Sorting

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UW CSE 160
Winter 2016

sorted vs. sort

```
hamlet = "to be or not to be that is the
question whether tis nobler in the mind to
suffer".split()

print "hamlet:", hamlet

print "sorted(hamlet):", sorted(hamlet)
print "hamlet:", hamlet

print "hamlet.sort():", hamlet.sort()
print "hamlet:", hamlet
```

Returns a new sorted list (does not modify the original list)

Modifies the list in place, returns None

- Lists are mutable – they can be changed
  - including by functions

Customizing the sort order

Goal: sort a list of names *by last name*

```
names = ["Isaac Newton", "Albert Einstein", "Niels
Bohr", "Marie Curie", "Charles Darwin", "Louis
Pasteur", "Galileo Galilei", "Margaret Mead"]

print "names:", names
```

This does not work:

```
print "sorted(names):", sorted(names)
```

When sorting, how should we compare these names?

```
"Niels Bohr"
"Charles Darwin"
```

Sort key

- A sort key is a function that can be called on each list element to extract/create a value that will be used to make comparisons.
- We can use this to sort on a value (e.g. “last_name”) other than the actual list element (e.g. “first_name last_name”).
- We could use the following sort key so help us sort by last names:

```
def last_name(str):
    return str.split(" ")[1]

print 'last_name("Isaac Newton"):', last_name("Isaac Newton")
```

Two ways to use a sort key:

1. Create a **new** list containing the sort key, and then sort it
2. Pass a key function to the sorted function

1. Use a sort key to create a new list

Create a different list that contains the sort key, sort it, then extract the relevant part:

```
names = ["Isaac Newton", "Fig Newton", "Niels Bohr"]
# keyed_names is a list of [lastname, fullname] lists
keyed_names = []
for name in names:
  keyed_names.append([last_name(name), name])

sorted_keyed_names = sorted(keyed_names)
sorted_names = []
for keyed_name in sorted_keyed_names:
  sorted_names.append(keyed_name[1])
print "sorted_names:", sorted_names
```

1) Create the new list.

2) Sort the list new list. If there is a tie in last names, sort by next item in list: fullname

3) Extract the relevant part.

Digression: Lexicographic Order

Aaron	[1, 9, 9]
Andrew	[2, 1]
Angie	[3]
with	[1]
withhold	[1, 1]
withholding	[1, 1, 1]
Able	[1, 1]
Charlie	[1, 1, 2]
baker	[1, 2]
delta	

2. Use a sort key as the `key` argument

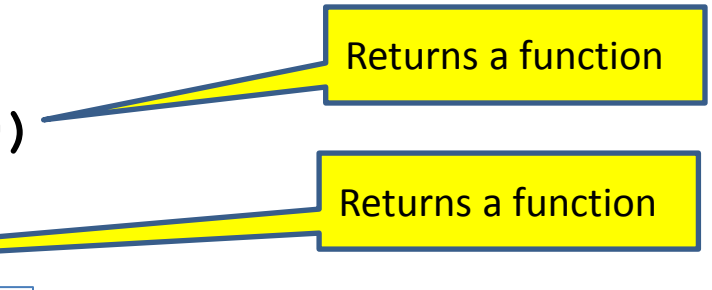
Supply the **`key`** argument to the **`sorted`** function or the **`sort`** function

```
def last_name(str):
    return str.split(" ")[1]

names = ["Isaac Newton", "Fig Newton", "Niels Bohr"]
print sorted(names, key = last_name)

print sorted(names, key = len)

def last_name_len(name):
    return len(last_name(name))

print sorted(names, key = last_name_len)
```

If there is a tie in last names, preserves original order of values.

itemgetter is a function that returns a function

```
import operator
operator.itemgetter(2, 7, 9, 10)
```




```
operator.itemgetter(2, 7, 9, 10)("dumbstricken")
operator.itemgetter(2, 5, 7, 9)("homesickness")
operator.itemgetter(2, 7, 9, 10)("pumpernickel")
operator.itemgetter(2, 3, 6, 7)("seminaked")
operator.itemgetter(1, 2, 4, 5)("smirker")

operator.itemgetter(9, 7, 6, 1)("beatnikism")
operator.itemgetter(14, 13, 5, 1)("Gedankenexperiment")
operator.itemgetter(12, 10, 9, 5)("mountebankism")
```

Using itemgetter

```
from operator import itemgetter
```

Another way to import, allows you to can call itemgetter directly.

```
student_score = ('Robert', 8)
itemgetter(0)(student_score)
```
⇒ "Robert"

```
itemgetter(1)(student_score)
```
⇒ 8

```
student_scores =
 [('Robert', 8), ('Alice', 9), ('Tina', 7)]
```

- Sort the list by name:

```
sorted(student_scores, key=itemgetter(0))
```

- Sort the list by score

```
sorted(student_scores, key=itemgetter(1))
```

Two ways to Import `itemgetter`

```
from operator import itemgetter
student_score = ('Robert', 8)
itemgetter(0)(student_score)
```
⇒ "Robert"

```
itemgetter(1)(student_score)
```
⇒ 8

Or

```
import operator
student_score = ('Robert', 8)
operator.itemgetter(0)(student_score)
```
⇒ "Robert"

```
operator.itemgetter(1)(student_score)
```
⇒ 8

Sorting based on two criteria

Goal: sort based on score;
if there is a tie within score, sort by name

Two approaches:

Approach #1: Use an itemgetter with two arguments

Approach #2: Sort twice (most important sort ***last***)

```
student_scores = [('Robert', 8), ('Alice', 9),
                  ('Tina', 10), ('James', 8)]
```

Approach #1:

```
sorted(student_scores, key=itemgetter(1,0))
```

Approach #2:

```
sorted_by_name = sorted(student_scores, key=itemgetter(0))
sorted_by_score = sorted(sorted_by_name, key=itemgetter(1))
```

Sort on most important criteria LAST

- Sorted by score (ascending), when there is a tie on score, sort using name

```
from operator import itemgetter
student_scores = [('Robert', 8), ('Alice', 9), ('Tina', 10), ('James', 8)]


sorted_by_name = sorted(student_scores, key=itemgetter(0))
>>> sorted_by_name
[('Alice', 9), ('James', 8), ('Robert', 8), ('Tina', 10)]

sorted_by_score = sorted(sorted_by_name, key=itemgetter(1))
>>> sorted_by_score
[('James', 8), ('Robert', 8), ('Alice', 9), ('Tina', 10)]
```

More sorting based on two criteria

If you want to sort different criteria in different directions, you must use multiple calls to **`sort`** or **`sorted`**

```
student_scores = [('Robert', 8), ('Alice', 9), \
                  ('Tina', 10), ('James', 8)]
```

Goal: sort score from highest to lowest; if there is a tie within score, sort by name alphabetically (= lowest to highest)

```
sorted_by_name = sorted(student_scores, key=itemgetter(0))
sorted_by_hi_score = sorted(sorted_by_name,
                            key=itemgetter(1), reverse=True)
```

Remember: Sort on most important criteria LAST

Sorting: strings vs. numbers

- Sorting the powers of 5:

```
>>> sorted([125, 5, 3125, 625, 25])
[5, 25, 125, 625, 3125]
>>> sorted(["125", "5", "3125", "625", "25"])
['125', '25', '3125', '5', '625']
```