National University of Computer and Emerging Sciences

Lab Manual 02
CL461-Artificial Intelligence Lab

Course	AI
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Section	B
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Table of Contents

1 Objectives

After performing this lab, students shall be able to understand Python data structures which includes:

- ✔ Python lists

- ✔ Python tuples
- ✔ Python dictionaries

2 Task Distribution

Total Time	**170 Minutes**
Lab 1 Revision	20 Minutes
Python Lists	20 Minutes
Python Tuples	10 Minutes
Python Dictionaries	20 Minutes
Exercise	90 Minutes
Online Submission	10 Minutes

3 Python Lists

Everything is Python is treated as an object. Lists in Python represent ordered sequences of values. Lists are "mutable", meaning they can be modified "in place". You can access individual list elements with square brackets. Python uses *zero-based* indexing, so the first element has index 0.

Here are a few examples of how to create lists:

```
# List of integers
primes = [2, 3, 5, 7]

# We can put other types of things in lists
planets = ['Mercury', 'Venus', 'Earth', 'Mars', 'Jupiter', 'Saturn',
'Uranus', 'Neptune']

# We can even make a list of lists
hands = [
    ['J', 'Q', 'K'],
    ['2', '2', '2'],
    ['6', 'A', 'K'], # (Comma after the last element is optional)
]

# A list can contain a mix of different types of variables:
my_favourite_things = [32, 'AI Lab, 100.25]
```

3.1 Indexing & Slicing Examples

Consider our list of planets created above:

```
planets[0]    # 'Mercury'
planets[1]    # 'Venus'
planets[-1]   # 'Neptune'
planets[-2]   # 'Uranus'

# List Slicing

# first three planets
planets[0:3]  # ['Mercury', 'Venus', 'Earth']
planets[:3]   # ['Mercury', 'Venus', 'Earth']

# All the planets from index 3 onward
planets[3:]   # ['Mars', 'Jupiter', 'Saturn', 'Uranus', 'Neptune']

# All the planets except the first and last
planets[1:-1] # ['Venus', 'Earth', 'Mars', 'Jupiter', 'Saturn',
'Uranus']

# The last 3 planets
planets[-3:]  # ['Saturn', 'Uranus', 'Neptune']
```

3.2 List Modification Examples

Working with the same planets list:

```
# Rename Mars
planets[3] = 'Malacandra'
# ['Mercury', 'Venus', 'Earth', 'Malacandra', 'Jupiter', 'Saturn',
'Uranus', 'Neptune']

# Rename multiple list indexes
planets[:3] = ['Mur', 'Vee', 'Ur']
['Mur', 'Vee', 'Ur', 'Malacandra', 'Jupiter', 'Saturn', 'Uranus',
'Neptune']
```

3.3 List functions

Python has several useful functions for working with lists.

```
len(planets)  # 8

# The planets sorted in alphabetical order
sorted(planets)
# ['Earth', 'Jupiter', 'Mars', 'Mercury', 'Neptune', 'Saturn',
'Uranus', 'Venus']
```

```
primes = [2, 3, 5, 7]
sum(primes)   # 17
max(primes)   # 7

# Let’s add Pluto to the planets list
planets.append('Pluto')

# Pop removes and returns the last element of the list
planets.pop() # ‘Pluto’

# Remove an item from a list given its index instead of its value
a = [-1, 1, 66.25, 333, 333, 1234.5]
del a[0]      # [1, 66.25, 333, 333, 1234.5]

# Remove slices from the list
del a[2:4]    # [1, 66.25, 1234.5]

planets.index('Earth')      # 2

# Is Earth a planet?
"Earth" in planets   # True

# Is Pluto a planet?
"Pluto" in planets   # False (We removed it remember)

# Finally to find all the methods associated with Python list object
help(planets)
```

3.4 List comprehensions

List comprehensions are one of Python's most unique features. List comprehensions combined with functions like min, max, and sum can lead to impressive one-line solutions for problems that would otherwise require several lines of code. The easiest way to understand them is probably to just look at a few examples:

```
# With list comprehension
squares = [n**2 for n in range(10)]       # [0, 1, 4, 9, 16, 25, 36,
49, 64, 81]

# Without list comprehension
squares = []
for n in range(10):
    squares.append(n**2)

# [0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
```

```
# List comprehensions are great of filtering and transformations
short_planets = [planet for planet in planets if len(planet) < 6]
# ['Venus', 'Earth', 'Mars']

[
    planet.upper() + '!'
    for planet in planets
    if len(planet) < 6
]
# ['VENUS!', 'EARTH!', 'MARS!']

# One line solution
def count_negatives(nums):
    # False + True + True + False + False equals to 2.
    # return len([num for num in nums if num < 0])
    return sum([num < 0 for num in nums])

count_negatives([5, -1, -2, 0, 3])
```

4 Python Tuples

Tuples are almost exactly the same as lists. They differ in just two ways.

1. The syntax for creating them uses parentheses instead of square brackets.
2. They cannot be modified (they are *immutable*).

Tuples are often used for functions that have multiple return values.

```
t = (1, 2, 3)
t = 1, 2, 3   # equivalent to above
t[0] = 100    # TypeError: 'tuple' object does not support item
assignment

# Classic Python Swapping Trick
a = 1
b = 0
a, b = b, a   # 0 1
```

4.1 Tuple Functions

There are only two tuple methods count() and index() that a tuple object can call.

```
thistuple = (1, 3, 7, 8, 7, 5, 4, 6, 8, 5)
x = thistuple.count(5)      # 2

thistuple = (1, 3, 7, 8, 7, 5, 4, 6, 8, 5)
x = thistuple.index(8)      # 3
```

5 Python Dictionaries

Dictionaries and lists share the following characteristics:

- Both are mutable.
- Both are dynamic. They can grow and shrink as needed.
- Both can be nested. A list can contain another list. A dictionary can contain another dictionary. A dictionary can also contain a list, and vice versa.

Dictionaries differ from lists primarily in how elements are accessed:

- List elements are accessed by their position in the list, via indexing.
- Dictionary elements are accessed via keys not by numerical index.

Duplicate keys are not allowed. A dictionary key must be of a type that is immutable. E.g. a key cannot be a list or a dict.

Here are a few examples to create dictionaries:

```
MLB_team = {
     'Colorado' : 'Rockies',
     'Boston'   : 'Red Sox',
     'Minnesota': 'Twins',
     'Milwaukee': 'Brewers',
     'Seattle'  : 'Mariners'
}
# Can also be defined as:
MLB_team = dict([
     ('Colorado', 'Rockies'),
     ('Boston', 'Red Sox'),
     ('Minnesota', 'Twins'),
     ('Milwaukee', 'Brewers'),
     ('Seattle', 'Mariners')
])
# Another way
tel = dict(sape=4139, guido=4127, jack=4098)

# dict comprehensions can be used to create dictionaries from
arbitrary key and value expression
{x: x**2 for x in (2, 4, 6)}       # {2: 4, 4: 16, 6: 36}

# Building a dictionary incrementally – if you don’t know all the
key-value pairs in advance
person = {}
person['fname'] = 'Joe'
person['lname'] = 'Fonebone'
person['age'] = 51
person['spouse'] = 'Edna'
person['children'] = ['Ralph', 'Betty', 'Joey']
person['pets'] = {'dog': 'Fido', 'cat': 'Sox'}
```

```
# {'fname': 'Joe', 'lname': 'Fonebone', 'age': 51, 'spouse': 'Edna',
'children': ['Ralph', 'Betty', 'Joey'], 'pets': {'dog': 'Fido', 'cat':
'Sox'}}
```

5.1 Dictionary Modification Examples

A few examples to access the dictionary elements, add new key value pairs, or update previous value:

```
# Retrieve a value
MLB_team['Minnesota']       # 'Twins'

# Add a new entry
MLB_team['Kansas City'] = 'Royals'

# Update an entry
MLB_team['Seattle'] = 'Seahawks'
```

5.2 Dictionary Formatting Example

The % operator works conveniently to substitute values from a dict into a string by name:

```
hash = {}
hash['word'] = 'garfield'
hash['count'] = 42
s = 'I want %(count)d copies of %(word)s' % hash  # %d for int, %s for
string
# 'I want 42 copies of garfield'
```

5.3 Dictionary Functions

The following is an overview of methods that apply to dictionaries:

```
# Let's use this dict for to demonstrate dictionary functions
d = {'a': 10, 'b': 20, 'c': 30}

# Clears a dictionary.
d.clear()     # {}

# Returns the value for a key if it exists in the dictionary.
print(d.get('b'))    # 20

# Removes a key from a dictionary, if it is present, and returns its
value.
d.pop('b')    # 20

# Returns a list of key-value pairs in a dictionary.
list(d.items())      # [('a', 10), ('b', 20), ('c', 30)]
list(d.items())[1][0]       # 'b'
```

```
list(d.items())[1][1]       # 20

# Returns a list of keys in a dictionary.
list(d.keys())       # ['a', 'b', 'c']

# Returns a list of values in a dictionary.
list(d.values())     # [10, 20, 30]

# Removes the last key-value pair from a dictionary.
d.popitem()   # ('c', 30)

# Merges a dictionary with another dictionary or with an iterable of
key-value pairs.
d2 = {'b': 200, 'd': 400}
d.update(d2)  # {'a': 10, 'b': 200, 'c': 30, 'd': 400}
```

For more details, visit iterate dictionary & dictionary comprehensions.

NOTE:
For more details, visit
https://realpython.com/iterate-through-dictionary-python/
https://www.datacamp.com/tutorial/python-dictionary-comprehension

6 Exercise (35 Marks)

- For this exercise, use the notebook *AI_Lab_2_Exercise.ipynb* provided on Google classroom.
- Open the *AI_Lab_2_Exercise.ipynb* on Google Collab by uploading it.
- The *main()* function is already defined and complete. DO NOT change it.
- Only enter your code within the space provided in the notebook.

6.1 Number of chickens (5 Marks)

Given an int count of a number of chickens, return a string of the form 'Number of chickens: <count>', where <count> is the number passed in. However, if the count is 10 or more, then use the word 'many' instead of the actual count. So chickens(5) returns 'Number of chickens: 5' and chickens(23) returns 'Number of chickens: many'.

6.2 Strings from both ends (5 Marks)

Create a string made of the first three and the last three characters of the original string s and return the new string, so 'intelligence' creates 'intcne'. However, if the string length is less than 3, return instead the empty string.

6.3 Replace occurrences of first character (5 Marks)

For a given string s, create a new string such that it replaces some characters of the string with '@'. To replace, find the first character of the given string s. Now find all occurrences of this first

character in the string and replace them with '@'. Do not change the first character itself.
e.g. 'Ooogle' create 'O@@gle'
Assume that the string is length 1 or more and take care of the word case.
Hint: s.replace(stra, strb) returns a version of string s where all instances of stra have been replaced by strb.

6.4 String jumble (5 Marks)

Create a new string with the help of two input strings a and b. The new string should be separated by a space b/w a and b. Also swap the first 2 chars of each string and return it.
e.g.
'mix', pod' -> 'pox mid'
'dog', 'dinner' -> 'dig donner'
Assume a and b are length 2 or more.

6.5 Matching first and last characters (5 Marks)

Taking a list of strings as input, our matching function returns the count of the number of strings whose first and last chars of the string are the same.
Also, only consider strings with length of 2 or more.

6.6 Sort tuple by last element (5 Marks)

Given a list of non-empty tuples, return a list sorted in increasing order by the last element in each tuple.
e.g. [(1, 7), (1, 3), (3, 4, 5), (2, 2)] creates [(2, 2), (1, 3), (3, 4, 5), (1, 7)]
Hint: use a custom key= function to extract the last element form each tuple.

6.7 Initialize dictionary (4 Marks)

Initialize dictionary with default values. One line solution.
Input:
employees = ['Kelly', 'Emma', 'John']
defaults = {"designation": 'Application Developer', "salary": 8000}
Output:
{'Kelly': {'designation': 'Application Developer', 'salary': 8000}, 'Emma': {'designation': 'Application Developer', 'salary': 8000}, 'John': {'designation': 'Application Developer', 'salary': 8000}}

7 Submission Instructions

Always read the submission instructions carefully.

- Rename your Jupyter notebook to your roll number and download the notebook as **.ipynb** extension.
- To download the required file, go to **File->Download .ipynb**
- Only submit the **.ipynb** file. DO NOT **zip** or **rar** your submission file
- Submit this file on Google Classroom under the relevant assignment.
- Late submissions will not be accepted