Scientific Programming with Python

Dictionaries and Sets

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Dictionaries

- *"Dictionary: 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"*
- *"a dictionary is a collection of words matched with their definitions"*
- Python has a built in dictionary type/data structure called dict which you can use to create dictionaries with arbitrary definitions

So Far

- Lists, Strings are sequential
- Dictionaries are mapped types
- The mapping is done from a key, immutable type, to a value, any Python data type

Dictionary Basics

- How to create an empty dictionary:

```
acronyms = {}
```

- To add key-value pairs:
-

```
acronyms['lol'] = "laughing out loud"
acronyms['tty'] = "talk to you later"
acronyms['bfn'] = "bye for now”
```

- Alternative way to create a dictionary:
- acronyms = {'bfn': 'bye for now', 'tty': 'talk to you later', 'lol': 'laughing out loud'}

Order is not important!

Dictionary: Basics

A collection of (key:value) pairs

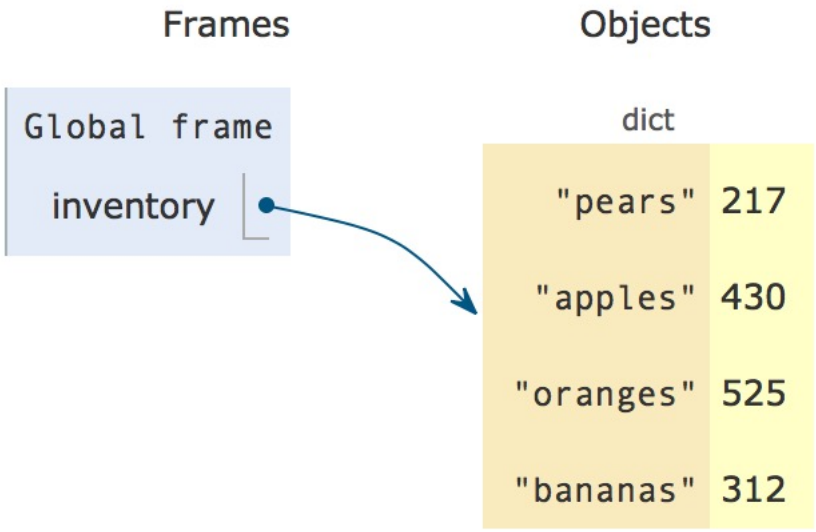
Example: Store the employee records indexed by SS#

```
>> Employees = {456965079: 'David Smith',
                823878356: 'Lisa Miller',
                813756744: 'Pat Murphy'  }
>>Employees[813756744]
```

'Pat Murphy'

Another Example

```
inventory = {'apples': 430, 'bananas': 312, 'oranges': 525, 'pears': 217}
inventory['bananas'] = inventory['bananas'] + 200
```



Properties of Dictionaries

- Not ordered
- Mutable
  - (key,value) pairs can be added
    ```
    dict[k] = newvalue
    ```
  - Value can be modified
    ```
    dict[k] = newvalue
    ```
  - Values can be deleted
    ```
    del dict[k]
    dict.pop(k)  also returns the value
    ```
  - The key itself is immutable

Dictionary Methods

Method	Parameters	Description
keys	none	Returns a view of the keys in the dictionary
values	none	Returns a view of the values in the dictionary
items	none	Returns a view of the key-value pairs in the dictionary
get	key	Returns the value associated with key; None otherwise
get	key,alt	Returns the value associated with key; alt otherwise

Using Dictionary Methods

```
inventory = {'apples': 430, 'bananas': 312, 'oranges': 525, 'pears': 217}
for akey in inventory.keys():
    print("Got key", akey, "which maps to value", inventory[akey])

ks = list(inventory.keys())
print(ks)
```

The method keys() will return an object view

Iterating over Dictionaries

- We can simply use the for loop:

- Employees = {
  '456965079': 'David Smith',
  '823878356': 'Lisa Miller',
  '813756744': 'Pat Murphy'}

```
for k in Employees:
    print("Got key", k)
```

Other uses

- We can use the operators in and not in to test if a key value exists in the dictionary:

```
if '456965079' in Employees:
    print(Employees['456965079'])
else:
    print("This SSN doesn't exist in our data base")
```

Aliasing and Copying

- Dictionaries are mutable objects so you should expect the same behavior we learned with lists.

- opposites = {'up': 'down', 'right': 'wrong', 'true': 'false'}
  alias = opposites

  print(alias is opposites)

  alias['right'] = 'left'
  print(opposites['right'])

Aliasing and Copying

- If you really want to create a copy of the dictionary use the dictionary copy method:

- ```
  opposites = {'up': 'down', 'right': 'wrong', 'true': 'false'}
  acopy = opposites.copy()

  print(acopy is opposites)

  acopy['right'] = 'left'
  print(opposites['right'])
  ```
  ```

Sparse Matrices

- Matrix: two dimensional collection, we can think of it as a list of lists.

```
matrix = [[0, 0, 0, 1, 0],
          [0, 0, 0, 0, 0],
          [0, 2, 0, 0, 0],
          [0, 0, 0, 0, 0],
          [0, 0, 0, 3, 0]]
```

$$\begin{bmatrix} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 \end{bmatrix}$$

Most of these entries are zeros!

Using a Dictionary to Represent Sparse Matrices

- matrix = {(0, 3): 1, (2, 1): 2, (4, 3): 3}
- To access an element in this matrix we use the [] operator:
- matrix[(0, 3)]

We use only one index, a tuple, to access elements

- Note that trying to access a zero element will cause errors. Instead we use the get method:
- matrix = {(0, 3): 1, (2, 1): 2, (4, 3): 3}
  print(matrix.get((1, 3), 0))

Sets

- The sets module provides classes for constructing and manipulating unordered collections of unique elements. Common uses include membership testing, removing duplicates from a sequence, and computing standard math operations on sets such as intersection, union, difference, and symmetric difference.
- Like other collections, sets support x in set, len(set), and for x in set. Being an unordered collection, sets do not record element position or order of insertion. Accordingly, sets do not support indexing, slicing, or other sequence-like behavior.

- Set syntax
- a= {1,4, 5}
- Empty set
- a=set()

Set Operations

Operation	Equivalent	Result
`len(s)`		number of elements in set *s* (cardinality)
`x in s`		test *x* for membership in *s*
`x not in s`		test *x* for non-membership in *s*
`s.issubset(t)`	`s <= t`	test whether every element in *s* is in *t*
`s.issuperset(t)`	`s >= t`	test whether every element in *t* is in *s*
`s.union(t)`	`s | t`	new set with elements from both *s* and *t*
`s.intersection(t)`	`s & t`	new set with elements common to *s* and *t*
`s.difference(t)`	`s - t`	new set with elements in *s* but not in *t*
`s.symmetric_difference(t)`	`s ^ t`	new set with elements in either *s* or *t* but not both
`s.copy()`		new set with a shallow copy of *s*

Examples

```
engineers = {'John', 'Jane', 'Jack', "Janice"}
programmers = {'Jack', 'Sam', 'Susan', 'Janice'}
managers =   {'Jane', 'Jack', 'Susan', 'Zack'}
#Compute union
employees = engineers | programmers | managers
#Compute intersection

engineering_management = engineers & managers
fulltime_management = managers - engineers - programmers
engineers.add('Marvin') # add element
print (engineers)
employees.issuperset(engineers) # superset test
False
employees.update(engineers) # update from another set
employees.issuperset(engineers)
True
```