Binary Numbers, Mutation, and Review Solutions

Computer Science Mentors

October 5 to October 8, 2020

1 Binary Tables

1. Fill out the following table. Write N/A if the conversion is not possible. Some entries have already been filled out for you.

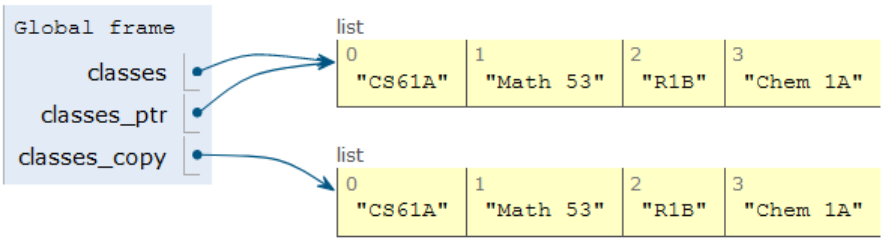
Decimal	Binary (unsigned)	Binary (two's complement)
25		
	0010 1010	
		0011 1100
-64		
		1010 1000

Decimal	Binary (unsigned)	Binary (two's complement)
25	0001 1001	0001 1001
42	0010 1010	0010 1010
60	0011 1100	0011 1100
-64	N/A	1100 0000
-88	N/A	1010 1000

2 Mutation

Lets imagine its your first year at Cal, and you have signed up for your first classes!

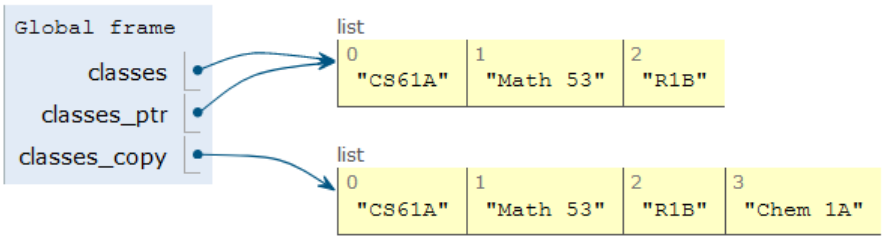
```
>>> classes = ["CS61A", "Math 53", "R1B", "Chem 1A"]
>>> classes_ptr = classes
>>> classes_copy = classes[:]
```



After a few weeks, you realize that you cannot keep up with the workload and you need to drop a class. Youve chosen to drop Chem 1A. Based on what we know so far, to change our classes list, we would have to create a new list with all the same elements as the original list except for Chem 1A. But that is silly, since all we really need to do is remove the Chem 1A element from our list.

We can fix this issue with list mutation. In Python, some objects, such as lists and dictionaries, are mutable, meaning that their contents or state can be changed over the course of program execution. Other objects, such as numeric types, tuples,and strings are immutable, meaning they cannot be changed once they are created. Therefore, instead of creating a new list, we can just call classes.pop(), which removes the last element from the list.

```
>>> classes.pop() # pop returns whatever item it removed
"Chem 1A"
```



List methods that mutate:

- `append(el)`: Adds el to the end of the list
- `extend(lst)`: Extends the list by concatenating it with lst
- `insert(i, el)`: Insert el at index i (does not replace element but adds a new one)
- `remove(el)`: Removes the first occurrence of el in list, otherwise errors
- `pop(i)`: Removes and returns the element at index i, if you do not include an index it pops the last element of the list

Ways to copy: list splicing ([start:end:step]), **`list`**`(...)`

1. What would Python display? If an error occurs, write "Error". If a function is displayed, write "Function". If nothing is returned, write "Nothing".

```
>>> a = [1, 2]
>>> b = a
>>> print(a.append([3, 4]))
None
>>> a
[1, 2, [3, 4]]
>>> b
[1, 2, [3, 4]]
>>> c = a[:]
>>> a[0] = 5
>>> a[2][0] = 6
>>> c
[1, 2, [6, 4]]
>>> a.extend([7, 8])
>>> a += [9]
>>> a += 10
TypeError: 'int' object is not iterable
>>> a
[5, 2, [6, 4], 7, 8, 9]
>>> print(c.pop(), c)
[6, 4] [1, 2]
```

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2. Given some list `lst`, possibly a deep list, mutate `lst` to have the accumulated sum of all elements so far in the list. If there is a nested list, mutate it to similarly reflect the accumulated sum of all elements so far in the nested list. Return the total sum of the original `lst`.

   Hint: The **`isinstance`** function returns True for **`isinstance`**`(l, list)` if `l` is a list and False otherwise.

```
def accumulate(lst):
    """
    >>> l = [1, 5, 13, 4]
    >>> accumulate(l)
    23
    >>> l
    [1, 6, 19, 23]
    >>> deep_l = [3, 7, [2, 5, 6], 9]
    >>> accumulate(deep_l)
    32
    >>> deep_l
    [3, 10, [2, 7, 13], 32]
    """
    sum_so_far = 0
    for ____________________________________________:
        ____________________________________________
        if isinstance(____________________, list):
            inside = ____________________________
            ____________________________________
        else:
            ____________________________________
            ____________________________________
    return ____________________________________
```

```
def accumulate(lst):
    sum_so_far = 0
    for i in range(len(lst)):
        item = lst[i]
        if isinstance(item, list):
            inside = accumulate(item)
            sum_so_far += inside
        else:
            sum_so_far += item
            lst[i] = sum_so_far
    return sum_so_far
```

To keep track of the accumulated sum we need to create a variable in the function that keeps track of the overall sum of the list so we can mutate it. To iterate through all the elements of the list AND have the ability to mutate them later on once we have the cumulative sum. The two possible data types in the list are

1. Integers: For integers we just add the value to the ongoing sum and then mutate the current index of the list to be the cumulative sum
2. Lists: We need to break down the list and get the values, both so that we can update them and so that we can add it into our sum. However, we dont know how many levels of nesting we have in our list (for example, we could have something like [1, [2, [3]]]), so we need a function that will sum up the values from a potentially nested list. Do we have a function that does this? Yes! We have accumulate. That is an indicator that we need to recursively call accumulate on this list. Now we just need to add in the solution of our recursive call to our overall sum.

Finally, we return the accumulated sum of the list which includes all values, even the nested ones because of the recursive call.

3 Review

1. Fill in `collapse`, which takes in a non-negative integer `n` and returns the number resulting from removing all digits that are equal to an adjacent digit, i.e. the number has no adjacent digits that are the same.

```
def collapse(n):
    """
    >>> collapse(12234441)
    12341
    >>> collapse(11200000013333)
    12013
    """
    left, last = n // 10, n % 10

    if _____________________________________:

        _____________________________________

    elif _____________________________________:

        _____________________________________

    else:

        _____________________________________
```

```
def collapse(n):
    left, last = n // 10, n % 10
    if left == 0:
        return last
    elif last == left % 10:
        return collapse(left)
    else:
        return collapse(left) * 10 + last
```

2. Implement the function `make_change`, which takes in a non-negative integer amount `n` and returns the minimum number of coins needed to make change for `n` using 1-cent, 3-cent, and 4-cent coins.

```
def make_change(n):
    """
    >>> make_change(5) # 5 = 4 + 1 (not 3 + 1 + 1)
    2
    >>> make_change(6) # 6 = 3 + 3 (not 4 + 1 + 1)
    2
    """

    if _____________________:
        return 0

    elif _____________________:

        _____________________________________________

    elif _____________________:

        _____________________________________________
    else:

        _____________________________________________
```

```
def make_change(n):
    if n == 0:
        return 0
    elif n < 3:
        return 1 + make_change(n - 1)
    elif n < 4:
        return 1 + min(make_change(n - 1), make_change(n - 3))
    else:
        return 1 + min(make_change(n - 1), make_change(n - 3),
            make_change(n - 4))
```

3. Given a list of integers `lst`, return the maximum sum of a subset of size `n`. If `n` is greater than or equal to the length of `lst`, just return the sum of the elements `lst`.

```
def max_subset_sum(lst, n):
    """
    >>> max_subset_sum([1, 2, 3, 4], 2)
    7
    >>> max_subset_sum([1, 4, 2, 0, 6], 3)
    12
    """

    if _____________________________:

        _____________________________

    elif _____________________________:

        _____________________________

    with_elem = _____________________________ + __________

    without_elem = _____________________________________

    return _____________________________________________
```

```
def max_subset_sum(lst, n):
    if n == 0:
        return 0
    elif len(lst) <= n:
        return sum(lst)
    with_elem = max_subset_sum(lst[1:], n - 1) + lst[0]
    without_elem = max_subset_sum(lst[1:], n)
    return max(with_elem, without_elem)
```