CMSC201
Computer Science I for Majors

Lecture 22 – Dictionaries

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Last Class We Covered

- Python's tuple data structure
- Tuples in functions (and as return values)
- Basic tuples operations, including…
  - Creation
  - Conversion
  - Repetition
  - Slicing
  - Traversing

Any Questions from Last Time?

Tuple Practice

```
def min_max(t):
    """Returns the smallest and largest
    elements of a sequence as a tuple"""
    return (min(t), max(t))

seq = [64, 71, 42, 73, 85, 33]
minOutput, maxOutput = min_max(seq)
print(minOutput, maxOutput)

string = 'We are the Knights who say... NI.'
print (min_max(string))
```

What does this output?

```
(33, 85)
(' ', 'y')
```

Tuple Practice 2

```
def printall(______):
    print (args)

printall(1, 2.0, 'three')
```

What belongs here?

Tuple Practice 2

```
def printall(*args):
    print (args)

printall(1, 2.0, 'three')
```

What does this do?

Any Questions from Last Time?

Lesson objectives

- Construct dictionaries and access entries in those dictionaries
- Use methods to manipulate dictionaries
- Decide whether a list or a dictionary is an appropriate data structure for a given application

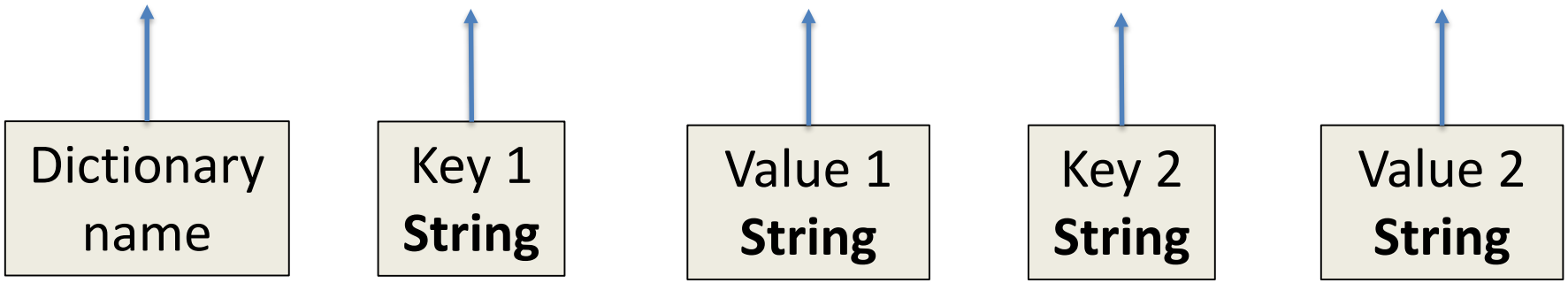
Dictionaries

- A dictionary organizes information by **association**, not position
  - Example: When you use a dictionary to look up the definition of “mammal,” you don’t start at page 1; instead, you turn directly to the words beginning with “M”
- Data structures organized by association are also called **tables** or **association lists**
- In Python, a **dictionary** associates a set of **keys** with data values

Dictionary Keys

- In Python, a ***dictionary*** is a set of 'keys' (words) all pointing to their own 'values' (meanings).

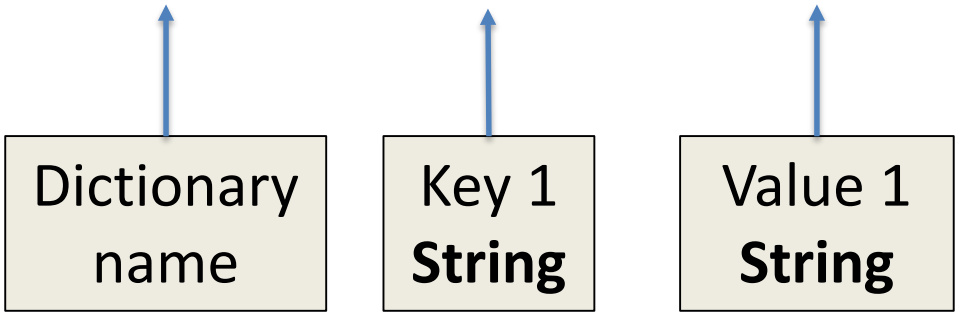
```
dict1 = {"first_name" : "John", "last_name" : "Cleese"}
```



Dictionaries

- Keys can be data of any immutable types, including other data structures
- It is best to think of a dictionary as an unordered set of *key: value* pairs, with the requirement that the keys are unique (within one dictionary)

```
dict1['John'] = 'Leo'
```



Creating Dictionaries

Creating Dictionaries

- There are three main ways to create a dictionary in Python:
  1. Construct a python dictionary (with curly braces syntax)
  2. You can also construct a dictionary from a list (or any iterable data structure) of key, value pairs
  3. Construct a dictionary from parallel lists

Creating Dictionaries (Curly Braces)

- The empty dictionary is written as two curly braces containing nothing

```
dict1 = {}
```

- To cast a list as a dictionary, you use **dict()**

```
dict1 = {"fname" : "John", "lname" : "Cleese"}
print (dict1)
```

```
{'lname': 'Cleese', 'fname': 'John‘}
```

Creating Dictionaries

```
dict1 = [('a', 'apple')]
print (dict1, type(dict1))
```

Is this a dictionary?

```
[('a', 'apple')] <class 'list'>
```

Must use curly braces {} to define a dictionary

Creating Dictionaries

```
dict2 = {'a', 'apple'}
print (dict2, type(dict2))
```

Is this a dictionary?

```
{('a', 'apple')} <class 'set'>
```

Must use a colon (:) between items, not a comma

Creating Dictionaries

```
dict3 = {'a':'apple'}
print (dict3, type(dict3))
```

Is this a dictionary?

```
{'a': 'apple'} <class 'dict'>
```

Hooray!

Creating a Dictionary

```
eng2sp = dict()
print (eng2sp)
    {} <class 'dict'>
```

What does this output?

```
eng2sp['one'] = 'uno'
print (eng2sp)
    {'one': 'uno'} <class 'dict'>
```

What does this output?

```
eng2sp['two'] = 'dos'
print (eng2sp)
    {'two': 'dos', 'one': 'uno'} <class 'dict'>
```

What does this output?

Creating Dictionaries (From List)

- To cast a list as a dictionary, you use **dict()**

```
myList = [(5, 'candy'),(15, 'cookies'),(23, 'ice cream')]
myDict = dict(myList)
print(type(myDict))
```

Must be key pairs

```
<class 'dict'>
```

Creating Dictionaries (From Parallel Lists)

- Here we have two parallel lists that we are putting together into a dictionary.

```
names = ["Tina", "Pratik", "Amber"]
major = ["Social Work", "Pre-Med", "Art"]

major_dict = {}
for i in range(len(names)):
    major_dict[names[i]] = major[i]

print (major_dict)
```

```
{'Pratik': 'Pre-Med', 'Tina': 'Social Work', 'Amber': 'Art'}
```

Creating Dictionaries (From Parallel Lists)

- Rather than using a for loop, there is a built-in function that can put parallel lists together (either into a tuple or dictionary)

- ***Zip*** is a built-in function that takes two or more sequences and "zips" them into a list of tuples, where each tuple contains one element from each sequence

Creating Dictionaries (From Parallel Lists)

```
names = ["Tina", "Pratik", "Amber"]
major = ["Social Work", "Pre-Med", "Art"]
majors_dict = dict(zip(names, major))
print(majors_dict)
print(type(majors_dict))
```

What does this output?

```
{'Amber': 'Art', 'Tina': 'Social Work', 'Pratik': 'Pre-Med'}
<class 'dict'>
```

Creating Dictionaries

- One other way to create a dictionary is by using ***dictionary comprehension***

```
dict1 = {x: x**2 for x in (2, 4, 6)}
print(dict1)
```

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

What does this output?

Dictionary Operations

Dictionary Operations

1. Accessing Values in Dictionary
2. Updating Dictionaries
3. Delete Dictionary Elements

Accessing Values in Dictionary

- To access dictionary elements, you can use the square brackets along with the key to obtain its value

```
dict1 = {'FName': 'Mike', 'LName': 'Jones', 'Age': 18};

print ("dict1['FName']: ", dict1['FName'])
print ("dict1['Age']: ",   dict1['Age'])
```

```
dict1['FName']:  Mike
dict1['Age']:  18
```

Updating Dictionaries

```
dict1 = {'FName': 'Mike', 'LName': 'Jones', 'Age': 18};

print("Before Update")
print("dict1['FName']: ", dict1['FName'])
print("dict1['Age']: ", dict1['Age'])

dict1['School']=  "UMBC"
dict1['Age']=  19

print("After Update")
print("dict1['School']: ", dict1['School'])
print("dict1['Age']: ", dict1['Age'])
```

New Entry

Updated Entry

Updating Dictionaries

```
Before Update
dict1['FName']:  Mike
dict1['Age']:  18


After Update
dict1['School']:  UMBC
dict1['Age']:  19
```

Delete Dictionary Elements

- You can either remove individual dictionary elements or clear the entire contents of a dictionary.
- You can also delete an entire dictionary in a single operation.

Delete Dictionary Elements

```
dict1 = {'FName': 'Mike', 'LName': 'Jones', 'Age': 18};

print("Before Update")
print("dict1['FName']: ", dict1['FName'])
print("dict1['LName']: ", dict1['LName'])
print("dict1['Age']: ", dict1['Age'])


del dict1['FName'] # remove entry with key 'Name'
#dict1.clear()     # remove all entries in dict
#del dict1         # delete entire dictionary

print("After Update")
print("dict1['LName']: ", dict1['LName'])
print("dict1['Age']: ", dict1['Age'])
```

If we remove, the dictionary, it will cause an error.

Dictionary Functions and Methods

Functions and Methods

- `len(dict)`
- `str(dict)`
- `type(variable)`
- `dict.clear()`
- `dict.copy()`
- `dict.fromkeys()`
- `dict.get(key, default=None)`
- `dict.items()`
- `dict.values()`
- `dict.keys()`
- `dict.setdefault(key, default=None)`
- `dict.update(dict2)`

From: http://www.tutorialspoint.com/python/python_dictionary.htm

Functions

- **`len(dict)`**
  - Gives the total length of the dictionary. This would be equal to the number of items in the dictionary.
- **`str(dict)`**
  - Produces a printable string representation of a dictionary
- **`type(variable)`**
  - Returns the type of the passed variable. If passed variable is dictionary, then it would return a dictionary type.

From: http://www.tutorialspoint.com/python/python_dictionary.htm

Methods

- **`dict.clear()`**
  - Removes all elements of dictionary *dict*
- **`dict.copy()`**
  - Returns a shallow copy of dictionary *dict*
- **`dict.fromkeys(seq, value=None)`**
  - Create a new dictionary with keys from seq and values *set* to *value*.
- **`dict.get(key, default=None)`**
  - For *key* key, returns value or default if key not in dictionary

Methods

- **`dict.items()`**
  - Returns a list of *dict*'s (key, value) tuple pairs
- **`dict.values()`**
  - Returns list of dictionary *dict*'s values
- **`dict.keys()`**
  - Returns list of dictionary dict's keys

Methods

- **`dict.setdefault(key, default=None)`**
  - Similar to get(), but will set dict[key]=default if *key* is not already in dict
- **`dict.update(dict2)`**
  - Adds dictionary *dict2*'s key-values pairs to *dict*

When to Use a Dictionary?

- You have to retrieve things based on some identifier, like names, addresses, or anything that can be a key.
- You don't need things to be in order. Dictionaries do not normally have any notion of order, so you have to use a list for that.
- You are going to be adding and removing elements and their keys.

Dictionary Examples

Example: The Hexadecimal System

- You can keep a hex-to-binary **lookup table** to aid in the conversion process

```
hexToBinaryTable = {'0': '0000', '1':'0001', '2':'0010',
                    '3': '0011', '4':'0100', '5':'0101',
                    '6': '0110', '7':'0111', '8':'1000',
                    '9': '1001', 'A':'1010', 'B':'1011',
                    'C': '1100', 'D':'1101', 'E':'1110',
                    'F': '1111'}
```

Example: The Hexadecimal System

- You can keep a hex-to-binary **lookup table** to aid in the conversion process

```
def convert(number, table):
    binary = ''
    for digit in number:
        binary = binary + table[digit]
    return binary
def main():
    print(convert("34A", hexToBinaryTable))
    print(convert("11C", hexToBinaryTable))
main()
```

```
001101001010
000100011100
```

Dictionary Example (Psychotherapist)

- Doctor in this kind of therapy responds to patient's statements by rephrasing them or indirectly asking for more information

- For example:
  - Writing a program that emulates a nondirective psychotherapist

Dictionary Example (Psychotherapist)

```
-bash-4.1$ python psych.py
Good morning, I hope you are well today.
What can I do for you?

>> my dad and I don't like each other
You seem to think that your dad and you don't like each
other

>> my mother and father are mean to each other
Why do you say that your mother and father are mean to
each other

>> I like to eat candy
Many of my patients tell me the same thing.
```

Dictionary Example (Psychotherapist)

- When user enters a statement, program responds in one of two ways:
  - With a randomly chosen hedge, such as “Please tell me more”
  - By changing some key words in user’s input string and appending the string to a randomly chosen qualifier
    - Thus, to “My teacher always plays favorites,” the program might reply, “Why do you say that your teacher always plays favorites?”

Dictionary Example (Psychotherapist)

- Program consists of a set of collaborating functions that share a common data pool
- Pseudocode:

```
output a greeting to the patient
while True
    prompt for and input a string from the patient
    if the string equals "Quit"
        output a sign-off message to the patient
        break
    call another function to obtain a reply to this string
    output the reply to the patient
```

Dictionary Example (Psychotherapist)

```
import random

hedges = ("Please tell me more.",
          "Many of my patients tell me the same thing.",
          "Please continue.")

qualifiers = ("Why do you say that ",
              "You seem to think that ",
              "Can you explain why ")

replacements = {"I":"you", "me":"you", "my":"your",
                "we":"you", "us":"you", "mine":"yours"}
```

Dictionary Example (Psychotherapist)

```
def reply(sentence):
    probability = random.randint(1,4)
    if probability == 1:
        return random.choice(hedges)
    else:
        return random.choice(qualifiers) + changePerson(sentence)

def changePerson(sentence):
    words = sentence.split()
    replyWords = []
    for word in words:
        replyWords.append(replacements.get(word, word))
    return " ".join(replyWords)
```

Dictionary Example (Psychotherapist)

```
def main():
    print("Good morning, I hope you are well today.")
    print("What can I do for you?")
    while True:
        sentence = input("\n>> ")
        if sentence.upper() == "QUIT":
            print ("Have a nice day!")
            break
        print(reply(sentence))
main()
```

Dictionary Example (Psychotherapist)

- Functions in this program can be tested in a bottom-up or a top-down manner
- Program's replies break down when:
  - User addresses the therapist in the second person
  - User uses contractions (for example, I'm and I'll)
- With a little work, you can make the replies more realistic

Any Other Questions?

Announcements

- No Lab this week (November 23rd to 26th)
  - No office hours after Wednesday at 2:30pm
- Homework 8 has been posted
  - Due on Tuesday, November 24th at 8:59pm
- Project 2
  - Will be posted on Tuesday, November 24th
  - Due on Tuesday, December 8th
- Next Class: Algorithms and Analysis

Have a Happy Thanksgiving!