Data Structures in Python
Chapter 1

1. **Introduction - Review Python**
2. Modelling Objects
3. Object-Oriented Programming
4. OOP - Fraction Example
5. OOP - Classes
6. Exceptions 1, 2
7. JSON

그런즉 너희가 먹든지 마시든지 무엇을 하든지 다 하나님의 영광을 위하여 하라 (고전10:31)

Logistics - Piazza

- Enroll yourself for this course at www.piazza.com
  - You are required to have your Handong email address and know this course name.
- Use **Piazza** for Q&A and to submit your homework assignments.
  - 1st homework assignment is available at github.com/idebtor/DSpy/jupyter/**Ch1-2 Review(1) Overview.ipynb**
    - Section 2.2.2
      - "원격으로 웹 페이지 읽어 오기" (1) ~ (7)
    - Exercises:
      - 1. LIst Comprehension
      - 2 Palindrome
  - Due: 11:55 PM, One week from today (or the lecture day)
    - Upload the file itself at **pset1** folder in Piazza.
    - Late work is not accepted.

Data Structures in Python

Table Of Contents

Chapter 1: Introduction to Data Structures and Python

- Python Review
- Object-Oriented Programming (OOP)

Chapter 2: Performance Analysis

Chapter 3: Linear Data Structures

- Stack and Queue

Chapter 4: Recursion

Chapter 5: Hashing, Sorting, and Searching

Chapter 6: Non-linear Data Structures

- Trees and Tree Algorithms

Chapter 7: Heap and Priority Queues

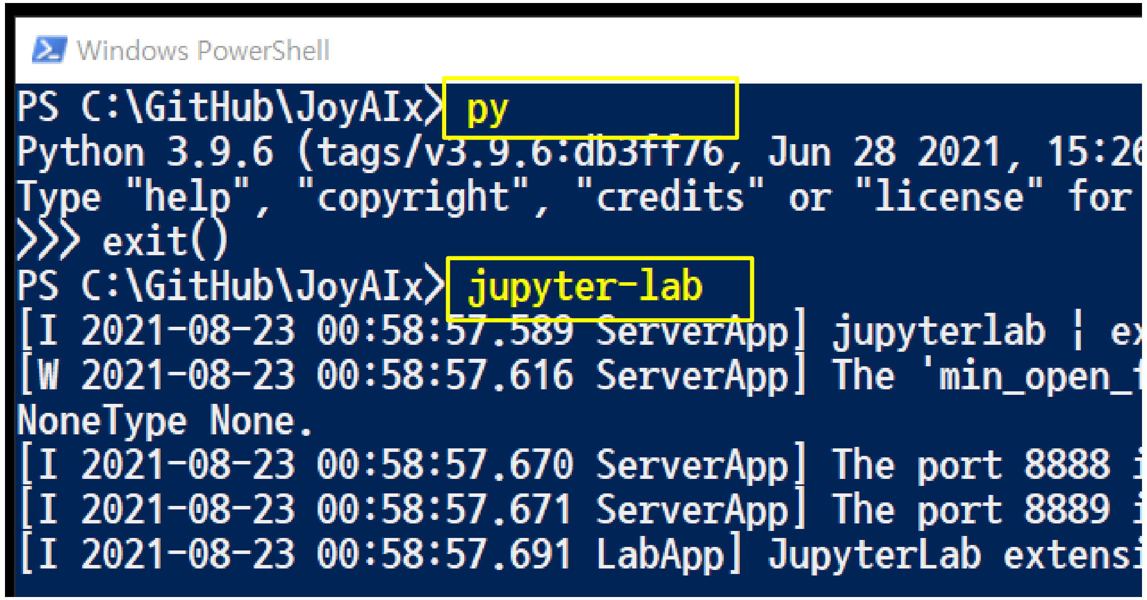
Chapter 8: (Optional) Graph and Graph Algorithms

Learning outcomes

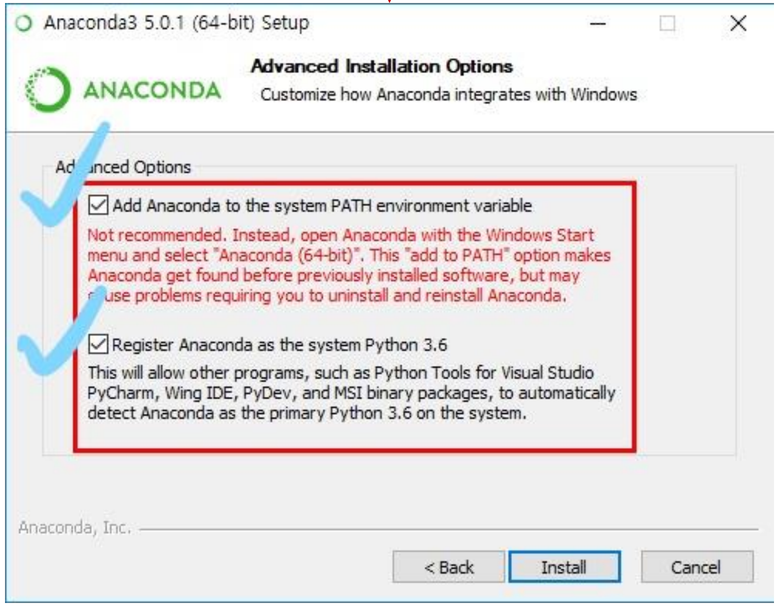
- A student who successfully completes this course will be able to:
  - Define a **class** to model and represent an **object. (OOP)**
  - **Write programs that store and manipulate data in standard linear data. structures (arrays, linked lists, stacks, queues) and non-linear data structures (hash tables, trees).**
  - Write code which handles important **exception** types.
  - Compare the efficiency of algorithms using standard **big-O notation.**
  - Implement **recursive data structures and solutions** to simple problems.
  - Explain the basic algorithm for any of the studied **sorting** methods.
  - Get familiar with **regular expressions** to extract data from a body of text.
- Tools to use
  - Use **Jupyter-lab** (or Jupyter notebook) for coding and reading the textbook.
  - Use **GitHub** to save and get source code files and resources for this course.

Git, GitHub & GitHub Desktop, Anaconda, and Jupyter-lab

- Install **Git** and **GitHub Desktop**
- Get an account at www.github.com
  - Read GettingStarted.md in www.github.com/idebtor/DSpy/
  - Clone **www.github.com/idebtor/DSpy** repository in your local computer.
- Install **Andaconda** package:
  - Make sure that you check the both options.
- Now you can start **Jupyter-lab** in console.



```
PS C:\GitHub\JoyAIx> py
Python 3.9.6 (tags/v3.9.6:db3ff76, Jun 28 2021, 15:26
Type "help", "copyright", "credits" or "license" for
>>> exit()
PS C:\GitHub\JoyAIx> jupyter-lab
[I 2021-08-23 00:58:57.589 ServerApp] jupyterlab | ex
[W 2021-08-23 00:58:57.616 ServerApp] The 'min_open_f
NoneType None.
[I 2021-08-23 00:58:57.670 ServerApp] The port 8888 i
[I 2021-08-23 00:58:57.671 ServerApp] The port 8889 i
[I 2021-08-23 00:58:57.691 LabApp] JupyterLab extensi
```


Anaconda3 5.0.1 (64-bit) Setup
ANACONDA
Advanced Installation Options
Customize how Anaconda integrates with Windows
Advanced Options
Anaconda, Inc.
< Back
Install
Cancel

☑ Add Anaconda to the system PATH environment variable

Not recommended. Instead, open Anaconda with the Windows Start menu and select "Anaconda (64-bit)". This "add to PATH" option makes Anaconda get found before previously installed software, but may cause problems requiring you to uninstall and reinstall Anaconda.

☑ Register Anaconda as the system Python 3.6

This will allow other programs, such as Python Tools for Visual Studio PyCharm, Wing IDE, PyDev, and MSI binary packages, to automatically detect Anaconda as the primary Python 3.6 on the system.

Agenda

- Topics:
  - Python Review
    - list
    - list comprehension
- References:
  - www.github.com/idebtor/DSpy:
    - Ch1-1: Introduction
    - Ch1-2: Review(1) ~ (7)
  - Problem Solving with Algorithms and Data Structures using Python
    - Chapter 1: Introduction

Python

- It is a programming language designed to be easy to read but **powerful**
  - **Readability**
  - **Simplicity**
  - **Extensibility**
- Ways of running a program
  - Interactive execution — great for learning
  - Creating a module (file) and executing the module
  - Use **Jupyter-lab** (or **Jupyter Notebook)** for interactive execution and documentation
- Install **Anaconda** Package that includes Python and Jupyter-lab (or Jupyter Notebook) and a very large library of standard modules

Lists

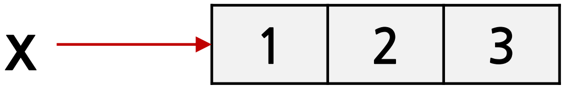
- Lists are a built-in type in Python
  - Use **square brackets** to signify a list
  - Lists can contain any type of data, or any mixture of data
  - Examples:

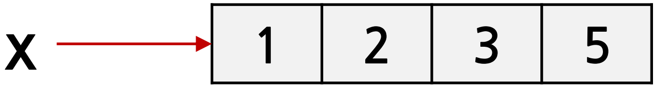
```
my_list1 = [1, 2, 3]

my_list2 = ['Hello', 'Is', 'there', 'anybody', 'out', 'there?']

my_list3 = [1, 5.899, 'Hello']

my_list4 = [4, 2, 6, 9, 3]
```

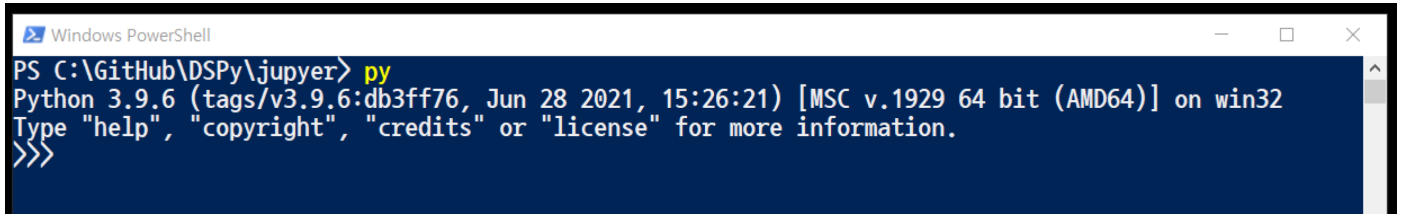
List functions

- Numerous list functions are supported
  - Use **help(list)** to find out the functions
  - Examples:

```
>>> x = [1, 2, 3]
>>> len(x)
3
>>> x + [4]
[1, 2, 3, 4]
>>> x += [5]
[1, 2, 3, 5]
>>> 3 in x
True
>>> x[0]
1
>>> [1, 2, 3] * 2
[1, 2, 3, 1, 2, 3]
```







```
PS C:\GitHub\DSPy\jupyer> py
Python 3.9.6 (tags/v3.9.6:db3ff76, Jun 28 2021, 15:26:21) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

List functions

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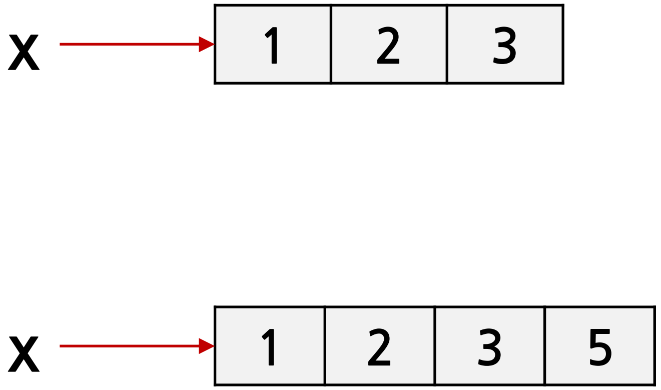
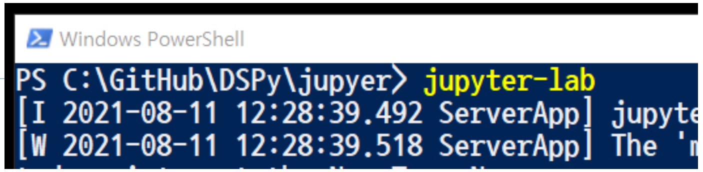
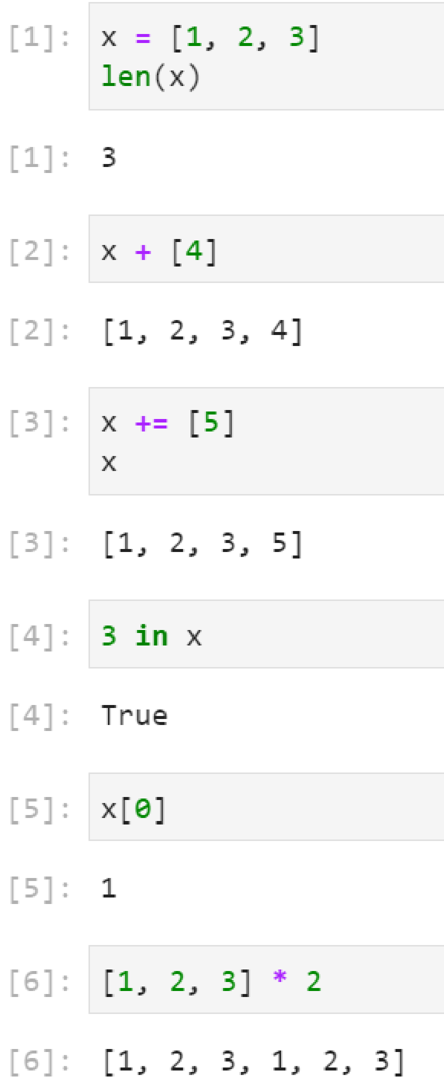
```





```
PS C:\GitHub\DSPy\jupyter> jupyter-lab
[I 2021-08-11 12:28:39.492 ServerApp] jupyte
[W 2021-08-11 12:28:39.518 ServerApp] The 'n
```



```
[1]: x = [1, 2, 3]
     len(x)
[1]: 3

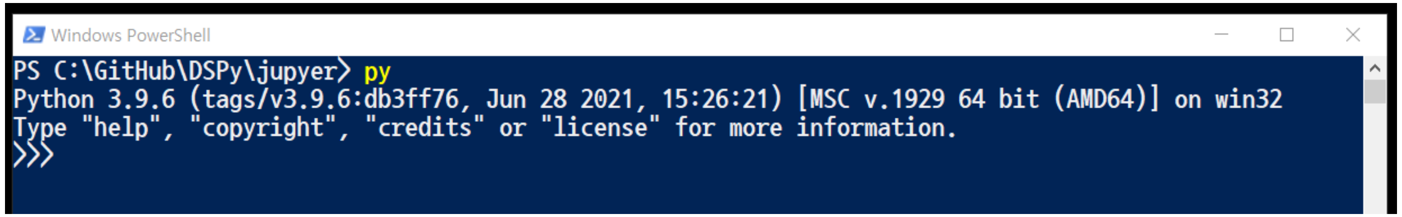
[2]: x + [4]
[2]: [1, 2, 3, 4]

[3]: x += [5]
     x
[3]: [1, 2, 3, 5]

[4]: 3 in x
[4]: True

[5]: x[0]
[5]: 1

[6]: [1, 2, 3] * 2
[6]: [1, 2, 3, 1, 2, 3]
```



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Type "help", "copyright", "credits" or "license" for more information.
>>>
```

List comprehensions

- A powerful feature of the Python language.
  - A list can be created using instructions that appear within the square bracket
  - Generate a new list by applying a function to every member of an original list

- The syntax of a “list comprehension” is tricky.
  - If you’re not careful, you might think it is a for-loop, an ‘in’ operation, or an ‘if’ statement since all three of these keywords (‘for’, ‘in’, and ‘if’) can also be used in the syntax of a list comprehension.
  - It’s something special all its own

```
my_list = [ x for x in range(9) ]
```

List comprehensions: Syntax 1

- The general format is as follows:

```
[expression for variable in sequence]
```

  - Where expression is some calculation or operation acting upon the variable.
    - For each member of the sequence, calculate a new value using expression, and then we collect these new values into a new list which becomes the return value of the list comprehension.

- Examples:

```
spells = [ ch for ch in 'Ann' ]
```

```
['A', 'n', 'n']
```

```
c_degs = [ -10, 0, 10, 100 ]
f_degs =
```

```
[14.0, 32.0, 50.0, 212.0]
```

```
basket = ['   banana', ' kiwi   ']
fruits =
```

```
['banana', 'kiwi']
```

```
square =
```

```
[1, 4, 9, 16]
```

List comprehensions: Syntax 2

- If the original list contains a variety of different types of values, then the calculations contained in the expression should be able to operate correctly on all of the types of list members.

```
items = [ 'hello', [1, 2], (a, b, c) ]
length =
```

```
[5, 2, 3]
```

- If the members of list are other containers, then the name can consist of a container of names that match the **type** and "**shape**" of the list members.

```
store = [ ('apple', 1), ('kiwi, 2), ('pear', 3) ]
order =
```

```
[2, 4, 6]
```

```
store = [ ('apple', 1), ('kiwi, 2), ('pear', 3) ]
order = dict([ (fruit, n * 2) for (fruit, n) in store ])
```

```
{'apple': 2, 'kiwi': 4, 'pear': 6}
```

List comprehensions: Syntax 3

- The expression of a list comprehension could also contain user-defined functions.

```
def c2f(c):
    return c * 1.8 + 32
```

```
c_degs = [ -10, 0, 100 ]
cflist =
```

```
[(-10, 14.0), (0, 32.0), (100, 212.0)]
```

- We can also create a list of tuples, and convert it a dictionary:

```
vector = [ 2, 4, 6 ]
square =
```

```
{2: 4, 4: 16, 6: 36}
```

List comprehensions that uses conditions (Filtered list)

- We can extend the syntax for a list comprehension to include a condition:

```
evens =
```

```
[0, 2, 4, 6, 8]
```

- The general format is as follows:

```
[expression for variable in sequence if condition]
```

  - Similar to regular list comprehensions, except now we might not perform the expression on every member of the list.
  - We first check each member of the list to see if it satisfies a filter condition. Those list members that return False for the filter condition will be omitted from the list before the list comprehension is evaluated.

List comprehensions: Filtered List

- Examples:

```
vector = [ 2, 4, 6 ]
my_vec = [ 3 * x for x in vector if x > 3 ]
```

```
[12, 18]
```

```
vector = [ 2, 4, 6 ]
my_vec = [ 3 * x for x in vector if x < 2 ]
```

```
[]
```

Summary: Features of lists

- Information in a list is stored contiguously in memory
  - location of the information can be calculated
  - location = start of the list + index * size of each element
- Efficiency issues
  - It takes the same time to access any of the elements
  - Slow to move elements around (i.e. add and delete elements from within the list)

Data Structures in Python Chapter 1

1. **Introduction - Review Python**
2. Modelling Objects
3. Object-Oriented Programming
4. Fraction Example
5. Classes
6. Exceptions 1, 2
7. JSON