

Dictionaries in Python

October 26, 2020

Administrative Notes

The design document for project 1 is due Wednesday night - you should be pretty close to finished with it by now

The code is due next Monday, November 2 - don't wait until the last minute!!!

Where we're going from here - this class from now to Exam #2

Today (10/26) - Dictionaries

Wednesday, 10/28 - Mutability

Next week - 11/2 and 11/4 - Recursion

Monday, 11/9 - Review for Exam & cover any missed details

Wednesday, 11/11 - Exam #2

After that - this section traditionally diverges in the last third - we will cover Comp Sci topics with a focus on using Comp Sci/Python to solve problems in your areas of study

For planning purposes

Project 2 released this Friday, 10/30; due Friday, 11/13

- It will focus on recursive programming


Project 3 released Friday, 11/14; due Friday, 12/4

- You get 3 weeks because of the Thanksgiving Holiday
- It will focus on using Python libraries and tools to solve some data analysis and presentation problems

The last lecture is Monday, December 7

Tentatively, the Final Exam is Monday, December 14, 3:30 - 5:30 pm online - *if that's a conflict let me know as soon as possible!!!*

What's a dictionary? *(from dictionary.com)*

dictionary [dik-shuh-ner-ee] [SHOW IPA](#) 

[SEE SYNONYMS FOR dictionary ON THESAURUS.COM](#)

noun, plural dic-tion-ar-ies.

- 1 a book, optical disc, mobile device, or online lexical resource (such as Dictionary.com) containing a selection of the words of a language, giving information about their meanings, pronunciations, etymologies, inflected forms, derived forms, etc., expressed in either the same or another language; lexicon; glossary. Print dictionaries of various sizes, ranging from small pocket dictionaries to multivolume books, usually sort entries alphabetically, as do typical CD or DVD dictionary applications, allowing one to browse through the terms in sequence. All electronic dictionaries, whether online or installed on a device, can provide immediate, direct access to a search term, its meanings, and ancillary information:
an unabridged dictionary of English; a Japanese-English dictionary.
- 2 a book giving information on particular subjects or on a particular class of words, names, or facts, usually arranged alphabetically:
a biographical dictionary; a dictionary of mathematics.
- 3 *Computers.*
 - a a list of codes, terms, keys, etc., and their meanings, used by a computer program or system.
 - b a list of words used by a word-processing program as the standard against which to check the spelling of text entered.

The definition we care about

“A list of codes, terms, keys, etc. and their meanings, used by a computer program or system”

-it's not just meanings. More generally, it's a set of *values* that we associate with the *key*.

In Python syntax

A dictionary, or *dict* for short, is enclosed in curly braces { }

There is a set of **keys**; each key is followed by a colon : and then its **value**

Key/value pairs in the dictionary are separated by commas ,

$\text{dict} = \{ \text{key}_1:\text{value}_1, \text{key}_2:\text{value}_2, \dots, \text{key}_n:\text{value}_n \}$

An example

```
dogs = { "doug": ["beagle","bulldog"], "lizzie": "Australian cattle dog", "penny":  
spaniel, "bonnie":beagle, "remy":shepherd}
```

The **keys** in this dictionary are the strings that represent the names of the dogs: "doug", "lizzie", "penny", "bonnie" and "remy".

The **values** in this dictionary are strings that represent the breed of the dog. Doug is a beagle/bulldog mix, so his value - his breed - is a list of the strings "beagle" and "bulldog." Lizzie is an Australian cattle dog, so her value is that string. And so on.

Rules for keys and values

Keys must be *unique* and *immutable*.

- Keys can only appear once in a dictionary. In the dog example, it would be illegal to list key “doug” with two different values. {“doug”:”beagle”, “doug”:”bulldog”} is not permitted. That’s why we put the two values in a list
- Keys have to be ints, floats, booleans, or strings. Keys cannot be lists or other dictionaries

Values can be anything. There are no practical restrictions.

- Values can be mutable or immutable. Values can be lists, ints, floats, booleans, strings... Values can even be dictionaries. Yes, you can nest a dictionary inside another dictionary.
- Values can be repeated. I used to have two beagles, Baron and Cleo. So they would be entered in a dictionary like this:

```
old_dogs = {“Baron”:”beagle”, “Cleo”:”beagle”}
```

How do you create a dictionary?

Create an empty dictionary:

```
cats = { }
```

Create a dictionary with content (the dogs dictionary is one example of this)

```
governors = { "Maryland": "Hogan", "Virginia": "Northam", "Louisiana": "Edwards" }
```

Dictionaries are *unordered*

Ordered means that there is a specific relationship between the elements in a structure. Each element has a location relative to other elements in the structure

Lists are **ordered**. Each list element has an index. We can specify a value in a list by giving its index. `student[0]`, `student[1]`, `student[len(student)-1]`

Dictionaries are not ordered. There is no “first element” in a dictionary. No “first key”, no “first value.” You can’t reference an element in a dictionary by its location.

`dogs{0}` is undefined. You’ll get an error if you try to reference it.

So how do you access elements of a dictionary?

By key value only. Put the key in square brackets:

`dogs['doug']` gets you the list `['beagle','bulldog']`

`dogs['remy']` gets the string `'shepherd'`

What if that key's not present?

`dogs['pepper']`

The get method

Another way to access a dictionary element that's more resilient to errors

```
dogs.get('pepper')
```

If that key doesn't exist, the method will return `None` (that special value we talked about) instead of erroring out. So your program can continue rather than crashing.

You can make it return something other than `None`, if you want

```
dogs.get('pepper', 'Key not found')
```

```
dogs.get('pepper', -1)
```

Adding to a dictionary

To add a new key/value pair, just use an assignment statement: `dict[key] = value`

```
dogs['cinder'] = 'doberman'
```

Since the dictionary has no order, there's no 'append' or 'insert.' You can't control where in the dictionary this goes

Also: if that key already exists, this statement overwrites the value associated with that key

```
dogs['penny'] = 'cocker spaniel'
```

doesn't add a new element to the dictionary, it just changes the value of the existing key.

Removing an element from a dictionary

```
del dict[key]
```

In the dogs example:

```
del dogs['cinder']
```

Removes the entire key/value pair associated with 'cinder'

But again, if that key doesn't exist in the dictionary, you'll error out. Your program may crash.

```
del dogs['lady']
```

A more resilient way to delete - the pop method

```
dogs.pop('lady')
```

Still causes an error if 'lady' is not a key in the dictionary

But you can specify a default value to return if the key isn't there

```
dogs.pop('lady', None)
```

OR

```
dogs.pop('lady', -1) etc.
```


popitem()

There is a related method called “popitem()”. E.g., `dogs.popitem()`

As of Python 3.7 - the version we’re using - it removes the last item (most recent item) inserted into the dictionary.

In previous versions, it removed a ***random*** item from the dictionary.

What's the difference between a dictionary and a list?

1. A list establishes a binding between a value and its location in the list; a dictionary establishes a binding between a key and a value
2. A list is ordered; a dictionary is unordered

When would you use a dictionary?

Use a list if you have an ordered collection of items - a list of student IDs; a list of grades; etc.

Use a dictionary if you have a set of unique keys that each map to a value.

The dog example - we have a set of dog names ('keys') that each map to one or more breeds of dogs ('values'). It would be awkward to use lists to store dog names and breeds and maintain the relationship.

- You could do it, but it would be awkward

Another example: a recipe

Here's a recipe for chocolate chip cookies (courtesy AltonBrown.com)

Let's make a dictionary to hold this recipe. The keys will be the ingredients: butter, eggs, flour. The values will be the quantity I need of each ingredient

```
recipe = { 'butter':[2,'sticks'], 'flour':[1.5, 'cups'], 'salt':[1, 'teaspoon'],  
          'Soda':[1,'teaspoon'], 'Granulated sugar':[0.25, 'cup'], 'brown  
sugar':[1,'cup'], 'egg':2, 'milk':[2,'tablespoons'], 'vanilla':[1.5, 'teaspoon'],  
          'Chocolate chips':[12,'ounces']}
```

Or a simpler version:

```
recipe = {'butter':2, 'flour':1.5, 'salt':1, 'Soda':1, 'Granulated sugar':0.25, 'brown sugar':1,  
          'egg':2, 'milk':2, 'vanilla':1.5, 'Chocolate chips':12}
```

- 8 ounces unsalted butter
- 12 ounces bread flour
- 1 teaspoon kosher salt
- 1 teaspoon baking soda
- 2 ounces granulated sugar
- 8 ounces light brown sugar
- 1 large egg
- 1 large egg yolk
- 2 tablespoons whole milk
- 1 1/2 teaspoons vanilla extract
- 12 ounces semisweet chocolate chips

How do we use this dictionary in a program?

```
eggs = int(input("how many eggs do you have?"))
if eggs < recipe["egg"]:
    print("Add a dozen eggs to your grocery list")

chips = int(input("how many ounces of chocolate chips do you have?"))
if chips < recipe["Chocolate chips"]:
    print("Get a bag of chocolate chips at the store")
```

One more topic: Creating a dictionary from two lists

Python “zip” function and “dict” constructor method

tl;dr:

```
a = [1,2,3]
b = [4,5,6]
d = dict(zip(a,b))
print(d)
[1:4, 2:5, 3:6]
```

The longer story: “zip” is a function that takes multiple iterable values (lists) and interweaves them, one element at a time. One element from list a, then one from list b, then the next one from a, then from b... until the shortest list is done. The return value from zip() is an iterator that can be used to build other structures. The return value from zip() is not meaningful to the average human.

“dict” is a constructor method that operates on an iterator and returns a dictionary. It’s analogous to the “list” method that creates lists.

Here, “zip(a,b)” weaves together the values 1,4,2,5,3,6 and returns an iterator built from them. Then “dict(zip(a,b))” takes that iterator and turns it into the dictionary you see. The first item becomes a key; the second its associated value. The third item becomes the second key; the fourth is its associated value. And so on.