course: CSC 135-01 - Computing Theory and Programming Languages

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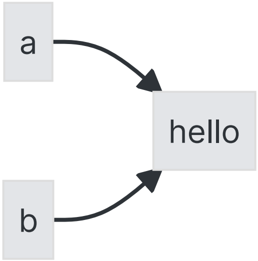
related_notes: 2022-02-15 2022-02-10-CSC135-01-LEC

Higher Order Functions and Recursion

W07.2 | Tuesday, February 15, 2022 | 08:57 AM

Notes

In Java a and b points to the same object; in addition, it's safe because Strings are immutable.



```
String a = "hello";
String b = "hello";
```

`list135` + Higher Order Functions

```
Back                                    Front
  [   | ] -> [   | ] -> [   | ] -> [   | ]
    ^          ^
list01       list2
list.map(lambda x: x + 1) [1,2,3] -> [2,3,4]
```

Recall the Cons list structure

```
class list135:

        def __init__(self, item=None, rest_of_list=None):
                self._item = item
                self._rest_of_list = rest_of_list

        def cons(self, item):
                new_node = list135(item, self)
                return new_node

        def first(self):
                """
                Returns: the front element
                """
                return self._item

        def rest(self):
                """
                Returns: the "copy" of old list with front
                element removed
                """
                return self._rest_of_list

        def is_empty(self):
                """
                Checks if the list is empty
                Returns: boolean
                """
                return self._rest_of_list == None
```

`list135` Recursive Approach - O(n) Space

```
Back                                           Front
  [   A  | ] -> [   B  | ] -> [   C  | ] -> [ / ]
  [ f(A) | ] -> [ f(B) | ] -> [ f(C) | ] -> [ / ]

Recursive solutions would not best for the computational overhead; where,
the, often small, call stack would be too greate and would amount to O(n)
calls on the run time stack.
```

```
def map(self, f):
        if(self.is_empty()):
                return self
        else:
                mapped_smaller_list = self._next.map(f)
                return mapped_smaller_list.cons(f(self._item))
```

`list135` Loop Approach

Time complexity: O(n) because it has to go though the whole list

Space complexity: O(1)

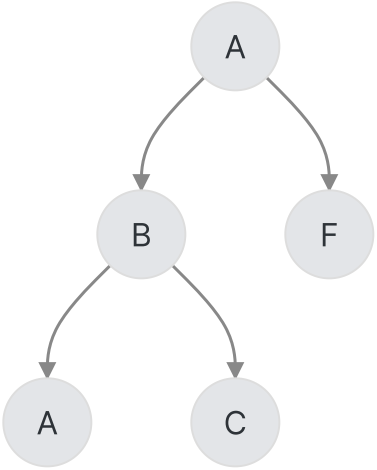
```
self and old
    v
[   A  | ] -> [   B  | ] -> [   C  | ] -> [ / ]

[ f(A) | ] -> [ f(B) | ] -> [ f(C) | ] -> [ / ]
    ^
    new
```

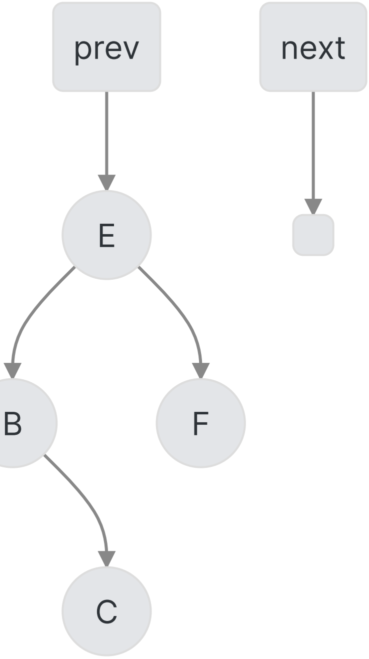
```
def map(self,f):
        if(self.is_empty())
                return self
        else:
                old = self
                new = list135(self._item)
                result = new
                while not old._next.is_empty():
                        # single paramter version of list135
                        # rest_of_list defaults to None
                        new._next = list135(f(old._next._item))
                        new = new._next
                        old = old._next
                # exit while old._next.is_empty() is true
                new._next = old._next
                return result
```

Binary Search Trees

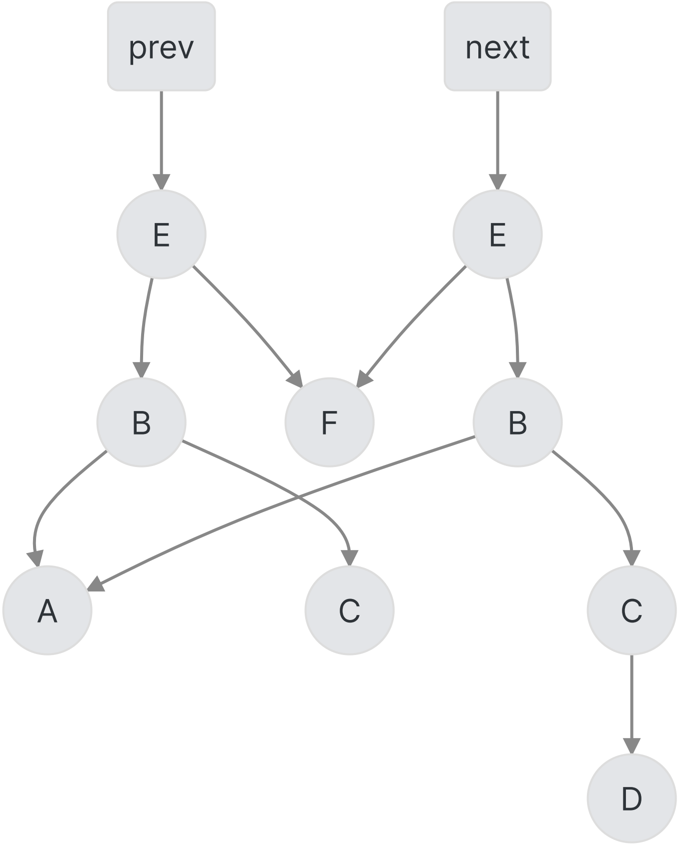
Time, Space, Changes: O(log n)



Insert D



Need to have a copy of the tree



Binary Search Trees Recursive Code

```python
def insert_new(cur, x):
        if x < cur.item:
                if cur.left == None:
                        tmp = node(x)
                        return node(cur.item, tmp, cur.right)
                else:
                        return node(cur.item, insert(cur.left, x), cur.right)
```