

Designing a flexible list

Madhavan Mukund

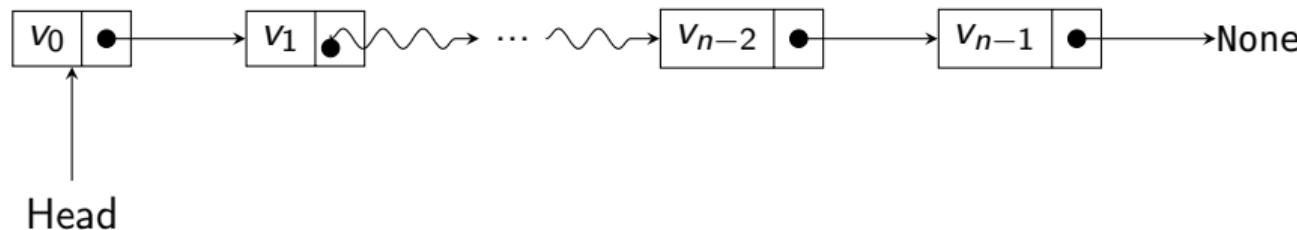
<https://www.cmi.ac.in/~madhavan>

Programming and Data Structures with Python

Lecture 12, 15 Sep 2022

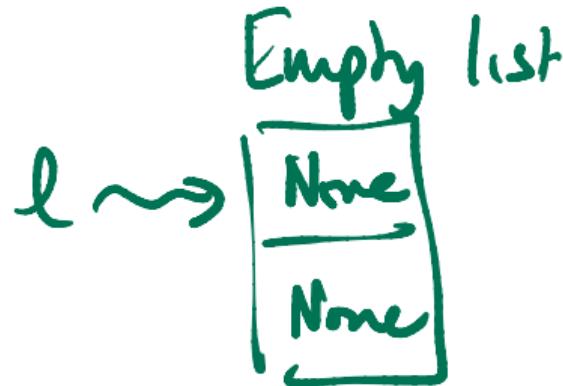
Lists

- Typically a sequence of nodes
- Each node contains a value and points to the next node in the sequence
 - “Linked” list
- Easy to modify
 - Inserting and deletion is easy via local “plumbing”
 - Flexible size
- Need to follow links to access $A[i]$
 - Takes time $O(i)$



Implementing lists in Python

- Python class `Node`



```
class Node:  
    def __init__(self, v = None):  
        self.value = v  
        self.next = None  
        return  
  
    def isempty(self):  
        if self.value == None:  
            return(True)  
        else:  
            return(False)
```

Implementing lists in Python

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 - `self.value` is the stored value
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- Creating lists
 - `l1 = Node()` — empty list
 - `l2 = Node(5)` — singleton list

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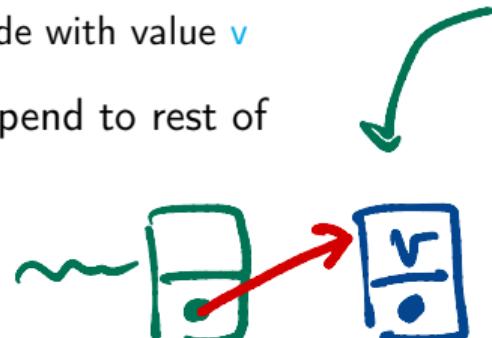
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 - `l1 = Node()` — empty list
 - `l2 = Node(5)` — singleton list
 - `l1.isempty() == True`
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Appending to a list

- Add v to the end of list l
- If l is empty, update $l.value$ from `None` to v
- If at last value, $l.next$ is `None`
 - Point `next` at new node with value v
- Otherwise, recursively append to rest of list

```
def append(self,v):  
    # append, recursive  
    if self.isempty():  
        self.value = v  
    elif self.next == None:  
        self.next = Node(v)  
    else:  
        self.next.append(v)  
    return
```



Appending to a list

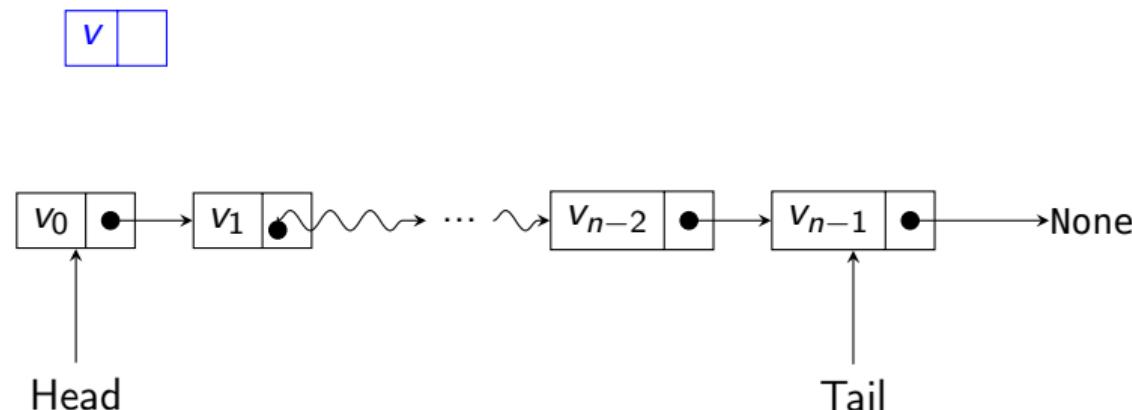
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- Iterative implementation
 - If empty, replace $l.value$ by v
 - Loop through $l.next$ to end of list
 - Add v at the end of the list

```
def append(self,v):  
    # append, iterative  
    if selfisempty():  
        self.value = v  
        return  
  
    temp = self  
    while temp.next != None:  
        temp = temp.next  
  
    temp.next = Node(v)  
    return
```

While self.
next !=
None
]
self =
self.next

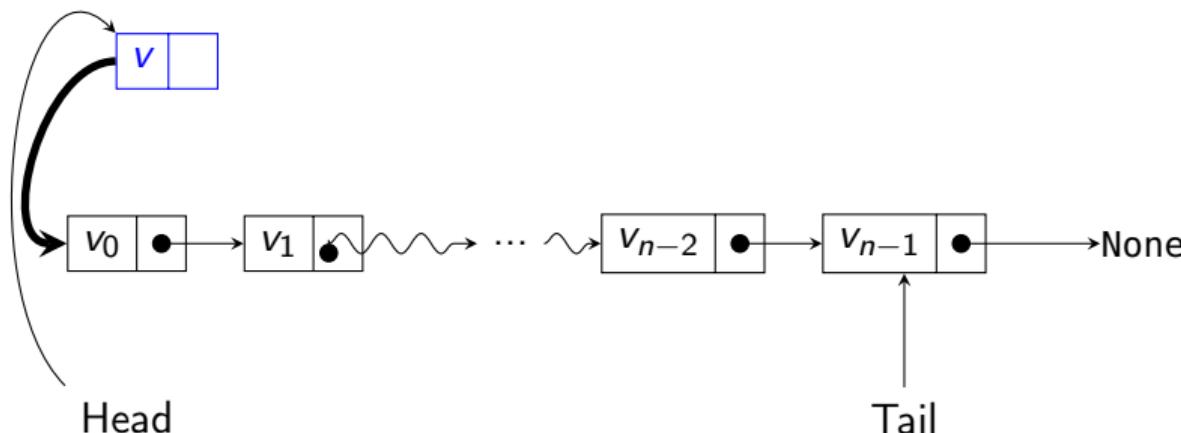
Insert at the start of the list

- Want to insert v at head
- Create a new node with v



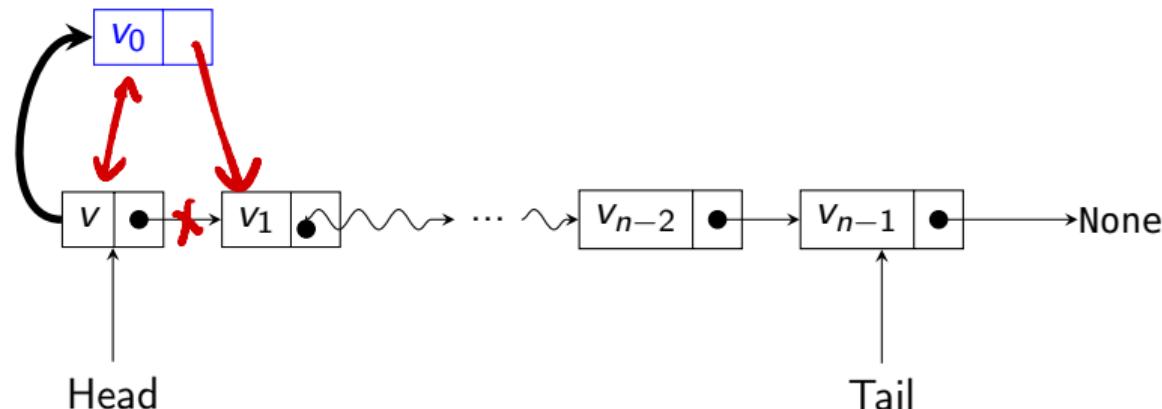
Insert at the start of the list

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- Cannot change where the head points!



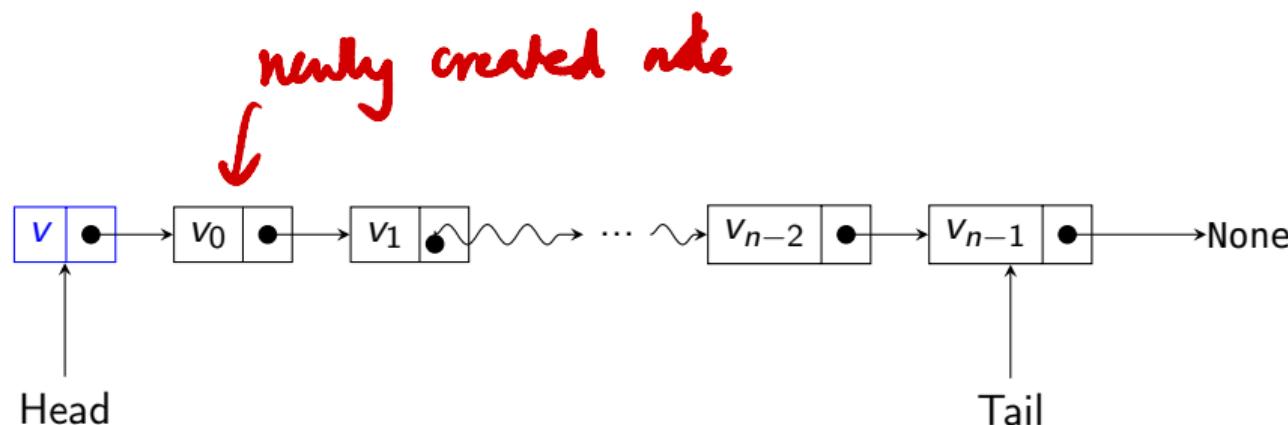
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- Cannot change where the head points!
- Exchange the values v_0, v
- Make new node point to `head.next`
- Make `head.next` point to new node



Appending to a list

- Create a new node with v
- Exchange the values v_0, v
- Make new node point to `head.next`
- Make `head.next` point to new node

$$(x,y) = (y,x)$$

$\text{self.next} \rightarrow \text{newnode}$

$\text{newnode.next} \rightarrow (\text{self.next})$

```
def insert(self,v):  
    if selfisempty():  
        self.value = v  
    return
```

$\text{newnode} = \text{Node}(v)$

```
# Exchange values in self and newnode  
(self.value, newnode.value) =  
(newnode.value, self.value)
```

```
# Switch links
```

```
(self.next, newnode.next) =  
(newnode, self.next)
```

```
return
```

Same as
append

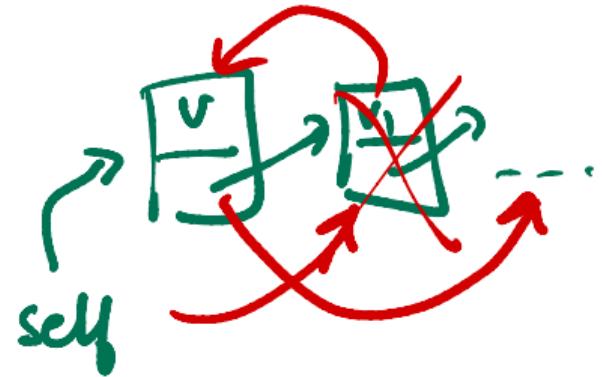
- create new node

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- Remove first occurrence of v
- Scan list for first v — look ahead at next node
- If next node value is v , bypass it

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- If next node value is v , bypass it
- Cannot bypass the first node in the list
 - Instead, copy the second node value to head
 - Bypass second node

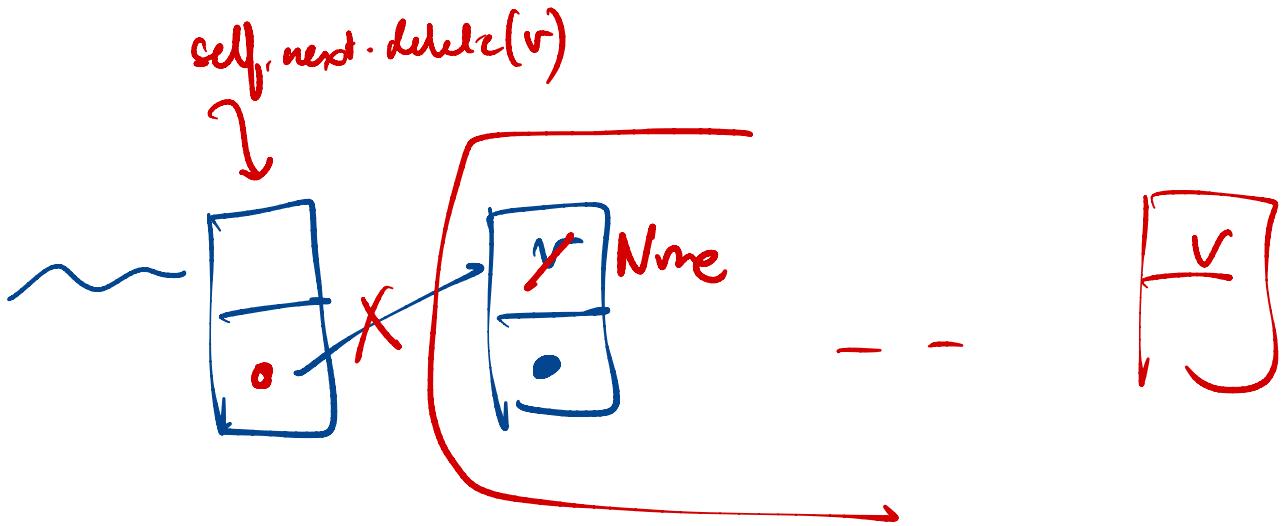


Delete a value v

- Remove first occurrence of v
- Scan list for first v — look ahead at next node
- If next node value is v , bypass it
- Cannot bypass the first node in the list
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 - Bypass second node
- Recursive implementation

```
def delete(self,v):  
    # delete, recursive  
  
    if self.isEmpty():  
        return  
  
    if self.value == v:  
        self.value = None  
        if self.next != None:  
            self.value = self.next.value  
            self.next = self.next.next  
        return  
  
    else:  
        if self.next != None:  
            self.next.delete(v)  
            if self.next.value == None:  
                self.next = None  
  
return
```

Creates empty list if currently singleton [v]



Delete a value v

- Remove first occurrence of v
- Scan list for first v — look ahead at next node
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- Recursive implementation
- Exercise: write an iterative version

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    if self.value == v:  
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        return  
    else:  
        if self.next != None:  
            self.next.delete(v)  
        if self.next.value == None:  
            self.next = None  
  
    return
```

Summary

- Use a linked list of nodes to implement a flexible list
- Append is easy
- Insert requires some care, cannot change where the head points to
- When deleting, look one step ahead to bypass the node to be deleted