ECE 20875

Python for Data Science

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(Adapted from material developed by Profs. Milind Kulkarni, Stanley Chan, Chris Brinton, David Inouye, Qiang Qiu)

higher order functions: filters, map/reduce, list comprehensions

higher order functions

- Since functions are treated as first-class objects in Python, they can …
  - Take one or more functions as arguments

```
def summation(nums):
    return sum(nums)

def main(f, args)
    result = f(args)
    print(result)

if __name__ == “__main__”:
    main(summation, [1,2,3])
```

  - Return one or more functions

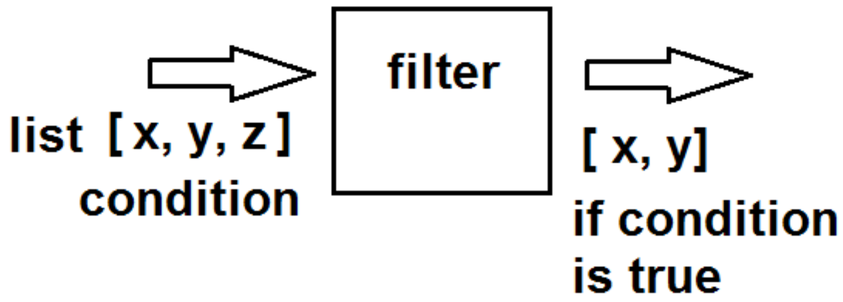
```
def add_two_nums(x, y):
    return x + y

def add_three_nums(x, y, z):
    return x + y + z

def get_appropriate(num_len):
    if num_len == 3:
        return add_three_nums
    else:
        return add_two_nums
```

  - `filter`, `map`, and `reduce` are examples of built-in higher order functions

filter

- Remove undesired results from a list
- Needs two inputs:
  - (boolean) function to be carried out
  - Iterable (list) to be filtered

```
li = [5, 7, 22, 97, 54, 62, 77, 23,
73, 61]
final_list = list(filter(lambda x:
(x%2 != 0) , li))
print(final_list)
```



- The **lambda** function
  - Anonymous, i.e., without a name
  - Formatted as

    `lambda arguments: expression`

  - Can have any number of arguments but only one expression

```
g = lambda x, y: x + y
print(g(5,6))
```

map

- Applies a function to all items in an input list (i.e., defines a mapping)
- Needs two inputs:
  - Function to apply
  - Iterable: A sequence, collection, or iterator object

```
items = [1, 2, 3, 4, 5]
squared = list(map(lambda x: x**2,
items))
```

- Can also map e.g., a list of functions

```
def multiply(x):
    return (x*x)
def add(x):
    return (x+x)

funcs = [multiply, add]
for i in range(5):
    value = list(map(lambda x:
                x(i), funcs))
    print(value)
```

reduce

- Perform computation on a list and return the (single value) result
  - Rolling computation applied to sequential pairs of values
- Needs two inputs:
  - Function to apply
  - Sequence to iterate over

```
li = [5, 8, 10, 20, 50, 100]
SUM = reduce((lambda x, y: x + y),
             li)
```

- Can also define (non-anonymous) functions

```
def do_sum(x1, x2):
    return x1 + x2
reduce(do_sum, li)
```

- Operator functions can also be used

```
reduce(operator.add, li)
```

- Need to import the relevant modules (reduce is not built in)

```
from functools import reduce
import operator
```

list comprehensions

(often better than using map/filter directly)

- Simple way of creating a list based on an *iterable* Python object
  - Elements in the new list are conditionally included and transformed as needed

    ```
    [output expression for item in iterable if condition]
    ```

  - An example:

    ```
    numbers = [1, 2, 3, 4, 5]
    squares = [n**2 for n in numbers if n > 2]
    ```

- Compared with a for loop
  - More computationally efficient
  - But less flexible!

- Can also have an if-else clause on the output expression

  ```
  [output expression if-else clause for item in iterable condition(s) on iterable]
  ```

  - Can use line breaks between brackets for readability

    ```
    numbers = [1, 2, 3, 4, 5, 6, 18, 20]
    squares = [
       "small" if number < 10 else "big"
       for number in numbers
       if number % 2 == 0
       if number % 3 == 0]
    ```

  - Can also be nested

    ```
    l = [['3','4','5'],['6','8','10','12']]
    l2 = [[float(y) for y in x] for x in l]
    ```