Sorting

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sorted vs. sort

- **`sorted(itr)`** - is a function that takes an iterable as a parameter (e.g. sequence types: list, string, tuple) and **returns** a sorted version of that parameter
- **`lst.sort()`** - is a method that sorts the **list** that it is called on **in-place** (and returns **`None`**). **`.sort()`** can only be called on lists

```
my_lst = [5, 3, 4, 2]
print(sorted(my_lst))    → [2, 3, 4, 5]
print(my_lst)            → [5, 3, 4, 2]

my_lst.sort()
print(my_lst)            → [2, 3, 4, 5]
```

Returns a new sorted list

Does **not** modify original list

Modifies the list **in place**, returns **`None`**

See in python tutor

sorted vs. sort example

```
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

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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"
```

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Aside: What does this do?

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

x = mystery("happy birthday")
print(x)
```

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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.

```
fruits = ["watermelon", "fig", "apple"]

print(sorted(fruits))
print(sorted(fruits, key=len))
```

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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 function as a sort key to help us sort by last names:

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

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

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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", "Ada Lovelace", "Fig Newton", "Grace Hopper"]
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.

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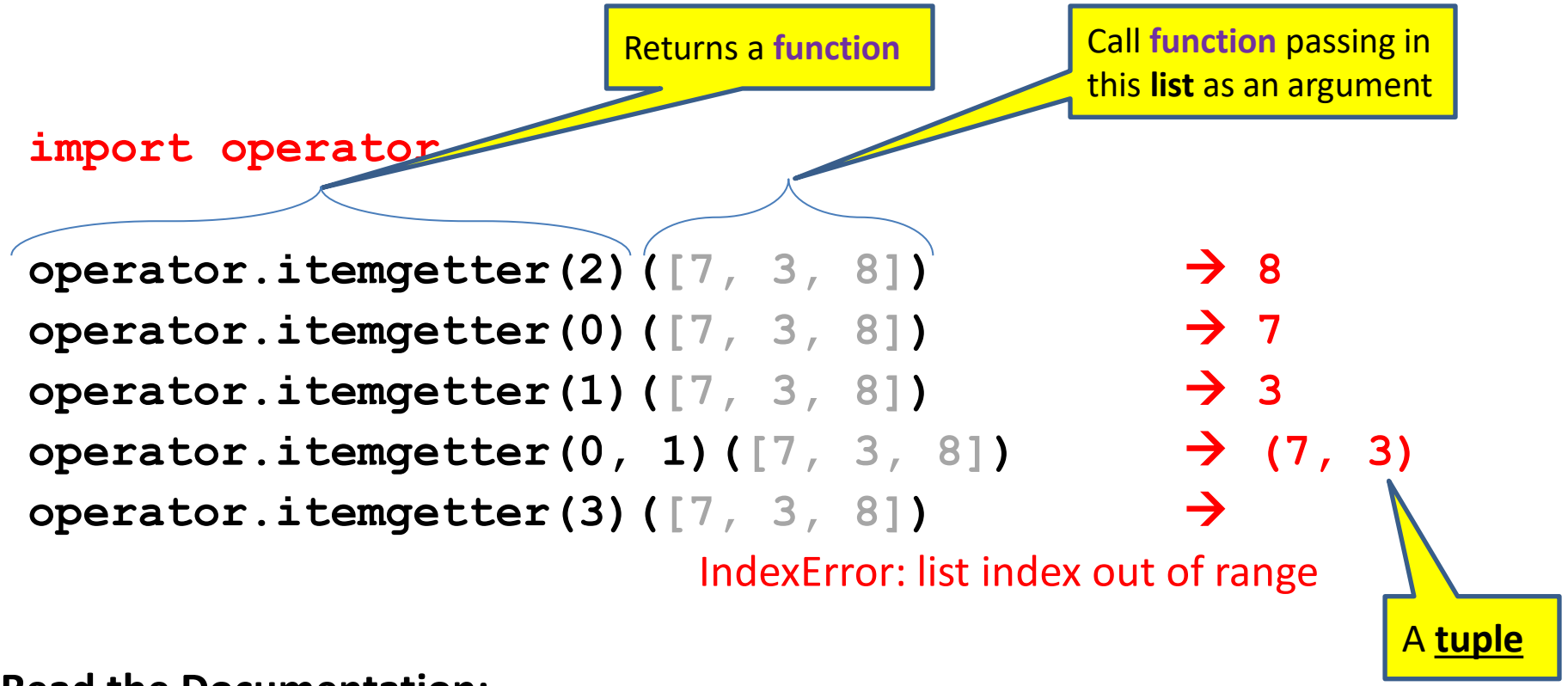
`itemgetter` is a function that returns a function

Useful for creating a function that will return particular elements from a sequence (e.g. list, string, tuple):



Read the Documentation:
https://docs.python.org/3/library/operator.html

Tuples

- Immutable
  - cannot change elements
- Create using ()
- Use square brackets
  - to query and slice

```
student_score = ('Robert', 8)
```

Two ways to Import `itemgetter`

```
import operator
student_score = ('Robert', 8)
operator.itemgetter(0)(student_score)  ⇒ "Robert"
operator.itemgetter(1)(student_score)  ⇒ 8
```

A **tuple**

Or

```
from operator import itemgetter
student_score = ('Robert', 8)
itemgetter(0)(student_score)  ⇒ "Robert"
itemgetter(1)(student_score)  ⇒ 8
```

Another way to import, allows you to call **`itemgetter`** directly.

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Using itemgetter

```
from operator import itemgetter
```

Another way to import, allows you to 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))
```

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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=temgetter(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)]
```

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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

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'`	

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']
```

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Aside: Use a sort key to create a new list

Create a different list that contains the value returned by 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.