CSC148-Section:L0301 Week#6-Wednesday

Instructed by

AbdulAziz Al-Helali

a.alhelali@mail.utoronto.ca

Office hours: Wednesday 11-1, BA2230.

Slides adapted from Professor Danny Heap course material winter17

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Outline

- Recursion
  - Quick review of recursion and the template for writing recursive functions
  - Implement recursive functions

Template for structural recursion

recursion when **input** is a recursive structure:

- Base case
  - if **input** cannot be decomposed into recursive sub-structures, you have a **base case** and you directly return a result ***without recursion***
- General case
  - if **input** can be decomposed into recursive sub-structures, solve them ***recursively*** and ***combine*** the result(s)

Template

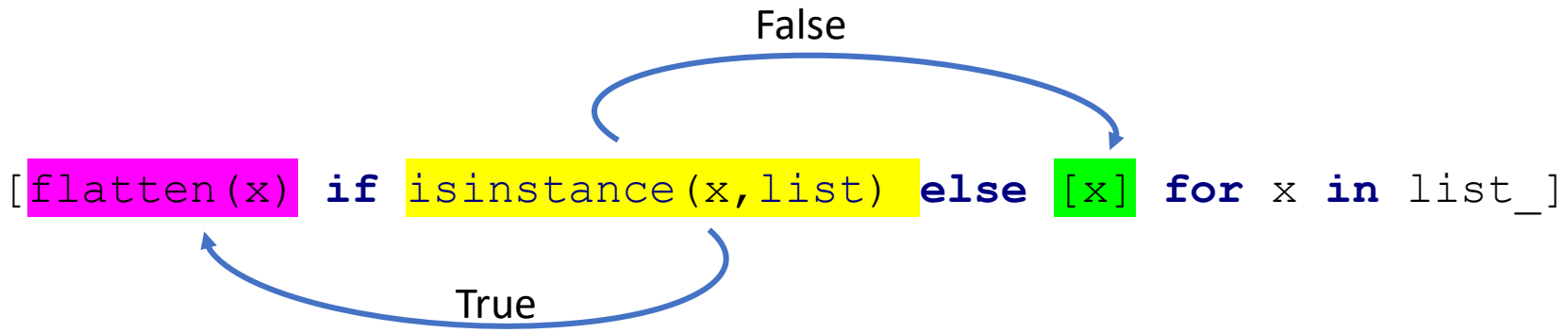
Use List comprehensions

```
if isinstance(list_, list):#General case
    return helper_function([your_rec_func(x) for x in list_])
else:#Base case
    return list_
```

do something with base input

functional if

<expression 1> if <condition> else <expression 2>



- expression 1 is evaluated if condition is True
- expression 2 is evaluated if condition is False

```
def gather_lists(list_: Union[List, object]) -> List[object]:
    """
    Return the concatenation of the sublists of list_.

    >>> list_ = [[1, 2], [3, 4]]
    >>> gather_lists(list_)
    [1, 2, 3, 4]
    >>> list_ = [[1,[ -1,0],2], [3, 4]]
    >>> gather_lists(list_)
    [1, -1, 0, 2, 3, 4]
    """
    # special form of sum for "adding" lists
```

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```
def gather_lists(list_: Union[List, object]) -> List[object]:
    """
    Return the concatenation of the sublists of list_.

    >>> list_ = [[1, 2], [3, 4]]
    >>> gather_lists(list_)
    [1, 2, 3, 4]
    >>> list_ = [[1,[ -1,0],2], [3, 4]]
    >>> gather_lists(list_)
    [1, -1, 0, 2, 3, 4]
    """
    # special form of sum for "adding" lists
    return sum([gather_lists1(x) for x in list_], [])
                if isinstance(list_, list)
                else [list_]
```

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```
def list_over(obj: Union[list, str], n: int) -> List[str]:
    """
    Return a list of strings of length greater than n in obj,
    or sublists of obj, if obj is a list.
    If obj is a string of length greater than n, return a list
    containing obj.  Otherwise return an empty list.

    >>> list_over("five", 3)
    ['five']
    >>> list_over("five", 4)
    []
    >>> list_over(["one", "two", "three", "four"], 3)
    ['three', 'four']
    """
```

```
def list_over(obj: Union[list, str], n: int) -> List[str]:
    """
    Return a list of strings of length greater than n in obj,
    or sublists of obj, if obj is a list.
    If obj is a string of length greater than n, return a list
    containing obj.  Otherwise return an empty list.

    >>> list_over("five", 3)
    ['five']
    >>> list_over("five", 4)
    []
    >>> list_over(["one", "two", "three", "four"], 3)
    ['three', 'four']
    """
    if isinstance(obj, list):
        return sum([list_over(x,n) for x in obj], [])
    else:
        return [obj] if len(obj)>n else []
```

```
def list_even(obj: Union[list, int]) -> List[int]:
    """
    Return a list of all even integers in obj,
    or sublists of obj, if obj is a list.  If obj is an even
    integer, return a list containing obj.  Otherwise return
    en empty list.

    >>> list_even(3)
    []
    >>> list_even(16)
    [16]
    >>> list_even([1, 2, 3, 4, 5])
    [2, 4]
    >>> list_even([1, 2, [3, 4], 5])
    [2, 4]
    >>> list_even([1, [2, [3, 4]], 5])
    [2, 4]
    """
```

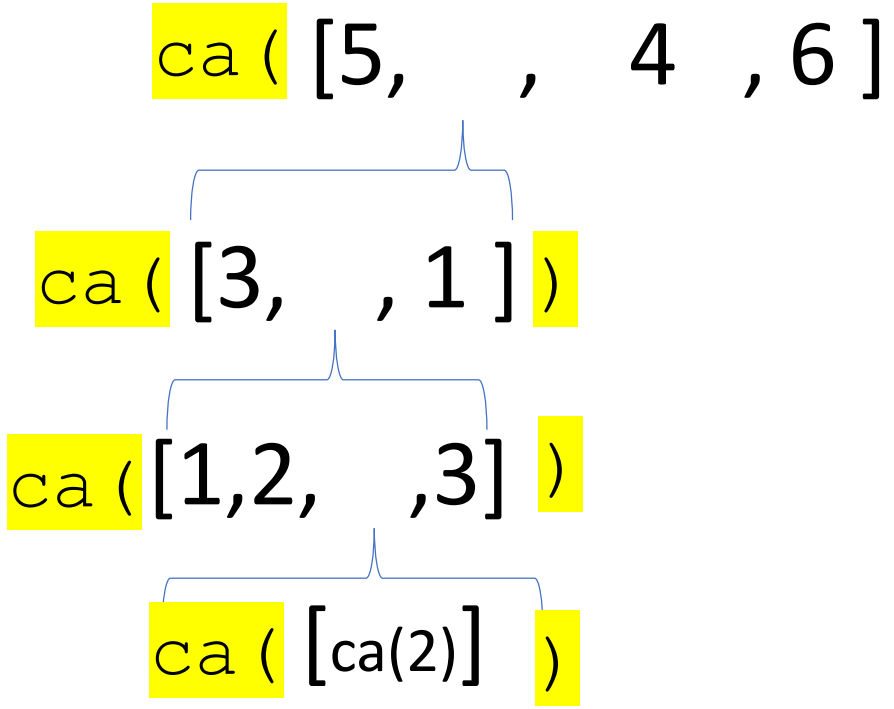
```
def list_even(obj: Union[list, int]) -> List[int]:
    """
    Return a list of all even integers in obj,
    or sublists of obj, if obj is a list.  If obj is an even
    integer, return a list containing obj.  Otherwise return
    en empty list.

    >>> list_even(3)
    []
    >>> list_even(16)
    [16]
    >>> list_even([1, 2, 3, 4, 5])
    [2, 4]
    >>> list_even([1, [2, [3, 4]], 5])
    [2, 4]
    """
    if isinstance(obj, list):
        return sum([list_even(x) for x in obj], [])
    else:
        return [obj] if obj%2==0 else []
```

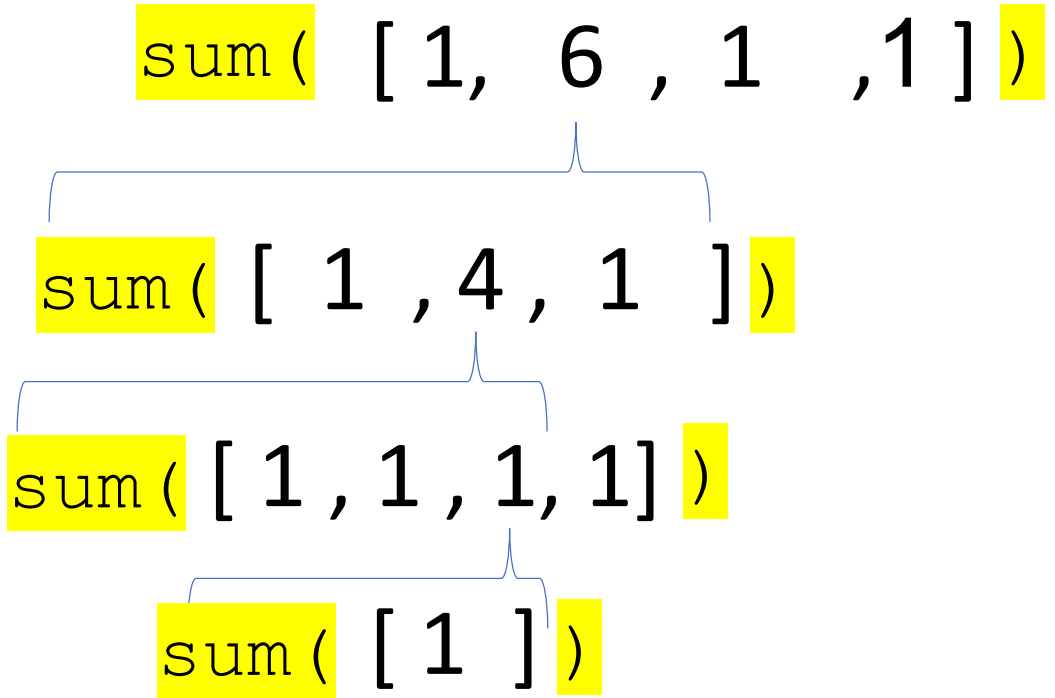
```
def count_all(obj: Union[list, object]) -> int:
    """
    Return the number of elements in obj or sublists of obj
     if obj is a list.
    Otherwise, if obj is a non-list return 1.

    >>> count_all(17)
    1
    >>> count_all([17, 17, 5])
    3
    >>> count_all([17, [17, 5], 3])
    4
    """
```

```
def count_all(obj: Union[list, object]) -> int:
    """
    Return the number of elements in obj or sublists of obj
     if obj is a list.
    Otherwise, if obj is a non-list return 1.

    >>> count_all(17)
    1
    >>> count_all([17, 17, 5])
    3
    >>> count_all([17, [17, 5], 3])
    4
    """
    if isinstance(obj, list):
        return sum([count_all(x) for x in obj])
    else:
        return 1
```

To save space, let us denote: count_all as ca
so that count_all([1,2] is ca([1,2]))

>>>ca([5, [3, [1,2,[2],3], 1], 4 , 6])
9 # answer is 9





```
def count_even(obj: Union[list, int]) -> int:
    """
    Return the number of even numbers in obj or sublists of obj
    if obj is a list.  Otherwise, if obj is a number, return 1
    if it is an even number and 0 if it is an odd number.

    >>> count_even(3)
    0
    >>> count_even(16)
    1
    >>> count_even([1, 2, [3, 4], 5])
    2
    """
```

```
def count_even(obj: Union[list, int]) -> int:
    """
    Return the number of even numbers in obj or sublists of obj
    if obj is a list.  Otherwise, if obj is a number, return 1
    if it is an even number and 0 if it is an odd number.

    >>> count_even(3)
    0
    >>> count_even(16)
    1
    >>> count_even([1, 2, [3, 4], 5])
    2
    """
    if isinstance(obj, list):
        return sum([count_even(x) for x in obj])
    else:
        return 1 if obj%2==0 else 0
```

```
def count_above(obj: Union[list, int], n: int) -> int:
    """
    Return tally of numbers in obj, and sublists of obj, that
are over n, if
    obj is a list.  Otherwise, if obj is a number over n, return
1.  Otherwise
    return 0.

    >>> count_above(17, 19)
    0
    >>> count_above(19, 17)
    1
    >>> count_above([17, 18, 19, 20], 18)
    2
    >>> count_above([17, 18, [19, 20]], 18)
    2
    """
```

```
def count_above(obj: Union[list, int], n: int) -> int:
    """
    Return tally of numbers in obj, and sublists of obj, that
are over n, if obj is a list.  Otherwise, if obj is a number
over n, return 1.  Otherwise
    return 0.

    >>> count_above(17, 19)
    0
    >>> count_above(19, 17)
    1
    >>> count_above([17, 18, [19, 20]], 18)
    2
    """
    if isinstance(obj, list):
        return sum([count_above(x,n) for x in obj])
    else:
        return 1 if obj>n else 0
```

```
def max_length(obj: Union[list, object]) -> int:
    """
    Return the maximum length of obj or any of its sublists,
     if obj is a list.
    otherwise return 0.

    >>> max_length(17)
    0
    >>> max_length([1, 2, 3, 17])
    4
    >>> max_length([1,[[1, 2, 3,2, 3,2, 3,2, 3], 4, [4, 5]]])
    9
    """
```

```
def max_length(obj: Union[list, object]) -> int:
    """
    Return the maximum length of obj or any of its sublists,
     if obj is a list.
    otherwise return 0.

    >>> max_length(17)
    0
    >>> max_length([1, 2, 3, 17])
    4
    >>> max_length([1,[[1, 2, 3,2, 3,2, 3,2, 3], 4, [4, 5]]])
    9
    """
    if isinstance(obj, list):
        t= [max_length(x) for x in obj]
        return max(t) if max(t)>len(t) else len(t)
    else:
        return 0
```