CMSC201
Computer Science I for Majors

Lecture 20 – Dictionaries

Last Class We Covered

- File I/O
  - Opening
  - Reading
  - Writing
  - Closing

Any Questions from Last Time?

File Input and Output (Review)

Quick Review

- Write the lines of code for the tasks below

1. Open the file "goodDogs.txt"
2. Read the file in (however you want), and print out each dog's name in the sentence "X is a good dog"
3. Finish using the file (what do you need to do?)

```
goodDogs.txt
Thor,Corgi
Coco,Chocolate Lab
Beethoven,St. Bernard
```

Today’s Objectives

- Learn about the dictionary data type
- 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

Organization

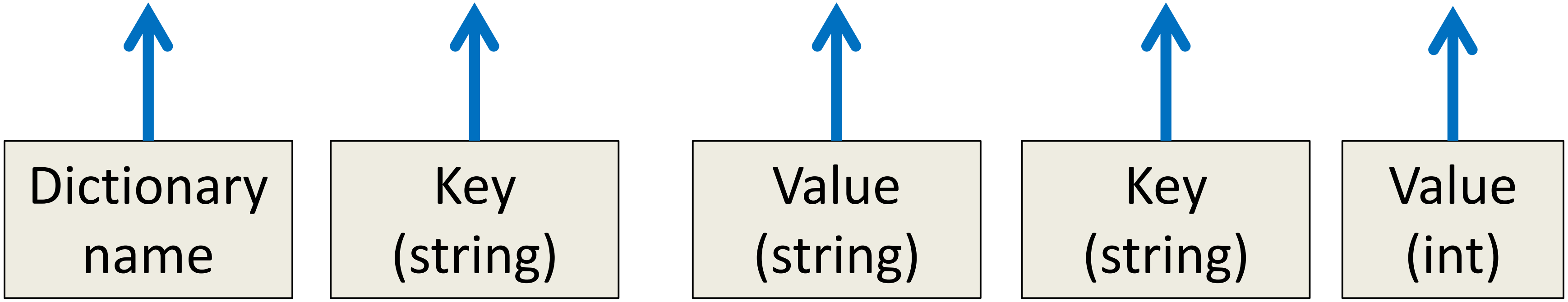
- Information in a list is organized how?
  - By order
- Information in a dictionary is organized...
  - By ***association***

- Python dictionaries associate a set of ***keys*** with corresponding data ***values***

Keys and Values

- A dictionary is a set of “keys” (terms), each pointing to their own “values” (meanings)

```
course = {"major" : "CMSC", "number" : 201}
```



Dictionary name

Key (string)

Value (string)

Key (string)

Value (int)

Purpose of Dictionaries

- Why use a dictionary instead of a list?
- Dictionaries are ***association*** based
  - It's very easy (and quick!) to find something if you know the key
- No matter how big the dictionary is, it can find any entry almost instantaneously
  - Lists would require iterating over the list until the item is found

Dictionary Keys

- Think of a dictionary as an unordered set of ***key:value*** pairs
- Dictionary keys must be ***unique***
  - A key in a dictionary is like an index in a list
  - Python must know exactly which value you want
- Keys can be of any data type
  - As long as it is ***immutable***

Dictionary Values

- Dictionary keys have many rules, but the values do not have many restrictions

- They do not have to be unique
  - Why?

We can have duplicate values in a list, but indexes must be unique

- They can be mutable or immutable
  - Why?

Since they don’t need to be unique, we can change them without restriction

Dictionary Usage Example

- What if we have a list of every student at UMBC, with all the info represented as a list?
  - The first element of the info list is the UMBC ID #
- How long would it take to find a specific student?
  - If the list is unsorted, a very long time!
  - If it's sorted, resort every time a student is added
- Finding a student by ID # in a dictionary, on the other hand, is very *very* quick

Hashing

- Why are dictionaries so fast?
  - Hashing!

- Hashing is a way of translating arbitrary data (like strings or large numbers) into a smaller set space for ease of use

Hashing

- Hashing takes in anything (a string, an int, a float, etc.) and generate a number based on it
  - Same result for same input
  - Use a number to tell where to store in memory

- Given the same input, you get the same number, and can find it again very quickly

Hash Functions

- A function that, given a value, returns a value that tells us where it is stored in memory
  - If it's in that location, it's in the dictionary
  - If it's not in that location, it's not in the dictionary
- The hashing function has no other purpose
  - If we look at the function's inputs and outputs, they probably won't "make sense"
  - This function is called a hash function because it "makes hash" of its inputs

Hash Usage Example

- The **`AB12345`** UMBC student ID number
  - Gives 67,600,000 possible combinations
  - Making a list of that size wastes a lot of space
    - Wouldn’t use even 1% of the list
  - Making a dictionary allows us to better store the thousands of students without requiring a massive waste of space

Creating Dictionaries

Creating Dictionaries (Curly Braces)

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

```
dict1 = {}
```

- To create a dictionary, use curly braces and a colon (:) to separate keys from their value

```
dict2 = {"name" : "Maya", "age" : 7}
```

Creating Dictionaries (From a List)

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

```
myPantry = [['candy', 5],
 ['cookies', 16],
 ['ice cream', 2]]
```

Must be key, value pairs

```
# cast to a dictionary
myDict = dict(myPantry)
```

Dictionary Operations

Dictionary Operations

- Dictionaries are probably most similar to a list

- You can do a number of operations:
  - Access a key’s value
  - Update a key’s value
  - Add new key:value pairs
  - Delete key:value pairs

Accessing Values

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

```
dogBreeds = {"A" : "Akita", "B" : "Basenji",
             "C" : "Chesapeake Bay Retriever"}
print("dogBreeds at C:", dogBreeds["C"])
print("dogBreeds at B:", dogBreeds["B"])
```

```
Output:
dogBreeds at C: Chesapeake Bay Retriever
dogBreeds at B: Basenji
```

Updating Values

- To update dictionary elements, you use the square brackets and the key to indicate which value you would like to update

```
dogBreeds["B"] = "Beagle"
print(dogBreeds)

Output:
{'C': 'Chesapeake Bay Retriever',
'B': 'Beagle', 'A': 'Akita'}
```

Why are these out of order?

Dictionaries organize by ***association***, not by order

Adding New Key:Value Pairs

- To add new values, we don't need to use **`append()`** – we simply state the key and value we want to use, with square brackets

```
dogBreeds["D"] = "Dunker"
dogBreeds["E"] = "Eurasier"
print(dogBreeds)

Output:
{'C': 'Chesapeake Bay Retriever', 'B': 'Beagle',
'A': 'Akita', 'E': 'Eurasier', 'D': 'Dunker'}
```

Deleting Key:Value Pairs

- Key:value pairs must be deleted together; you can’t have a key with no value
- To delete a key:value, use the **`del`** keyword and specify the key you want to delete

```
del dogBreeds["D"]
print(dogBreeds)

Output:
{'C': 'Chesapeake Bay Retriever', 'B': 'Beagle',
'A': 'Akita', 'E': 'Eurasier'}
```

Time for…

LIVECODING!!!

Creating Dictionaries (From Two Lists)

- Here we have two lists
  - Of the same length
  - Contents of each index match up
    - (Pratik is Social Work, Amber is Pre-Med, etc.)

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

- Write the code to create a dictionary from these

Dictionary Methods

Methods

- Methods are functions that are specific to a data type (like **`append()`** or **`lower()`**, etc.)

- **`theDictionary.get(theKey)`**
  - For a key **`theKey`**, returns the associated value
  - If **`theKey`** doesn't exist, returns **`None`**
  - Optionally use a second parameter to return something other than **`None`** if not found
    - **`theDictionary.get(theKey, -1)`**

Methods

- **`theDictionary.values()`**
  - Returns a "view" of the **`theDictionary`**'s values
  - Need to cast to a list
- **`theDictionary.keys()`**
  - Returns a "view" of the **`theDictionary`**'s keys
  - Need to cast to a list

- The two lists returned are in the same order
  - (Value at index 0 matches key at index 0, etc.)

When to Use Dictionaries

- Dictionaries are very useful if you have...
  - Data whose order doesn't matter
  - A set of unique keys
    - Key is a word, value is the definition (or translation)
    - Key is a postal abbreviation, value is the full state name
    - Key is a name, value is a list of their game scores
  - A need to find things easily and quickly
  - A need to easily add and remove elements

Daily CS History

- Charles Babbage
  - – Invented the Analytical Engine
    - Was never built, but would have used punched cards to control a mechanical calculator
  - – Work fell into obscurity, and computer builders in the 30s and 40s re-invented many of his architectural innovations
  - – Also invented the cow catcher for trains

More Daily CS History

- Ada Lovelace
  - – Wrote the first ever computer algorithm
  - – Realized the potential of the Analytical Engine
    - If numbers could be used to represent other things (like music notes), the “engine might compose elaborate and scientific pieces of music of any degree of complexity or extent”

Announcements

- Project 3 will be out soon
  - As well the next survey
  - Due dates will be adjusted accordingly

Image Sources

- Charles Babbage (adapted from):
  - https://commons.wikimedia.org/wiki/File:Charles_Babbage_1860.jpg
- Ada Lovelace (adapted from):
  - https://commons.wikimedia.org/wiki/File:Ada_Lovelace.jpg