

Functions as Objects


- Functions are **first class objects**:
 - They have types
 - They can be elements of data structures like lists
 - They can appear in expressions
 - As part of an assignment statement
 - As an argument to a function!!
- Particular useful to use functions as arguments when coupled with lists
 - Aka **higher order programming**

Example

```
def applyToEach(L, f):  
    """assumes L is a list, f a function  
        mutates L by replacing each element,  
        e, of L by f(e)"""  
    for i in range(len(L)):  
        L[i] = f(L[i])
```

Example

```
def applyToEach(L, f):          L = [1, -2, 3.4]
    for i in
        range(len(L)):
            L[i] = f(L[i])
```



```
applyToEach(L, abs)
print(L)
```

```
applyToEach(L, int)
print(L)
```

```
applyToEach(L, fact)
print(L)
```

```
applyToEach(L, fib)
print(L)
```

Example

```
def applyToEach(L, f):  
    for i in  
        range(len(L)):  
        L[i] = f(L[i])
```

L = [1, -2, 3.4]

```
applyToEach(L, abs)  
print(L)
```



[1, 2,
3.3999999999999999]

```
applyToEach(L, int)  
print(L)
```

```
applyToEach(L, fact)  
print(L)
```

```
applyToEach(L, fib)  
print(L)
```

Example

```
def applyToEach(L, f):  
    for i in  
        range(len(L)):  
        L[i] = f(L[i])
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L = [1, -2, 3.4]

```
applyToEach(L, abs)  
print(L)
```

[1, 2,
3.3999999999999999]

```
applyToEach(L, int)  
print(L)
```



[1, 2, 3]

```
applyToEach(L, fact)  
print(L)
```

```
applyToEach(L, fib)  
print(L)
```

Example

```
def applyToEach(L, f):  
    for i in  
        range(len(L)):  
        L[i] = f(L[i])
```

```
applyToEach(L, abs)  
print(L)
```

```
applyToEach(L, int)  
print(L)
```

```
applyToEach(L, fact,  
print(L)
```

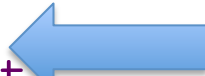
```
applyToEach(L, fib)  
print(L)
```

L = [1, -2, 3.4]

[1, 2,
3.3999999999999999]

[1, 2, 3]

[1, 2, 6]



Example

```
def applyToEach(L, f):  
    for i in  
        range(len(L)):  
        L[i] = f(L[i])
```

```
applyToEach(L, abs)  
print(L)
```

```
applyToEach(L, int)  
print(L)
```

```
applyToEach(L, fact)  
print(L)
```

```
applyToEach(L, fib)  
print(L)
```

L = [1, -2, 3.4]

[1, 2,
3.3999999999999999]

[1, 2, 3]

[1, 2, 6]

[1, 2, 13]



Lists of functions

```
def applyFuns(L, x):  
    for f in L:  
        print(f(x))
```

```
applyFuns([abs, int, fact, fib], 4)  
4  
4  
24  
5
```


Generalizations of higher order functions

- Python provides a general purpose HOP, `map`
- Simple form – a unary function and a collection of suitable arguments
 - `map(abs, [1, -2, 3, -4])`
 - `[1, 2, 3, 4]`
- General form – an n-ary function and n collections of arguments
 - `L1 = [1, 28, 36]`
 - `L2 = [2, 57, 9]`
 - `map(min, L1, L2)`
 - `[1, 28, 9]`