CMSC201
Computer Science I for Majors

Lecture 22 – Searching

Welcome Back!

Review: Tuples & Dictionaries

- Create an empty tuple
- Create a dictionary that contains three different (key, value) pairs, similar to “a is for apple”
  - Add one additional (key, value) pair
  - Update one of your (key, value) pairs
  - Remove one of your (key, value) pairs
- Why must dictionary keys be unique?
- Do values need to be unique?

Review: Matching Symbols

- Match the following data types to the symbols needed to create them (may be more than one)

Dictionary

List

String

Tuple

{ }

( )

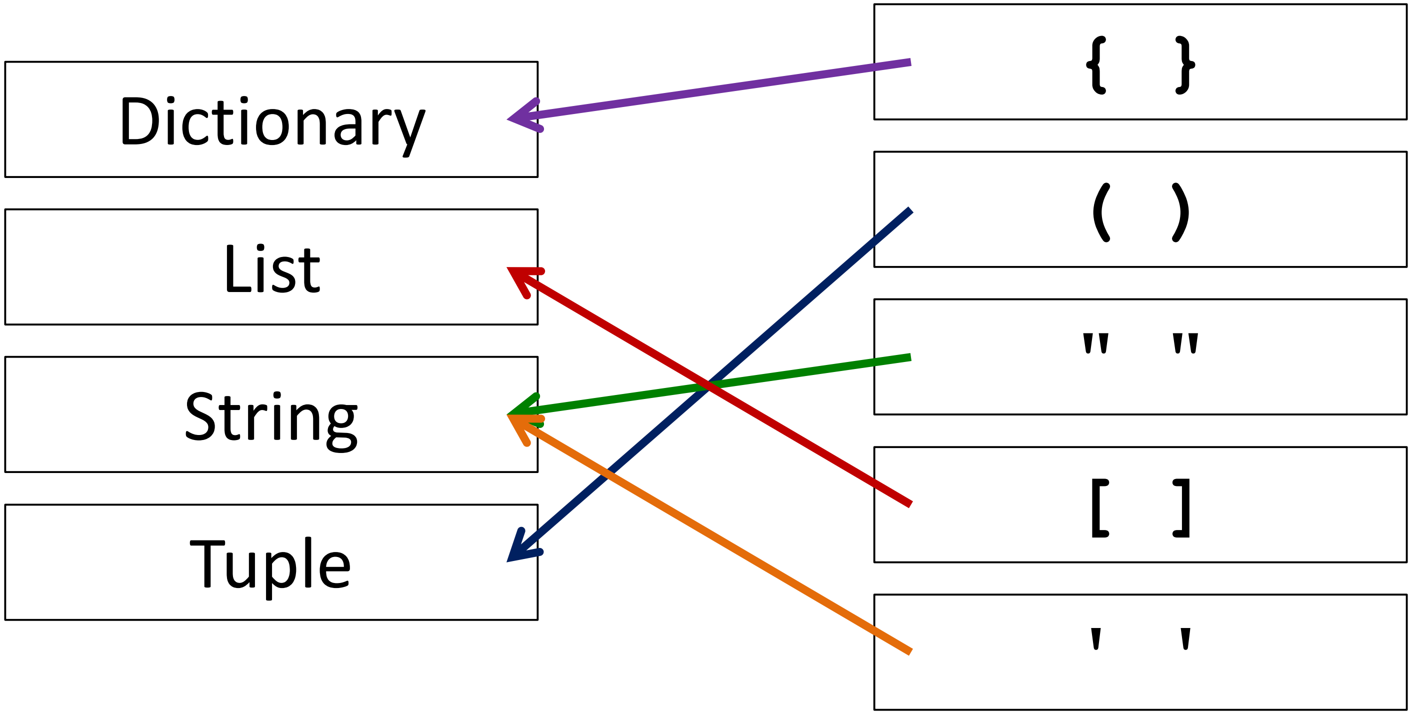
" "

[ ]

' '

Review: Matching Symbols

- Match the following data types to the symbols needed to create them (may be more than one)



Dictionary

List

String

Tuple

{ }

( )

" "

[ ]

' '

Review: Mutability

- Which of the following are mutable data types?

Boolean	???
Dictionary	???
Float	???
Integer	???
List	???
String	???
Tuple	???

Review: Mutability

- Which of the following are mutable data types?

Boolean	Immutable
Dictionary	**Mutable**
Float	Immutable
Integer	Immutable
List	**Mutable**
String	Immutable
Tuple	Immutable

Review: Implementation

- You are given a dictionary of the NATO phonetic alphabet, in the form:

```
ALPHA = {"A" : "Alpha", "B" : "Bravo",
"C" : "Charlie", ... etc.}
```

- Write a function to convert a string from the user into its phonetic code words
  - You only need to handle letters (case insensitive)

Review: Implementation Example

- Here is an example of how it should work:

```
Please enter a word: EXAMPLE
The word "EXAMPLE" becomes
"Echo X-ray Alpha Mike Papa Lima Echo"

Please enter a word: dogmeat
The word "dogmeat" becomes
"Delta Oscar Golf Mike Echo Alpha Tango"
```

Any questions about the material we just reviewed?

Today's Objectives

- To learn more about searching algorithms
  - Linear search
  - Binary search

Search

Motivations for Searching

- Want to know if something exists
  - Python can do this for us!

- Want to know where something exists
  - Python can actually do this for us too!
  - **`raceWinners.index(718)`**

- But **how** does Python does this?

Exercise: **`find()`**

- Write a function that takes a list and a variable and returns the index of the variable in the list
  - If it's not found, return -1
  - You can't use **`index()`**!

```
def find(searchList, var)
```

Exercise: find() Solution

```
def find(searchList, var):
    for i in range(len(searchList)):
        if searchList[i] == var:
            return i

    # outside the loop, means that
    # we didn't find the variable
    return -1
```

Linear Search

- You just programmed up a search function!

- This algorithm is called ***linear search***
- It’s a common, fundamental algorithm in CS

- It’s especially useful when our information isn’t in a sorted order
  - But it isn’t very fast

Searching Sorted Information

- Now, imagine we’re looking for information in something sorted, like a phone book
- We know someone’s name (it’s our “variable”), and want to find their number in the book

- What is a good method for locating their phone number?
  - Think about how you would do this.

Algorithm in English

- Open the book midway through.
  - If the person’s name is **on** the page you opened to
    - You’re done!
  - If the person’s name is **after** the page you opened to
    - Tear the book in half, throw the first half away and repeat this process on the second half
  - If the person’s name is **before** the page you opened to
    - Tear the book in half, throw the second half away and repeat this process on the first half
- This is rough on the phone book, but you’ll find the name!

Binary Search

Binary Search

- The algorithm we just demonstrated is better known as ***binary search***
  - We talked about it briefly last class, remember?

- Binary search is only usable on <u>sorted</u> lists
  - Why?

Solving Binary Search

- Binary search is a problem that can be broken down into
  - Something simple (breaking a list in half)
  - A smaller version of the original problem (searching that half of the list)

- That means we can use ... recursion!

Exercise: Recursive Binary Search

- Write a recursive binary search!

- To make the problem slightly easier, make it "checking to see if something is in a sorted list"
  - If there's no "middle" of the list, we'll just look at the lower of the two "middle" indexes

Exercise: Recursive Binary Search

- Write a recursive binary search!
- Remember to ask yourself:
  - What is our base case(s)?
  - What is the recursive step?

```
def binarySearch(myList, item):
```

- A hint: in order to get the number at the middle of the list, use this line:

```
myList[len(myList) // 2]
```

Time for…

LIVECODING!!!

Announcements

- Final is Thursday, December 15th (3:30 – 5:30)
- Project 2 will come out soon
- The third survey will be announced on Blackboard shortly (0.5% of your grade)
  - Not on Blackboard
  - TA Feedback; anonymous to the TAs