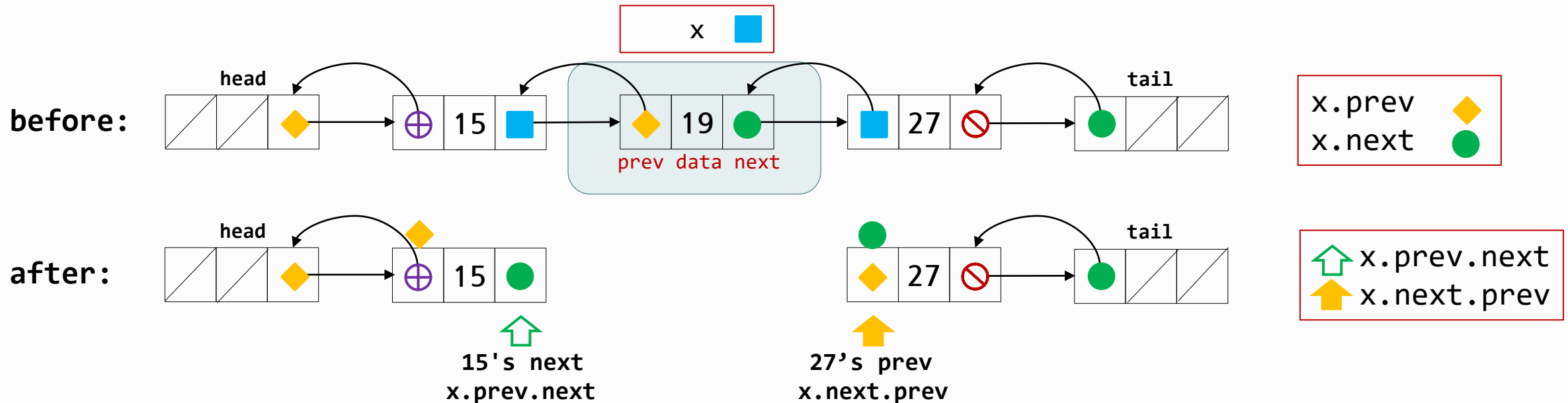
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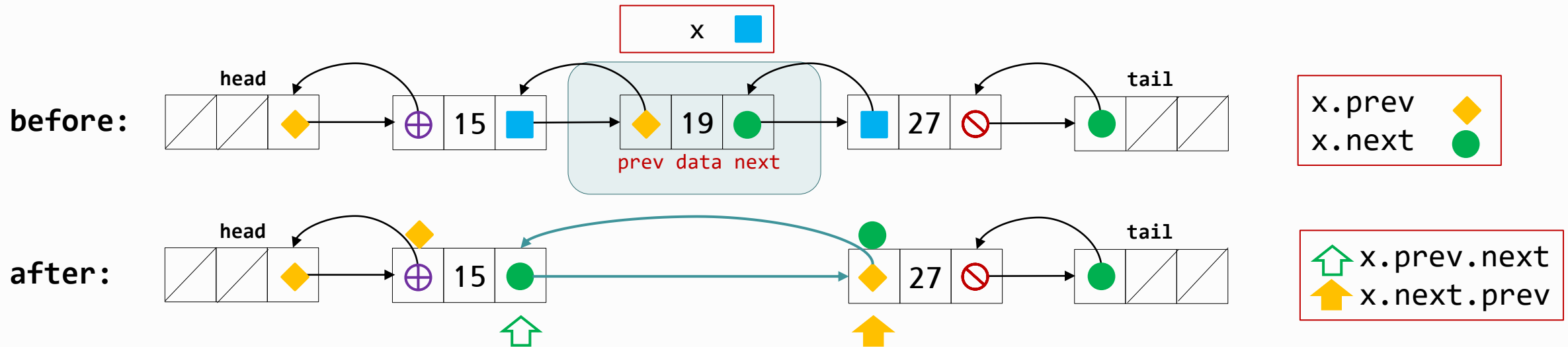


- Since the node **15's next** is **x.prev.next**, the node **27's prev** is **x.next.prev**,





```
def remove(self, x):  
    if x == None: return None  
    x.prev.next = x.next  
    x.next.prev = x.prev
```

## Key Operations: remove(x)

- **remove()** removes the node **x** only if **x** is a node in the list. If not, return **None**.

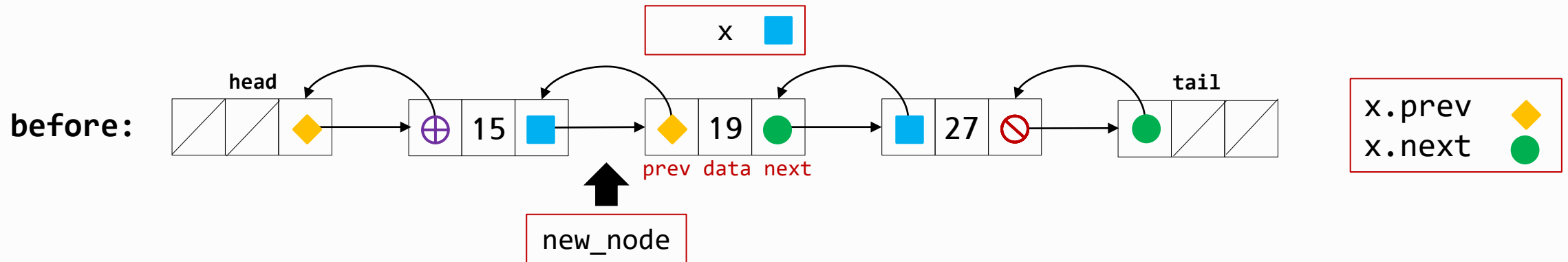


- Since the node **15's next** is **`x.prev.next`**, the node **27's prev** is **`x.next.prev`**,

```
def remove(self, x):  
    if x == None: return None  
     x.prev.next = x.next   
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```

## Key Operations: insert(data, x)

- **insert()** inserts a **new node** with **data** at the position of the node **x** in the list.

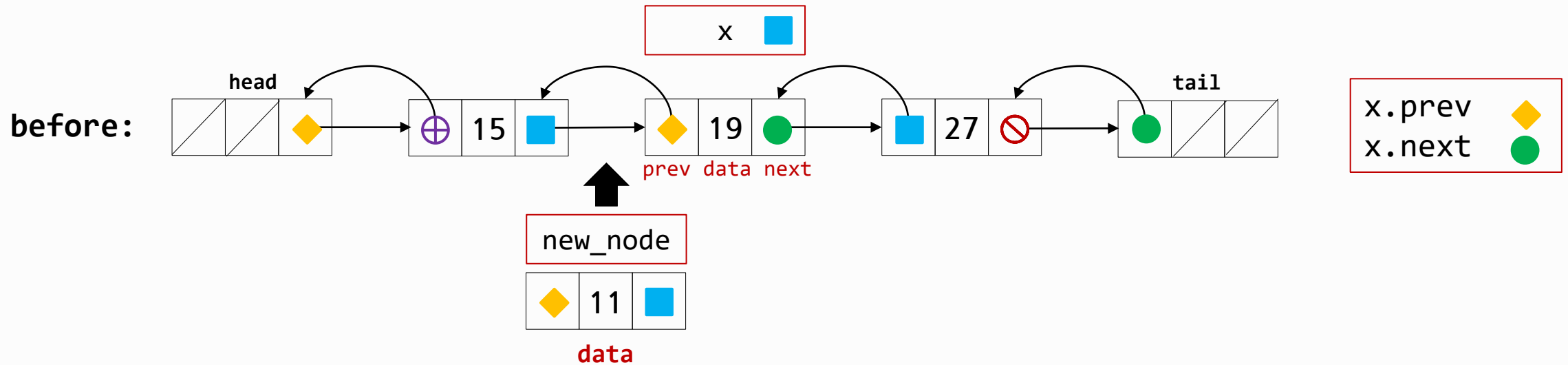


- Concepts:
  - The new node goes into between the node 15 and the node 19.
  - The new node pushes the node 19 to the right.
  - The new links must be made between the nodes **15**, the **new node** and the node **19**.



## Key Operations: insert(data, x)

- **insert()** inserts a **new node** with **data** at the position of the node **x** in the list.

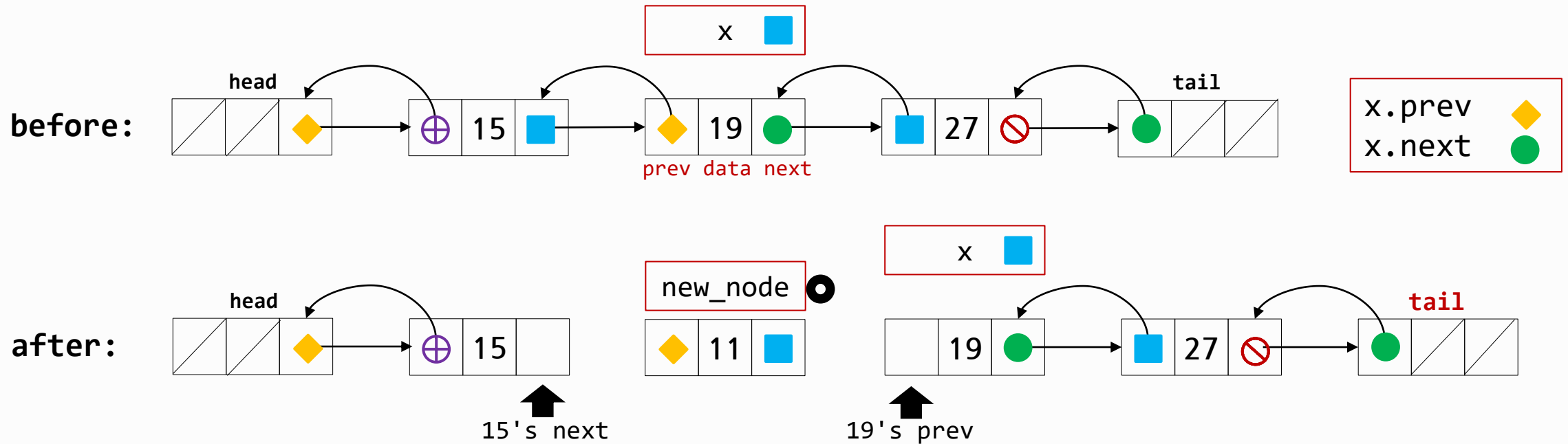


- Instantiate a **new node** between the node 15 and 19 with the following settings:
  - (1) **data** = data provided with an argument, 11 for example.
  - (2) **prev** = the node 15
  - (3) **next** = the node 19
  - Then, the new node would be instantiated: **new\_node = Node( data, x.prev, x )**

```
def __init__(self, data=None, prev=None, next=None):
```

## Key Operations: insert(data, x)

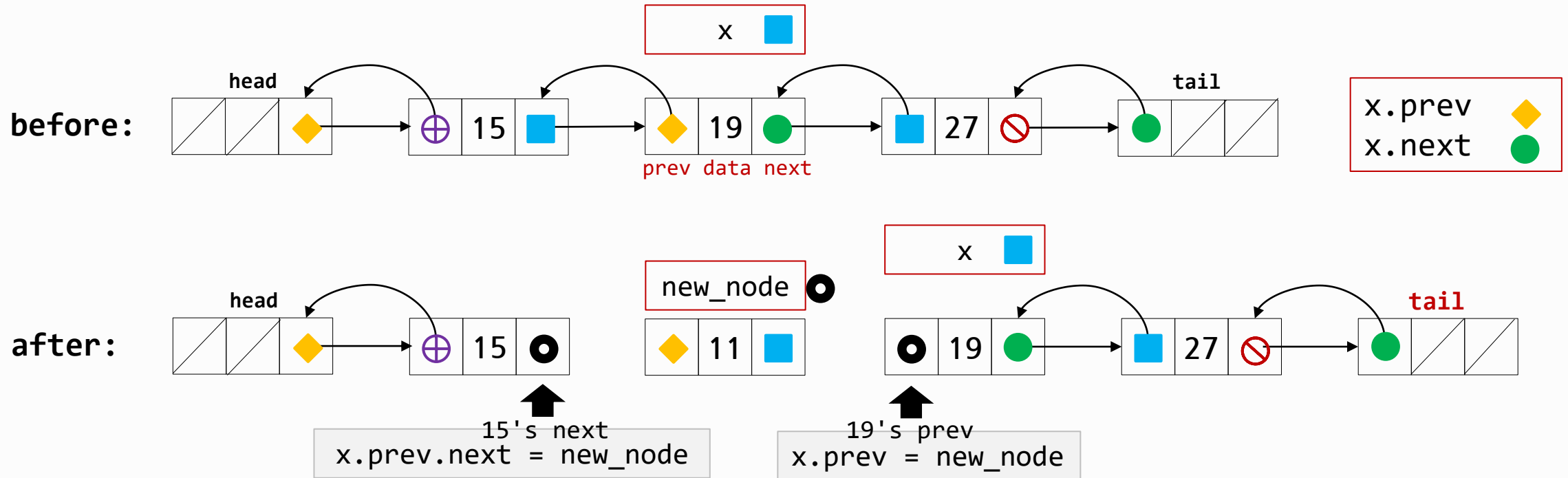
- **insert()** inserts a **new node** with **data** at the position of the node **x** in the list.



- Now the **new\_node** is linked with the node 15 and the node 19.
- The nodes 15 and 19, however, must link to the new node.
- Let us suppose the **new\_node** is instantiated, denoting with a **donut shape dot**. ●
- This **new node's reference** must go in the node **15's next** and the node **19's prev**.
- The node 15's next is **x.prev.next**, and the node 19's prev is **x.prev**.

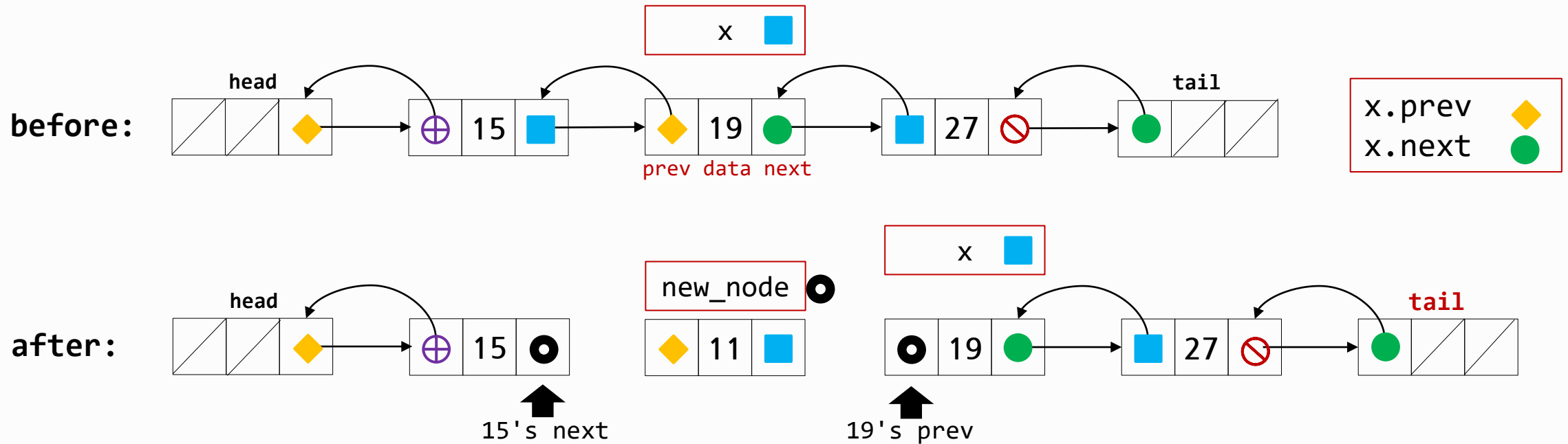
## Key Operations: insert(data, x)

- **insert()** inserts a new node with **data** at the position of the node **x** in the list.



## Key Operations: insert(data, x)

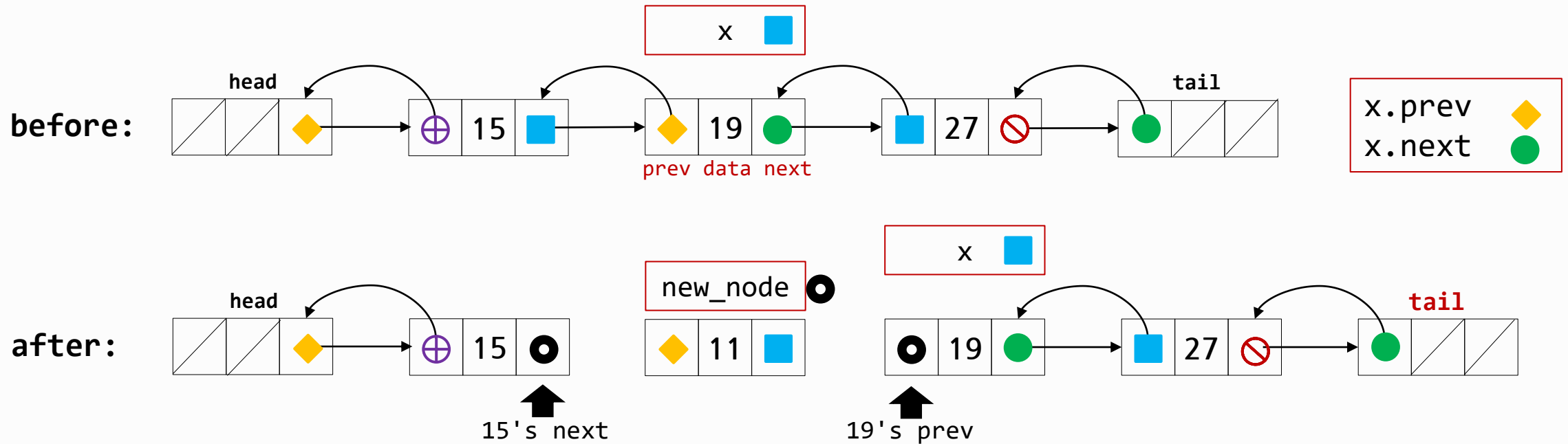
- **insert()** inserts **a new node** with **data** at the position of the node **x** in the list.



```
def insert(self, data, x):
    new_node = Node(data, x.prev, x)
    x.prev.next = new_node
    x.prev      = new_node
```

## Key Operations: insert(data, x)

- **insert()** inserts a new node with **data** at the position of the node **x** in the list.



```
def insert(self, data, x):  
    new_node = Node(data, x.prev, x)  
    x.prev.next = new_node  
    x.prev      = new_node
```

- The node **x** can be any node in the list including the 1<sup>st</sup> node and the **tail** node.
- **begin()** returns the 1<sup>st</sup> node, and **end()** returns the **tail** node, respectively.

## Key Operations: `remove()` and `insert()`

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- With two operations, `remove()` and `insert()`, Some methods may be simply coded.
- For example:
  - `pop()` - remove the last node
    - `self.remove(self.end().prev)`
  - `popleft()` - remove the first node
    - `self.remove(self.begin())`
  - `append(data)` - insert a node at the end
    - `self.insert(data, self.end())`
  - `appendleft(data)` - insert a node at the front
    - `self.insert(data, self.begin())`

# Summary

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- Doubly Linked List Class ADT
  - Two sentinel nodes helps simplifying some operations.
  - Use `begin()` and `end()` method instead of accessing `__head` and `__tail` directly.
  - The time complexity of two key operations such as `remove()` and `insert()` is  $O(1)$ .

# 학습 정리

- 1) Doubly-linked List 클래스를 구현할 때, `__head`, `__tail` 대신 `begin()`, `end()` 를 사용하는 것이 바람직하다
- 2) `remove()`, `insert()` 작업의 시간복잡도는  $O(1)$ 이다



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수고했습니다  
곧 다음 시간에  
다시 뵙겠습니다

