Tuples + Sorting

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Based on slides by Chris Piech and Mehran Sahami
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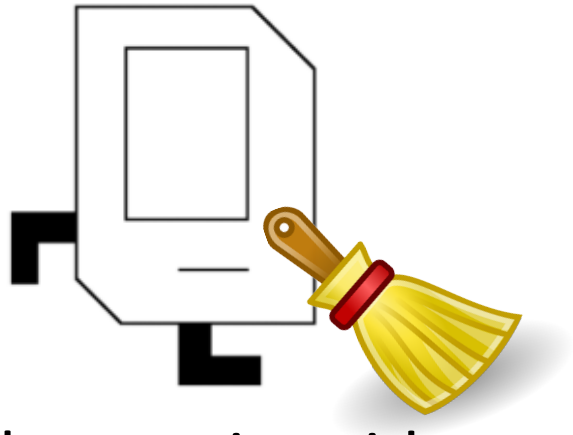
Housekeeping



- YEAH Hours and bonus tips video posted for Assignment 5
- There will be another YEAH hours live on Friday (check Ed for details)

Learning Goals

1. Learning about tuples in Python
2. Writing code using tuples
3. Learning about sorting

Tuples

What is a Tuple?

- A **tuple** is way to keep track of an *ordered collection* of items
  - Similar to a list, but *immutable* (can't be changed in place)
  - Ordered: can refer to elements by their position
  - Collection: list can contain multiple items
- Often used to keep track of data that are *conceptually related*, such as
  - Coordinates for a *point*: (x, y)
  - RGB values for a *color*: (red, green, blue)
  - Elements of an *address*: (street, city, state, zipcode)
- Can be used to return multiple values from a function

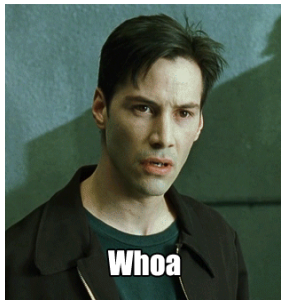
Show Me the Tuples!

- Creating tuples
  - Tuples start/end with parentheses. Elements separated by commas.

```
my_tuple = (1, 2, 3)
point = (4.7, -6.0)
strs = ('strings', 'in', 'tuple')
addr = ('102 Ray Ln', 'Stanford', 'CA', 94305)
empty_tuple = ()
```

- If you want a tuple with one element, you must use a comma to create it (otherwise it is just the element):

```
>>> tuple_one = (1, )
>>> type(tuple_one)
 <class 'tuple'>
```

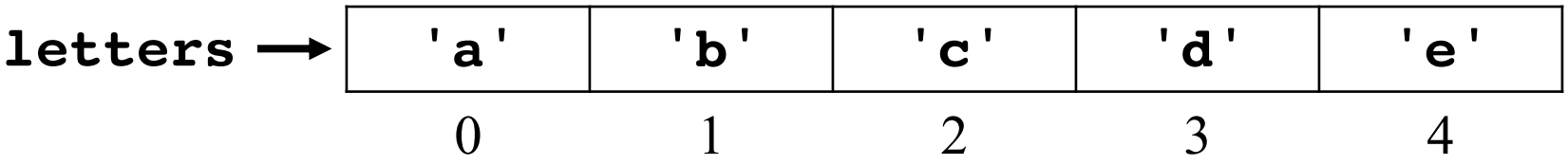


Accessing Elements of Tuple

- Consider the following tuple:

```
letters = ('a', 'b', 'c', 'd', 'e')
```

- Access elements of tuple just like a list:
  - Indexes start from 0



- Access individual elements:

`letters[0]` is `'a'`

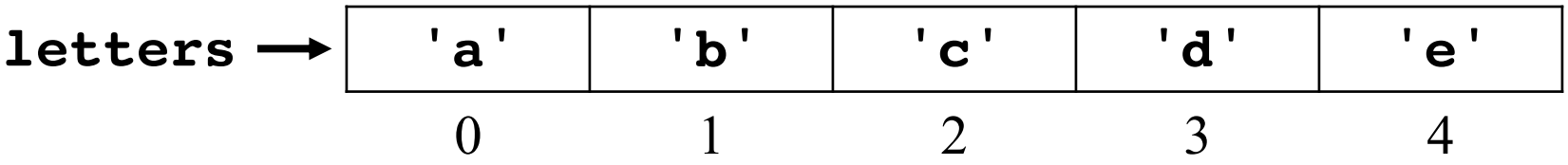
`letters[4]` is `'e'`

Accessing Elements of Tuple

- Consider the following tuple:

```
letters = ('a', 'b', 'c', 'd', 'e')
```

- Access elements of tuple just like a list:
  - Indexes start from 0



- **Cannot** assign to individual elements:
  - Tuples are **immutable**

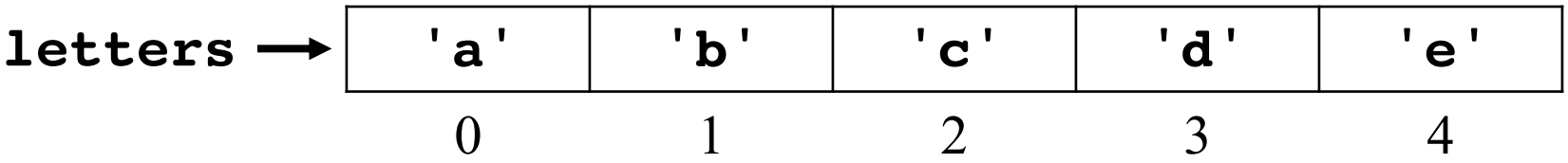
```
letters[0] = 'x'
TypeError: 'tuple' object does not support
item assignment
```

Accessing Elements of Tuple

- Consider the following tuple:

```
letters = ('a', 'b', 'c', 'd', 'e')
```

- Access elements of tuple just like a list:
  - Indexes start from 0



- **Cannot** assign to individual elements:
  - Tuples are **immutable**
  - Also, there are no **append**/**pop** functions for tuples
  - Tuples cannot be changed in place
  - To change, need to create new tuple and overwrite variable

Getting Length of a Tuple

- Consider the following tuple:

```
letters = ('a', 'b', 'c', 'd', 'e')
```

- Can get length of tuple with **`len`** function:

`len(letters)` is `5`

  - Elements of list are indexed from 0 to length – 1

- Using length to loop through a tuple:

```
for i in range(len(letters)):
    print(f"{i} -> {letters[i]}")
```

```
0 -> a
1 -> b
2 -> c
3 -> d
4 -> e
```

Indexes and Slices

- Consider the following tuple:

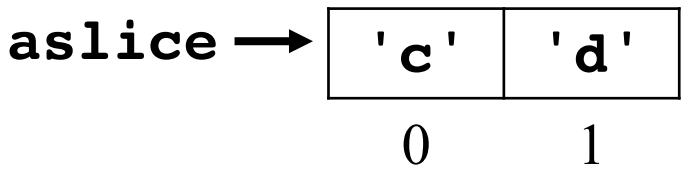
```
letters = ('a', 'b', 'c', 'd', 'e')
```

- Negative indexes in tuple work just the same as lists
  - Work back from end of tuple
  - Example:

`letters[-1]` is `'e'`

- Slices work on tuples in the same was as on lists

```
>>> aslice = letters[2:4]
>>> aslice
('c', 'd')
```



Good Times with Tuples

- More tuple examples:

```
chartreuse_rgb = (127, 255, 0)
stanford = ('450 Jane Stanford Way', 'Stanford', 'CA', 94305)
```

- Printing tuples:

```
>>> print(chartreuse_rgb)
(127, 255, 0)
>>> print(stanford)
('450 Jane Stanford Way', 'Stanford', 'CA', 94305)
```

- Check if tuple is empty (empty tuple is like "False")

```
if stanford:
    print('stanford is not empty')
else:
    print('stanford is empty')
```

More Good Times with Tuples

- More tuple examples:

```
chartreuse_rgb = (127, 255, 0)
stanford = ('450 Jane Stanford Way', 'Stanford', 'CA', 94305)
```

- Check to see if a tuple contains an element:

```
state = 'CA'
if state in stanford:
    # do something
```

- General form of test (evaluates to a Boolean):

element **`in`** *tuple*

  - Returns **`True`** if ***element*** is a value in ***tuple***, **`False`** otherwise
  - Can also test if element is not in tuple using **`not in`**

A Few Tuple Functions

```
chartreuse_rgb = (127, 255, 0)
```

- Function: **`max(chartreuse_rgb)`**
  - Returns maximal value in the tuple

```
>>> max(chartreuse_rgb)
255
```

- Function: **`min(chartreuse_rgb)`**
  - Returns minimal value in the tuple

```
>>> min(chartreuse_rgb)
0
```

- Function: **`sum(chartreuse_rgb)`**
  - Returns sum of the values in the tuple

```
>>> sum(chartreuse_rgb)
382
```

Looping Through Tuple Elements

```
stanford = ('450 Jane Stanford Way', 'Stanford', 'CA', 94305)
```

- For loop using **range**:

```
for i in range(len(stanford)):
    elem = stanford[i]
    print(elem)
```

Output:

```
450 Jane Stanford Way
Stanford
CA
94305
```

- For-each loop:

```
for elem in stanford:
    print(elem)
```

- These loops both iterate over all elements of the tuple
  - Variable **elem** is set to each value in tuple (in order)
  - Works just the same as iterating through a list

Tuples as Parameters

- When you pass a tuple as a parameter, think of it like passing an integer
  - In function, changing tuple parameter is changing a copy

```
def remove_red(rgb_tuple):
    rgb_tuple = (0, rgb_tuple[1], rgb_tuple[2])
    print(f"In remove_red: {rgb_tuple}")

def main():
    chartreuse_rgb = (127, 255, 0)
    remove_red(chartreuse_rgb)
    print(f"In main: {chartreuse_rgb}")
```

Output:

```
In remove_red: (0, 255, 0)
In main: (127, 255, 0)
```

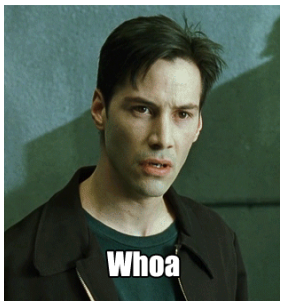
Assignment with Tuples

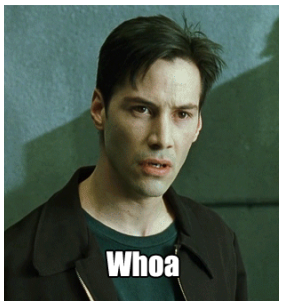
- Can use tuples to assign multiple variables at once:
  - Number of variables on left-hand side of assignment needs to be the same as the size of the tuple on the right-hand side

```
>>> (x, y) = (3, 4)
>>> x
3
>>> y
4
```

- You don't even need parentheses – the tuple is implied:

```
>>> x, y = y, x # swap x and y
>>> x
4
>>> y
3
```





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DIE LUFT DER FREIHEIT WEHT
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Returning Tuples from Functions

- Can use tuples to return multiple values from function
  - Stylistic point: values returned should make sense as something that is grouped together (e.g., (x, y) coordinate)

```
def get_date():
    day = int(input("Day (DD): "))
    month = int(input("Month (MM): "))
    year = int(input("Year (YYYY): "))
    return day, month, year

def main():
    (dd, mm, yyyy) = get_date()
    print(f"{mm}/{dd}/{yyyy}")
```

Terminal:

```
Day (DD): 10
Month (MM): 05
Year (YYYY): 1970
5/10/1970
```

Returning Tuples from Functions

- Can use tuples to return multiple values from function
  - Stylistic point: values returned should make sense as something that is grouped together (e.g., (x, y) coordinate)

```
def get_date():
    day = int(input("Day (DD): "))
    month = int(input("Month (MM): "))
    year = int(input("Year (YYYY): "))
    return day, month, year

def main():
    (dd, mm, yyyy) = get_date()
    print(f"{mm}/{dd}/{yyyy}")
```

  - Note: all paths through a function should return a tuple of the same length, otherwise program might crash
  - For functions that return tuples, comment should specify the number of return values (and their types)

Tuples and Lists

- Can create lists from tuples using **`list`** function:

```
>>> my_tuple = (10, 20, 30, 40, 50)
>>> my_list = list(my_tuple)
>>> my_list
[10, 20, 30, 40, 50]
```

- Can create tuples from lists using **`tuple`** function:

```
>>> a_list = ['summer', 'of', 2020]
>>> a_tuple = tuple(a_list)
>>> a_tuple
('summer', 'of', 2020)
```

Tuples and Dictionaries

- Can get key/value pairs from dictionaries as tuples using the **`items`** functions:

```
>>> dict = {'a':1, 'b':2, 'c':3, 'd':4}
>>> list(dict.items())
[('a', 1), ('b', 2), ('c', 3), ('d', 4)]
```

- Can loop though key/value pairs as tuples:

```
for key, value in dict.items():
    print(f"{key} -> {value}")
```

Output:

```
a -> 1
b -> 2
c -> 3
d -> 4
```

Tuples in Dictionaries

- Can use tuples as keys in dictionaries:

```
>>> dict = {('a',1): 10, ('b',1): 20, ('a',2): 30}
>>> list(dict.keys())
[('a', 1), ('b', 1), ('a', 2)]
>>> list(dict.values())
[10, 20, 30]
```

- Can use tuples as values in dictionaries:

```
>>> colors = {  'orange': (255, 165, 0),
                'yellow': (255, 255, 0),
                'aqua':   (0, 128, 128)  }
>>> list(colors.values())
[(255, 165, 0), (255, 255, 0), (0, 128, 128)]
>>> list(colors.keys())
['orange', 'yellow', 'aqua']
```

Putting it all together: colors.py

Sorting

Basic Sorting

- The **`sorted`** function orders elements in a collection in increasing (non-decreasing) order
  - Can sort any type that support < and == operations
  - For example: int, float, string
  - **`sorted`** returns new collection (original collection unchanged)

```
>>> nums = [8, 42, 4, 8, 15, 16]
>>> sorted(nums)
[4, 8, 8, 15, 16, 42]
>>> nums
[8, 42, 4, 8, 15, 16]     # original list not changed

>>> strs = ['banana', 'zebra', 'apple', 'donut']
>>> sorted(strs)
['apple', 'banana', 'donut', 'zebra']
```

Intermediate Sorting

- Can sort elements in decreasing (non-increasing) order
  - Use the optional parameter **`reverse=True`**

```
>>> nums = [8, 42, 4, 8, 15, 16]
>>> sorted(nums, reverse=True)
[42, 16, 15, 8, 8, 4]

>>> strs = ['banana', 'APPLE', 'apple', 'donut']
>>> sorted(strs, reverse=True)
['donut', 'banana', 'apple', 'APPLE']
```

- Note case sensitivity of sorting strings!
  - Any uppercase letter is less than any lowercase letter
  - For example: **`'Z'`** < **`'a'`**

Advanced Sorting

- Sorting using a custom function
  - Use the optional parameter **key=<*function name*>**

```
def get_len(s):
    return len(s)

def main():
    strs = ['a', 'bbbb', 'cc', 'zzzz']
    sorted_strs = sorted(strs, key=get_len)
    print(sorted_strs)
```

Output:

```
['a', 'cc', 'bbbb', 'zzzz']
```

Super Deluxe Advanced Sorting

- Sorting a list of tuples with a custom function
  - Use the optional parameter **`key=`**<*function name*>

```
def get_count(food):
    return food[1]

def main():
    foods = [('apple', 5), ('banana', 2), ('chocolate', 137)]
    sort_names = sorted(foods)
    print(sort_names)
    sort_count = sorted(foods, key=get_count)
    print(sort_count)
    rev_sort_count = sorted(foods, key=get_count, reverse=True)
    print(rev_sort_count)
```

Output:

```
[('apple', 5), ('banana', 2), ('chocolate', 137)]
[('banana', 2), ('apple', 5), ('chocolate', 137)]
[('chocolate', 137), ('apple', 5), ('banana', 2)]
```

Learning Goals

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