Python Sorting

The easiest way to sort is with the sorted(list) function, which takes a list and returns a new list with those elements in sorted order. The original list is not changed.

```
a = [5, 1, 4, 3]
print sorted(a)  ## [1, 3, 4, 5]
print a  ## [5, 1, 4, 3]
```

It's most common to pass a list into the sorted() function, but in fact it can take as input any sort of iterable collection. The older list.sort() method is an alternative detailed below. The sorted() function seems easier to use compared to sort(), so I recommend using sorted().

The sorted() function can be customized though optional arguments. The sorted() optional argument reverse=True, e.g. sorted(list, reverse=True), makes it sort backwards.

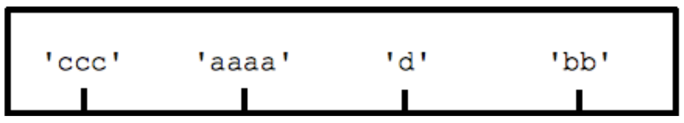
```
strs = ['aa', 'BB', 'zz', 'CC']
print sorted(strs)  ## ['BB', 'CC', 'aa', 'zz'] (case sensitive)
print sorted(strs, reverse=True)   ## ['zz', 'aa', 'CC', 'BB']
```

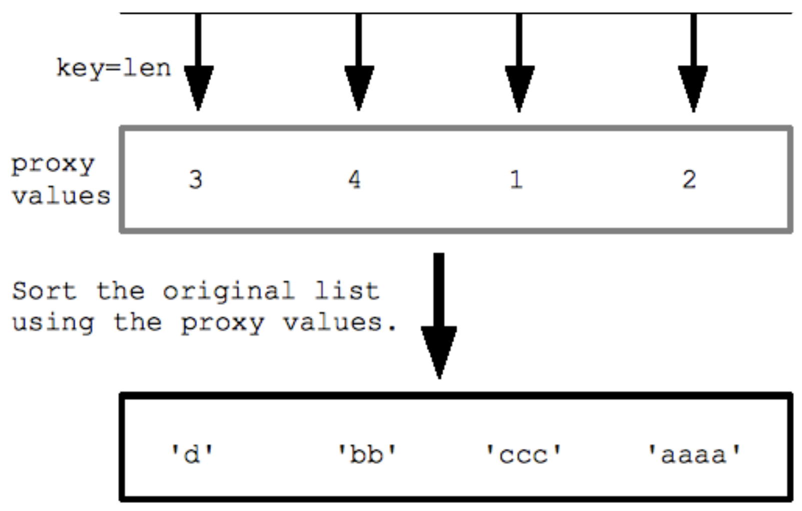
Custom Sorting With key=

For more complex custom sorting, sorted() takes an optional "key=" specifying a "key" function that transforms each element before comparison. The key function takes in 1 value and returns 1 value, and the returned "proxy" value is used for the comparisons within the sort.

For example with a list of strings, specifying key=len (the built in len() function) sorts the strings by length, from shortest to longest. The sort calls len() for each string to get the list of proxy length values, and the sorts with those proxy values.

```
strs = ['ccc', 'aaaa', 'd', 'bb']
print sorted(strs, key=len)  ## ['d', 'bb', 'ccc', 'aaaa']
```





As another example, specifying "str.lower" as the key function is a way to force the sorting to treat uppercase and lowercase the same:

```
## "key" argument specifying str.lower function to use for sorting
print sorted(strs, key=str.lower)  ## ['aa', 'BB', 'CC', 'zz']
```

You can also pass in your own MyFn as the key function, like this:

```
## Say we have a list of strings we want to sort by the last letter of the str
strs = ['xc', 'zb', 'yd' ,'wa']

## Write a little function that takes a string, and returns its last letter.
## This will be the key function (takes in 1 value, returns 1 value).
def MyFn(s):
  return s[-1]

## Now pass key=MyFn to sorted() to sort by the last letter:
print sorted(strs, key=MyFn)  ## ['wa', 'zb', 'xc', 'yd']
```

To use key= custom sorting, remember that you provide a function that takes one value and returns the proxy value to guide the sorting. There is also an optional argument "cmp=cmpFn" to sorted() that specifies a traditional two-argument comparison function that takes two values from the list and returns negative/0/positive to indicate their ordering. The built in comparison function for strings, ints, ... is cmp(a, b), so often you want to call cmp() in your custom comparator. The newer one argument key= sorting is generally preferable.

sort() method

As an alternative to sorted(), the sort() method on a list sorts that list into ascending order, e.g. list.sort(). The sort() method changes the underlying list and returns None, so use it like this:

```
  alist.sort()            ## correct
  alist = blist.sort()    ## NO incorrect, sort() returns None
```

The above is a very common misunderstanding with sort() -- it *does not return* the sorted list. The sort() method must be called on a list; it does not work on any enumerable collection (but the sorted() function above works on anything). The sort() method predates the sorted() function, so you will likely see it in older code. The sort() method does not need to create a new list, so it can be a little faster in the case that the elements to sort are already in a list.

Tuples

A tuple is a fixed size grouping of elements, such as an (x, y) co-ordinate. Tuples are like lists, except they are immutable and do not change size (tuples are not strictly immutable since one of the contained elements could be mutable). Tuples play a sort of "struct" role in Python -- a convenient way to pass around a little logical, fixed size bundle of values. A function that needs to return multiple values can just return a tuple of the values. For example, if I wanted to have a list of 3-d coordinates, the natural python representation would be a list of tuples, where each tuple is size 3 holding one (x, y, z) group.

To create a tuple, just list the values within parenthesis separated by commas. The "empty" tuple is just an empty pair of parenthesis. Accessing the elements in a tuple is just like a list -- len(), [ ], for, in, etc. all work the same.

```
  tuple = (1, 2, 'hi')
  print len(tuple)  ## 3
  print tuple[2]    ## hi
  tuple[2] = 'bye'  ## NO, tuples cannot be changed
  tuple = (1, 2, 'bye')  ## this works
```

To create a size-1 tuple, the lone element must be followed by a comma.

```
  tuple = ('hi',)   ## size-1 tuple
```

It's a funny case in the syntax, but the comma is necessary to distinguish the tuple from the ordinary case of putting an expression in parentheses. In some cases you can omit the parenthesis and Python will see from the commas that you intend a tuple.

Assigning a tuple to an identically sized tuple of variable names assigns all the corresponding values. If the tuples are not the same size, it throws an error. This feature works for lists too.

```
(x, y, z) = (42, 13, "hike")
print z  ## hike
(err_string, err_code) = Foo()  ## Foo() returns a length-2 tuple
```

List Comprehensions (optional)

List comprehensions are a more advanced feature which is nice for some cases but is not needed for the exercises and is not something you need to learn at first (i.e. you can skip this section). A list comprehension is a compact way to write an expression that expands to a whole list. Suppose we have a list nums [1, 2, 3], here is the list comprehension to compute a list of their squares [1, 4, 9]:

```
nums = [1, 2, 3, 4]

squares = [ n * n for n in nums ]   ## [1, 4, 9, 16]
```

The syntax is `[ expr for var in list ]` -- the `for var in list` looks like a regular for-loop, but without the colon (:). The *expr* to its left is evaluated once for each element to give the values for the new list. Here is an example with strings, where each string is changed to upper case with '!!!' appended:

```
strs = ['hello', 'and', 'goodbye']

shouting = [ s.upper() + '!!!' for s in strs ]
## ['HELLO!!!', 'AND!!!', 'GOODBYE!!!']
```

You can add an if test to the right of the for-loop to narrow the result. The if test is evaluated for each element, including only the elements where the test is true.

```
## Select values <= 2
nums = [2, 8, 1, 6]
```

```
small = [ n for n in nums if n <= 2 ]  ## [2, 1]

## Select fruits containing 'a', change to upper case
fruits = ['apple', 'cherry', 'bannana', 'lemon']
afruits = [ s.upper() for s in fruits if 'a' in s ]
## ['APPLE', 'BANNANA']
```

Exercise: list1.py

To practice the material in this section, try later problems in **list1.py** that use sorting and tuples (in the Basic Exercises).