Sorting

BBM 101 - Introduction to Programming I

Hacettepe University
Fall 2015

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Slides based on material prepared by Ruth Anderson, Michael Ernst and Bill Howe in the course CSE 140
University of Washington

Sorting

```
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
```

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

Sorting

```
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)
```

Run main

```
C:\Python34\python.exe C:/Users/Vahid/PycharmProjects/untitled/main.py
hamlet: ['to', 'be', 'or', 'not', 'to', 'be', 'that', 'is', 'the', 'question', 'whether', 'tis', 'nobler',
 'in', 'the', 'mind', 'to', 'suffer']
sorted(hamlet): ['be', 'be', 'in', 'is', 'mind', 'nobler', 'not', 'or', 'question', 'suffer', 'that', 'the',
 'the', 'tis', 'to', 'to', 'to', 'whether']
hamlet: ['to', 'be', 'or', 'not', 'to', 'be', 'that', 'is', 'the', 'question', 'whether', 'tis', 'nobler',
 'in', 'the', 'mind', 'to', 'suffer']
hamlet.sort(): None
hamlet: ['be', 'be', 'in', 'is', 'mind', 'nobler', 'not', 'or', 'question', 'suffer', 'that', 'the', 'the',
 'tis', 'to', 'to', 'to', 'whether']

Process finished with exit code 0
```


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 different value that you use to sort a list, instead of the actual values in the list

```
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", "Fred 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])
```

1) Create the new list.

Take a look at the list you created, it can now be sorted:

```
print "keyed_names:", keyed_names
print "sorted(keyed_names):", sorted(keyed_names)
print "sorted(keyed_names, reverse = True):"
print sorted(keyed_names, reverse = True)
```

(This works because Python compares two elements that are lists *elementwise*.)

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

2) Sort the list new list.

3) Extract the relevant part.

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", "Fred Newton", "Niels Bohr"]
print "sorted(names, key = last_name):"
print sorted(names, key = last_name)

print "sorted(names, key = last_name, reverse = True):"
print sorted(names, key = last_name, reverse = True)

print sorted(names, key = len)

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

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


itemgetter is a Function that Returns a Function

```
import operator
```

All: ('m', 'i', 'k', 'e')

```
print(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
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

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)]
```

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

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)

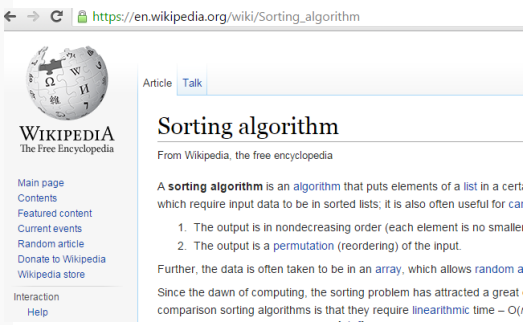
```
sorted_by_name = sorted(student_scores, key=itemgetter(0) )
sorted_by_hi_score = sorted(sorted_by_name,
                            key=itemgetter(1), reverse=True)
```


Sorting: strings vs. numbers

- Sorting the powers of 5:

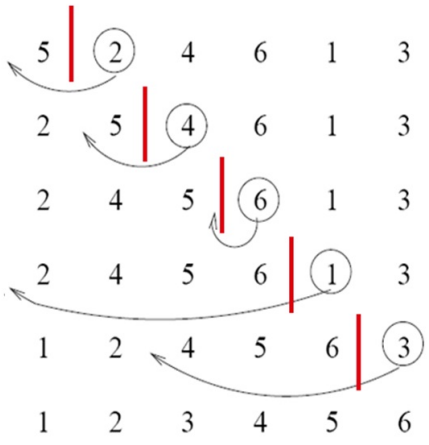
```
>>> sorted([125, 5, 3125, 625, 25])
[5, 25, 125, 625, 3125]
>>> sorted(["125", "5", "3125", "625", "25"])
['125', '25', '3125', '5', '625']
```

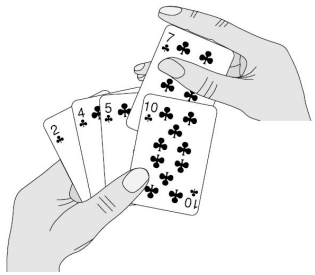

Different sorting algorithms



Insertion sort

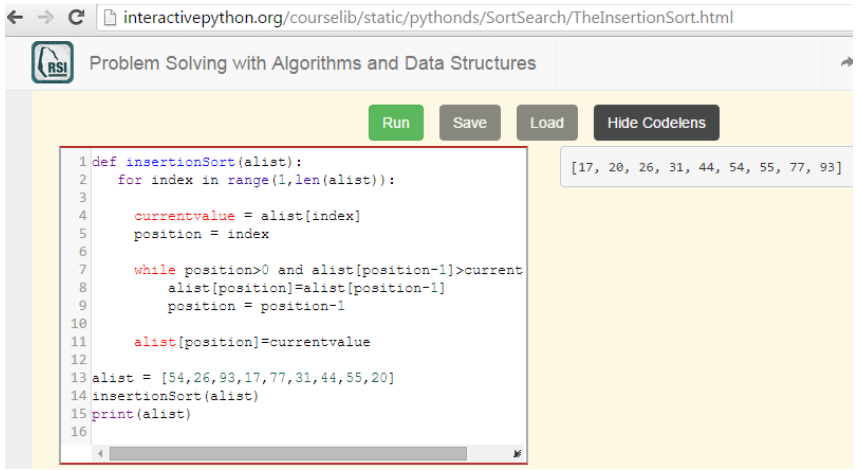
- Idea:





Done !

Insertion sort



Bubble Sort

- It repeatedly steps through the list to be sorted,
- compares each pair of adjacent items and swaps them if they are in the wrong order.
- The pass through the list is repeated until no swaps are needed, which indicates that the list is sorted.
- The algorithm, which is a comparison sort, is named for the way smaller elements "bubble" to the top of the list.

Bubble Sort

```
def bubbleSort(alist):
    for passnum in range(len(alist)-1,0,-1):
        for i in range(passnum):
            if alist[i]>alist[i+1]:
                temp = alist[i]
                alist[i] = alist[i+1]
                alist[i+1] = temp

alist = [54,26,93,17,77,31,44,55,20]
bubbleSort(alist)
print(alist)
```