# Data Structures

BILD 62

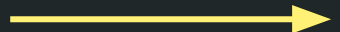
# *From last class:* Rules for creating new variable names

**Variable names should only ever contain letters, numbers, and underscores.**

- Do not start with a number.
- No spaces in variable names.
- Variable names are **case-sensitive**.
- Names cannot be keywords (e.g., and, break, try).
- Names cannot contain symbols, including dashes ( - )

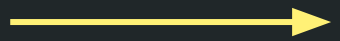
# We’re learning how to deal with more and more complex data

```
data_point = 8.02
```



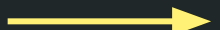
**single variable** (int, float, string)

```
data = [8.38,3.34,6.35]
```



**data structure** (list, tuple, dictionary)

```
big_data = [data_1,data_2,...]
```



**array** or **dataframe**

# Troubleshooting

# You'll encounter various types of errors

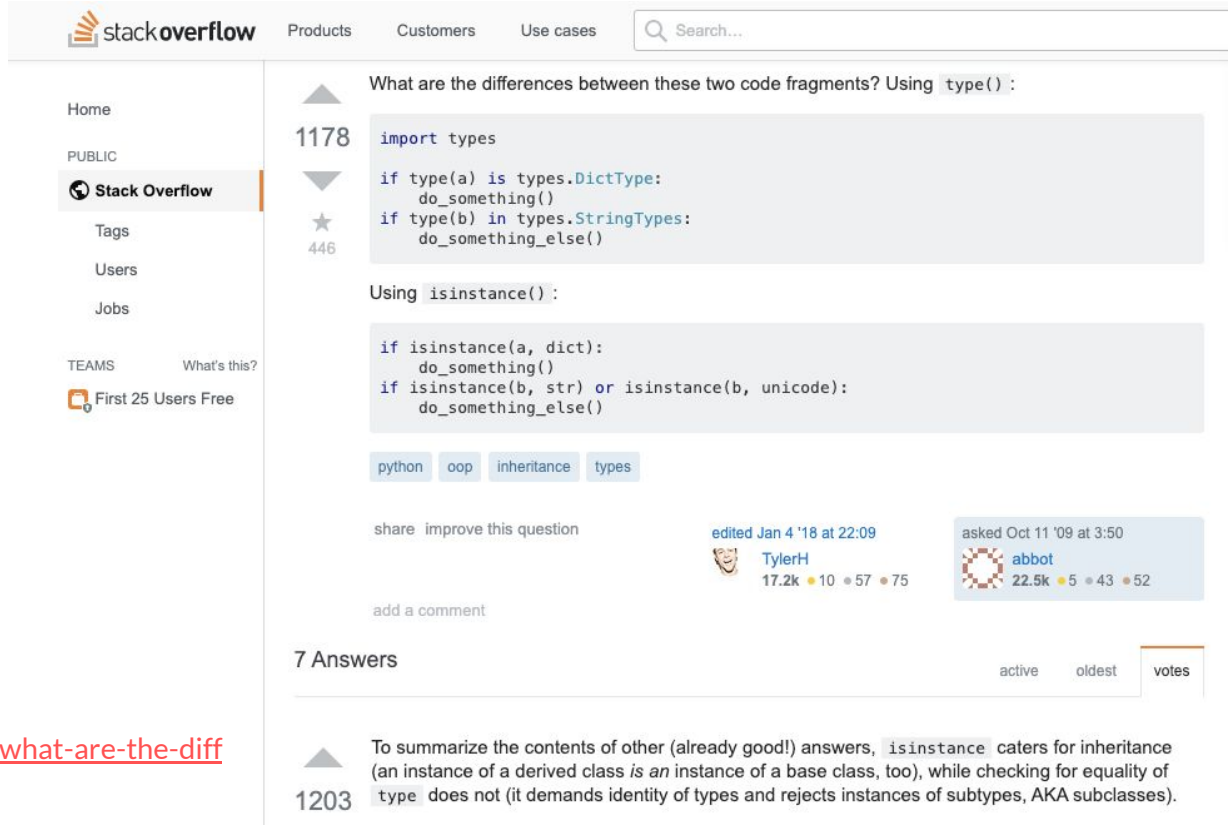
- **Syntax**: language rules broken
  - E.g., quotes missing, incorrect indentation
- **Runtime**: unable to execute
  - E.g., zero division error, or an unrecognized variable
- **Semantic/Logical**: unexpected output, e.g.:

```
>>> name = "Alice"
>>> print("Hello name")
>>> Hello name
```

**For a full list of possible errors:**
https://www.tutorialsteacher.com/python/error-types-in-python

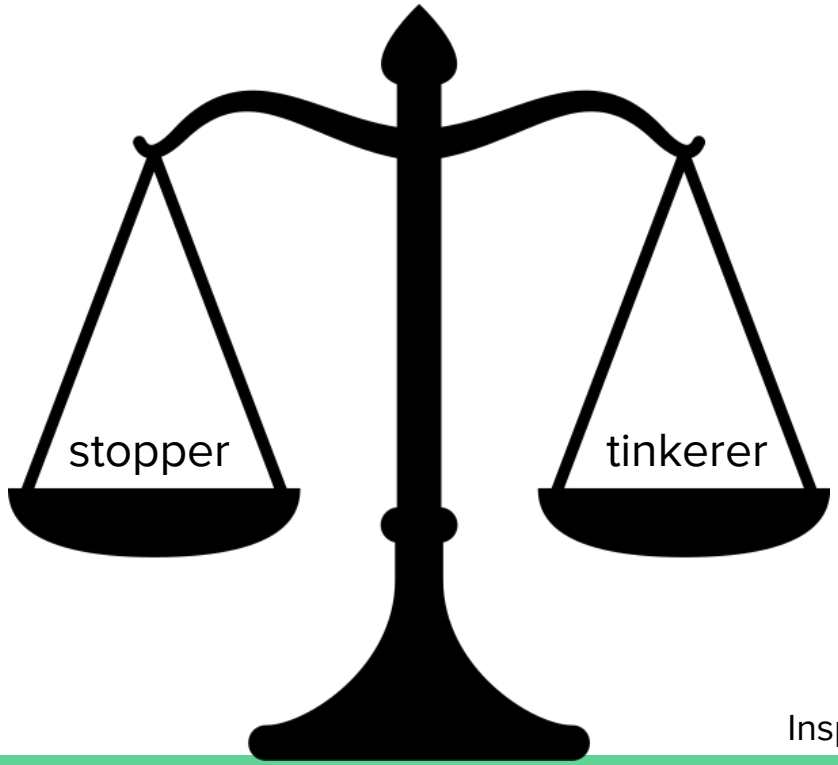
# Introducing: Stack Overflow

If you have a question about something, chances are at least a thousand other people on the internet had that same question.




https://stackoverflow.com/questions/1549801/what-are-the-differences-between-type-and-isinstance

# Be a ***mover***: Make forward progress, & strike a balance between stopping & tinkering forever.




Inspired by Shannon Ellis (COGS18)

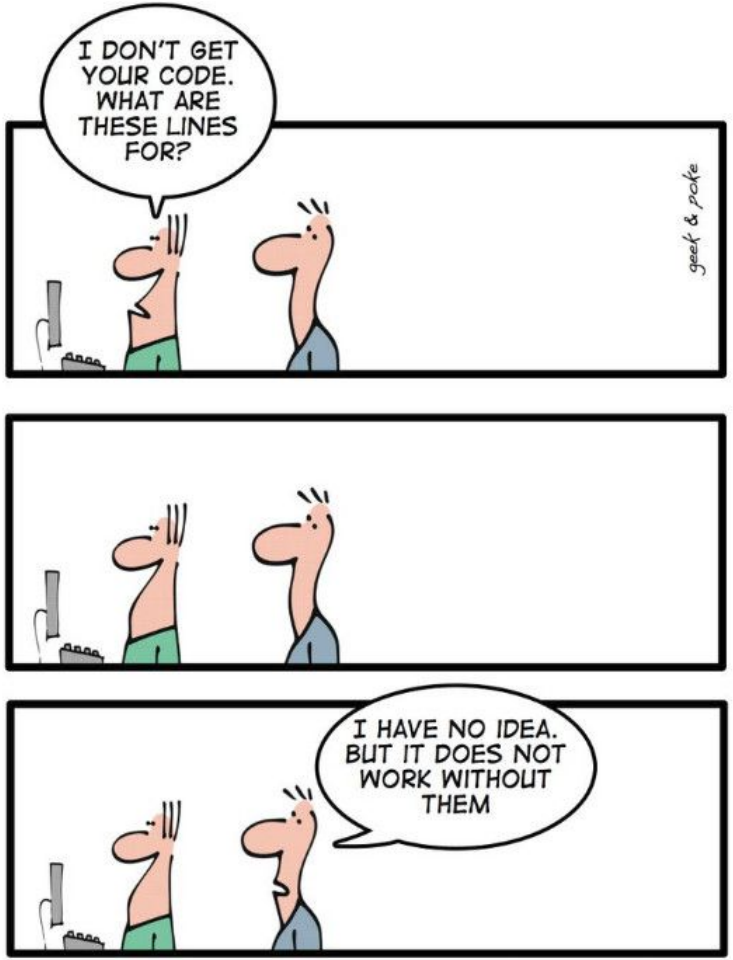
# Consider the two hour rule

- If you're stuck, work on a problem for **an hour**.
- If you're still stuck, take a **30 minute break**.
- Then, try again for **30 minutes**.
- If you're still stuck, post on Canvas, or reach out to the teaching staff.

Inspired by Shannon Ellis (COGS18)

# Where else can I get help?

- GitHub: programmers' social media platform
  - especially for issues related to specific codes/packages
- Canvas Discussion Boards
- Office hours
- DataQuest/Stepik Lessons
- End-of-lecture resources
- Course materials




Geek&Poke
http://geek-and-poke.com/geekandpoke/2009/7/25/the-art-of-programming-part-2.html

# Objectives for today

- **Compare & contrast** the types of variables that Python uses to store data points
- **Understand** the syntax for lists, tuples, and dictionaries
- **Index, slice, cast, and mutate** lists

Python has different ways to store data: **lists**, **tuples**, **dictionaries**, and **sets.**

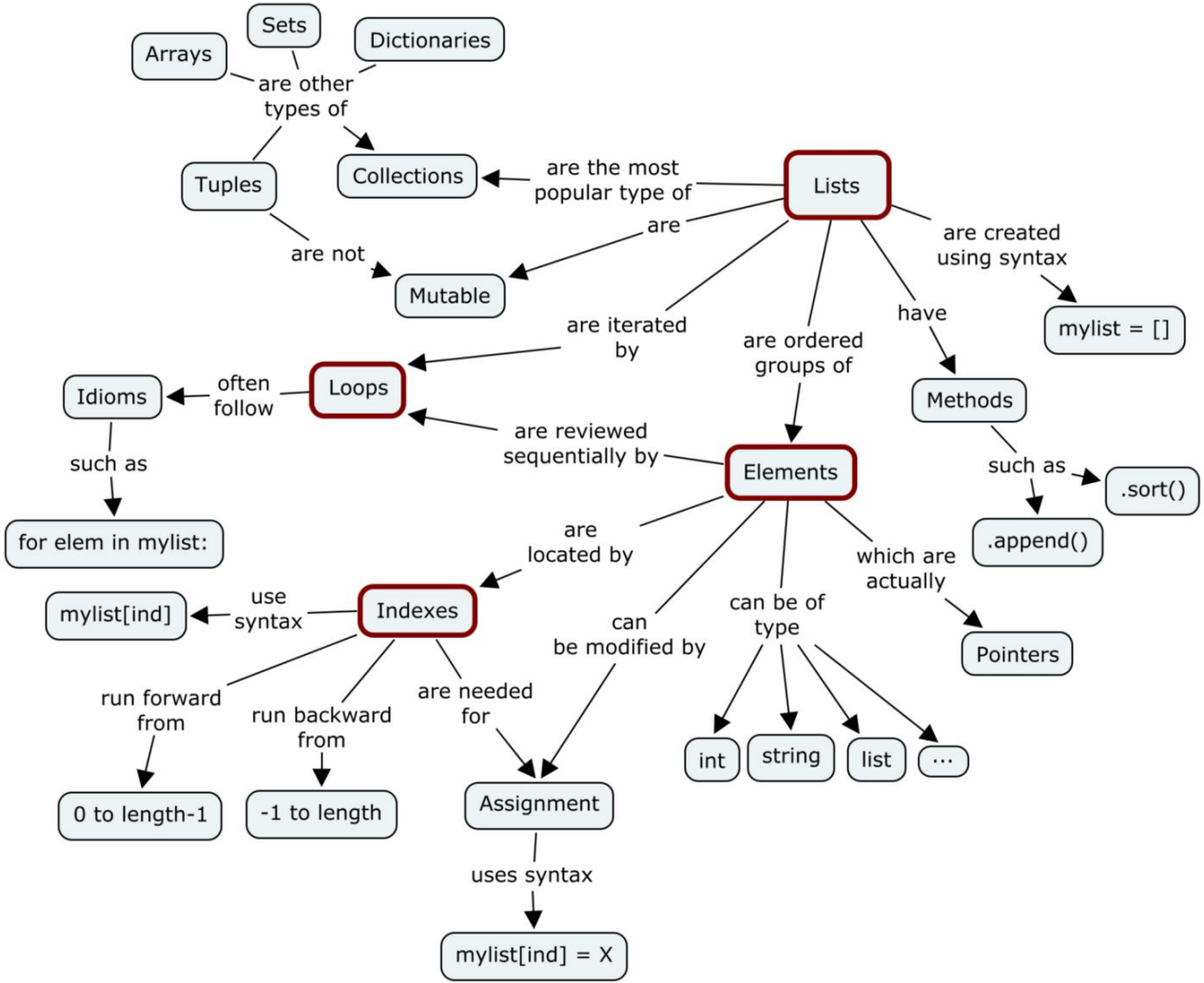
These differ in their **syntax, mutability,** and use cases.

**Sets are a mutable collection of distinct (unique) immutable values that are unordered.** *(We're not going to talk much about sets.)*

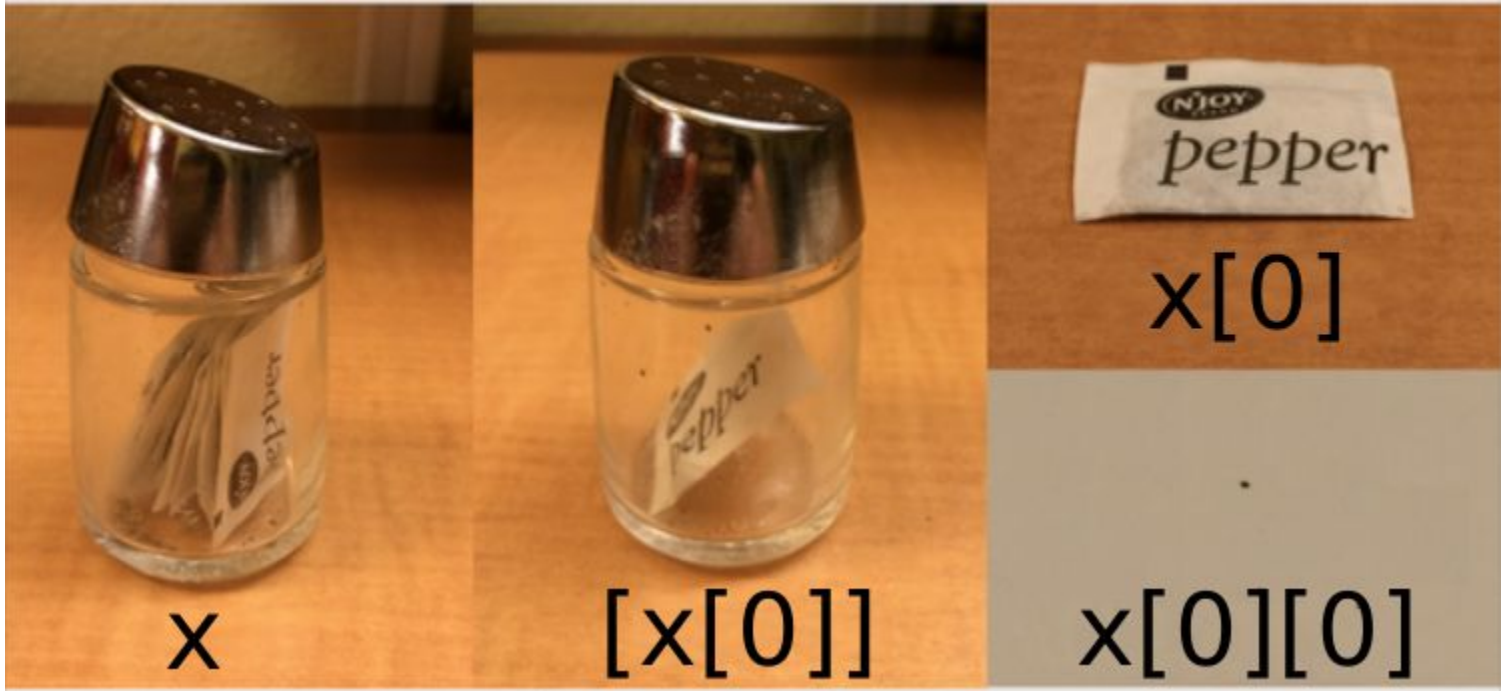
# A word on mutability

| Class | Description | Immutable? |
|---|---|---|
| **bool** | Boolean value | ✓ |
| **int** | integer (arbitrary magnitude) | ✓ |
| **float** | floating-point number | ✓ |
| **list** | mutable sequence of objects | |
| **tuple** | immutable sequence of objects | ✓ |
| **str** | character string | ✓ |
| **set** | unordered set of distinct objects | |
| **frozenset** | immutable form of set class | ✓ |
| **dict** | associative mapping (aka dictionary) | |

Mutable vs Immutable Objects in Python | by megha mohan | Medium




[Mutable vs Immutable Objects in Python | by megha mohan | Medium]




List of lists (source)

## **Lists** are flexible & efficient containers for heterogeneous data

- Lists are **mutable**: we can change individual elements of the list
- Denoted by brackets & elements are separated by commas

```
my_list = ['apples', 'bananas', 'oranges']
```

**Let's do this in the Jupyter Notebook!**

**Corresponding notes are here for your reference.**

- Check the length of your list by using `len(my_list)`
- Use `my_list.append()` to add elements to a list
- Remove elements by index using `del my_list[2]`
- Remove elements by value by using `my_list.remove('oranges')`
- Sort by using `my_list.sort()`

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# Indexing lists

```
my_list = [1,2,5,2,3]

my_list[1] = 2

my_list[-1] = 3

my_list[5] =

    IndexError
```

Index number

Allows you to count from the end (could be -2, etc.)

Shown if you try to get an index that doesn't exist

# Slicing lists

```
my_list[0:2]

my_list[1:3]

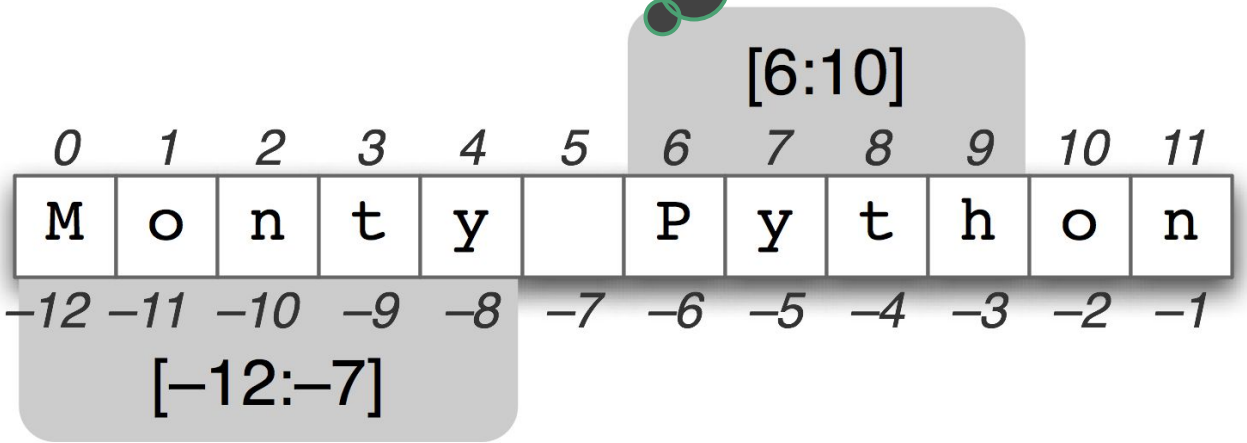
my_list[:3]

my_list[3:]

my_list[:]
```

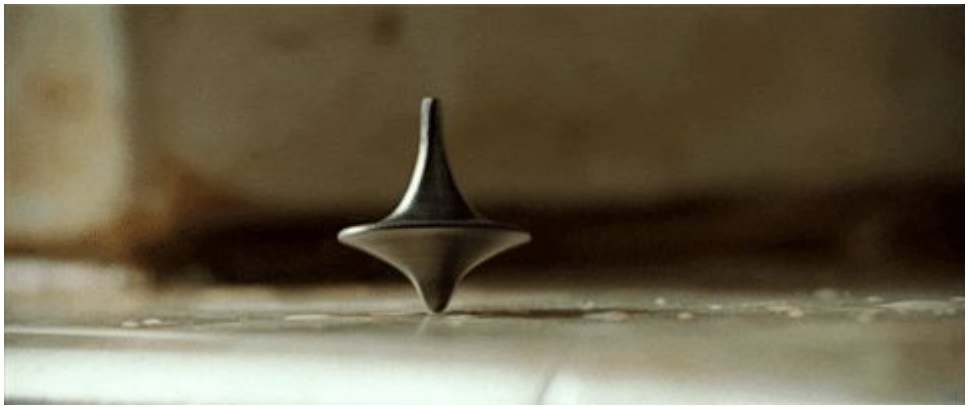
**`[included:excluded]`**
It doesn't show you the stop element (it shows you elements with indices 0 & 1)

One way to remember how slices work is to think of the indices as pointing between characters, with the left edge of the first character numbered 0. Then the right edge of the last character of a string of n characters has index n.



# Lists of lists

```
>>> gene_1 = [‘gene1’,0.48,0.55]
>>> gene_2 = [‘gene2’,0.38,0.85]
>>> gene_3 = [‘gene3’,0.21,0.81]
>>> all_genes = [gene_1, gene_2, gene_3]
>>> print(all_genes[0][-1])
```



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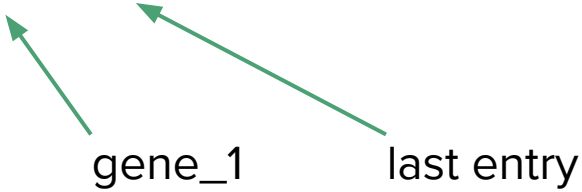
>>> 0.55
```



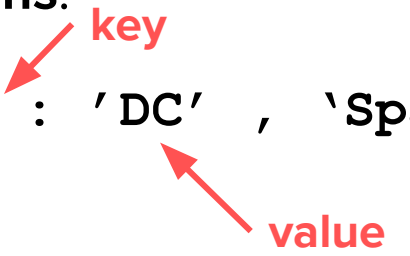
# Tuples

- A tuple is an **immutable** collection of ordered items, that can be of mixed type.
- Tuples are created using parentheses.
- Indexing works similar to lists.

```
>>> my_tuple = ( 3, ‘blue’, 54.1)
```

# Dictionaries link keys to values

- Denoted by **curly braces** and elements are separated by **commas**. Assignments are done using **colons**.




```
>>> capitals =  {'US' : 'DC' , 'Spain':'Madrid',
'Italy:'Rome'}

>>> capitals['US']

>>> 'DC'
```

- You'll get a Key Error if you ask for a key that doesn't exist
    - Use **`'Germany' in capitals`** to check

# Working with dictionaries in Python

- Use **`capitals.update(morecapitals)`** to add another dictionary
- Use **`del capitals['US']`** to delete entries
- Loop by key or values, or both

# When dictionaries are useful

1. Flexible & efficient way to associate labels with heterogeneous data
2. Use where data items have, or can be given, labels
3. Appropriate for collecting data of different kinds (e.g., name, addresses, ages)

# Resources

Software Carpentries Lists

Storing Multiple Values in Lists – Programming with Python

Python 101: Lists, Tuples, and Dictionaries

Whirlwind Tour of Python: Built-In Data Structures