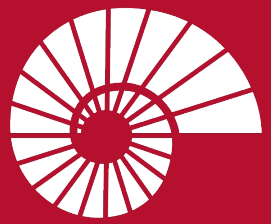

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10 – Dictionaries

COMP 125 Programming with Python

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How can we store and organize data?

- **Collection**: A data structure used to store multiple values in a single unit
  - In most other programming languages, the most basic collection is an array, which stores values of the same type

- So far, we have seen **lists** and **tuples** for general data storage
  - Their items are accessed by their indices, which are **integer values from 0 to len() – 1**

```
L = [11, 22, 33, 44]
T = (1, 2, 3)
L[0], T[2]
```

- Some data types can be easily organized into related pairs.
  - e.g. phone numbers: John Doe -> 5161718
  - We want to access the phone number of a person via their name
  - But we cannot use a name (string) as an index.

Dictionaries

- A collection (sometimes called container) data type that maps "**keys**" to their associated "**values**"
- Defined using curly brackets: {key1:value1, key2:value2, …}

```
ids = {'Cigdem': 1111, 'Gunduz': 2222, 'Demir': 3333}
print(ids['Cigdem'])
print(ids)
ids['Gunduz'] =  4444
print(ids)
```

```
1111
{'Cigdem': 1111, 'Gunduz': 2222, 'Demir': 3333}
{'Cigdem': 1111, 'Gunduz': 4444, 'Demir': 3333}
```

- The values in a dictionary can be objects of any type
- The keys must be **immutable** objects (e.g., they can be strings, integers, floating point values, and tuples but cannot be lists)

Dictionaries (more examples)

1. Storing the dimensions and properties of a furniture

```
table = {'width' : 2.5, 'height' : 5, 'length' : 2, 'color' : 'brown'}
print(table)
print(table['color'])
print(table['width'])
table['color'] = 'red'
print(table['color'])
```

```
{'width': 2.5, 'height': 5, 'length': 2, 'color': 'brown'}
brown
2.5
red
```

2. Labeling points in the 2D Cartesian coordinate system

```
markers = {(0, 0.5) : '*', (1.5, 1) : '+', (4, 5) : '*', (1, -3.5) : '*'}
print(markers)
print(markers[(1.5, 1)])
markers[(1.5, 1)] = 'red'
print(markers[(1.5, 1)])
```

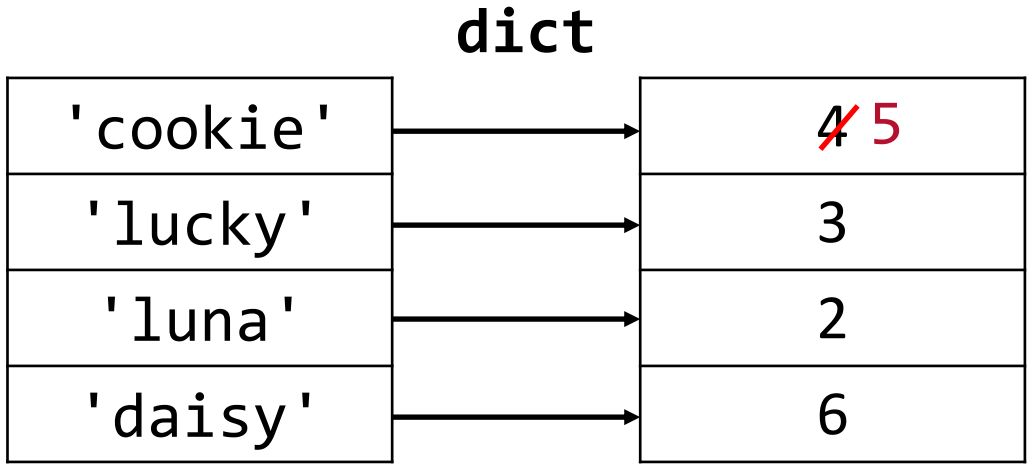
```
{(0, 0.5): '*', (1.5, 1): '+', (4, 5): '*', (1, -3.5): '*'}
+
red
```

Dictionaries

- Let's define a dictionary of pets and the number of times they are fed in a day

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
```

- Let's visualize



Can **"get"** (retrieve) the value

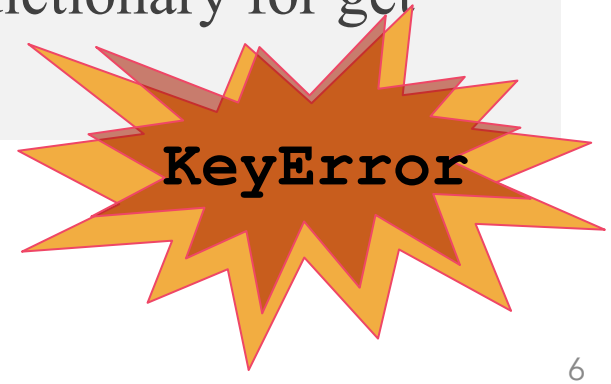
```
a = d['cookie']
a → 4
```

Can **"set"** the values

```
d['cookie'] = 5
```

Error if key not in the dictionary for get

```
b = d['bailey']
```



Dictionaries

- Can create a new key-value pair

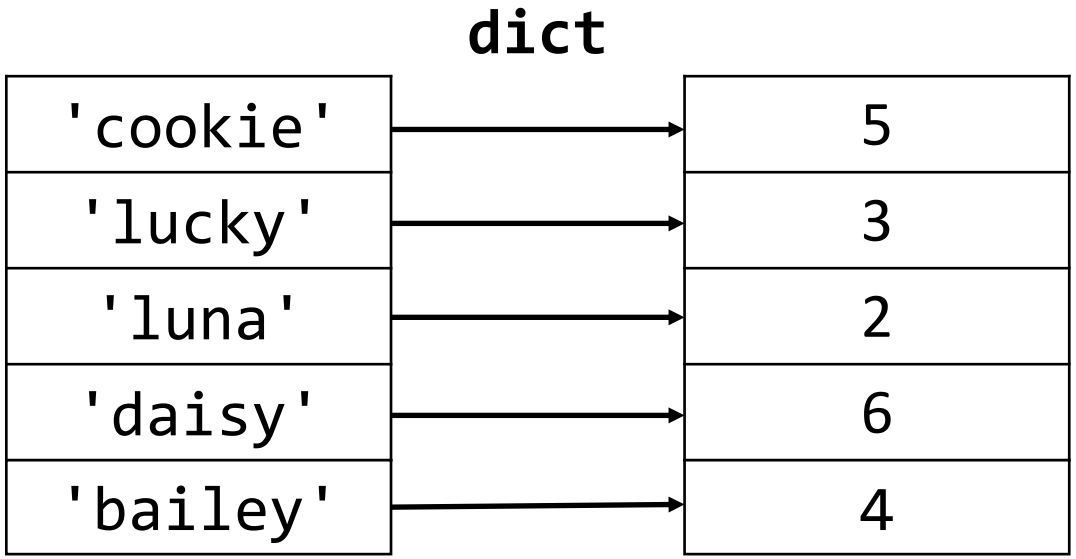
```
d['bailey'] = 4
```

- Can check if a key exists

```
'cookie' in d
→ True

'hunter' in d
→ False

'hunter' not in d
→ True
```



Some useful dictionary methods

- **`keys()`:** Returns an iterable data type that holds the **keys**
- **`values()`:** Returns an iterable data type that holds the **values**
- **`items()`:** Returns an iterable data type that holds the **key-value pairs** as tuples

```
table = {'width' : 2.5, 'height' : 5, 'length' : 2, 'color' : 'brown'}
print(table)
print(table.keys())
print(table.values())
print(table.items())
```

```
{'width': 2.5, 'height': 5, 'length': 2, 'color': 'brown'}
dict_keys(['width', 'height', 'length', 'color'])
dict_values([2.5, 5, 2, 'brown'])
dict_items([('width', 2.5), ('height', 5), ('length', 2), ('color', 'brown')])
```

Key selection

- We strongly recommend you to use unique keys (case sensitive) in a single dictionary to prevent unwanted side effects
- However, you may use the same keys in different dictionaries

```
table = {'color' : 'red', 'height' : 10}
chair = {'color' : 'green', 'COLOR' : 14}

print(table)
print(table.keys())
print(table.values())
print(table.items())

print(chair)
print(chair.keys())
print(chair.values())
print(chair.items())
```

```
{'color': 'red', 'height': 10}
dict_keys(['color', 'height'])
dict_values(['red', 10])
dict_items([('color', 'red'), ('height', 10)])

{'color': 'green', 'COLOR': 14}
dict_keys(['color', 'COLOR'])
dict_values(['green', 14])
dict_items([('color', 'green'), ('COLOR', 14)])
```

Dictionaries (more examples)

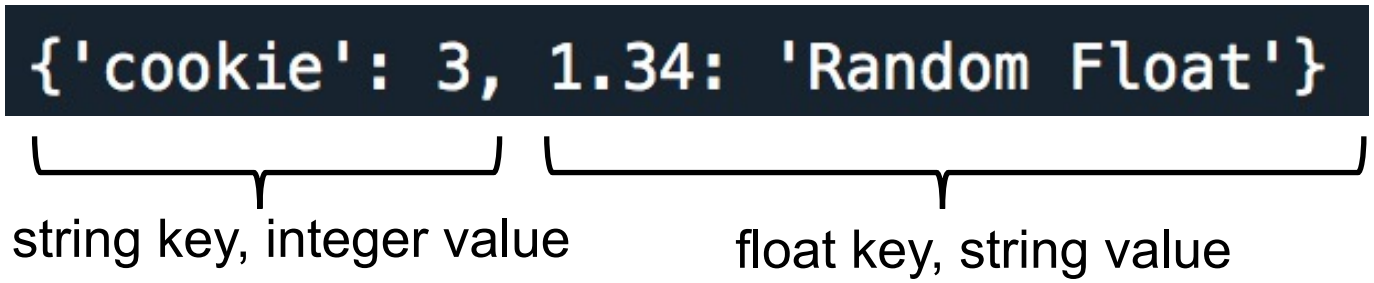
```
# Create an empty dictionary (both methods work)
d = {}
d = dict()

# Add the key-value pair
d['cookie'] = 1

# Update the key-value pair (note that get and set done at the same line)
d['cookie'] += 2

# Keys and values do not have to be of the same type
d[1.34] = 'Random Float'

print(d)
```



Iterating over keys

```
how_old = {'Koc': 28, 'Bogazici': 158, 'METU': 65}

# keys() method returns an iterable collection of all keys
# iterable means it can be used in a for loop
how_old.keys()
→ dict_keys(['Koc', 'Bogazici', 'METU'])

# You can ase use list() to convert d.keys() into a list
list(how_old.keys())
→ ['Koc', 'Bogazici', 'METU']
```

Iterating over keys

```
how_old = {'Koc': 28, 'Bogazici': 158, 'METU': 65}

for university in how_old.keys():
    print(university)
```

Output:

```
Koc
Bogazici
METU
```

Iterating over values

```
how_old = {'Koc': 28, 'Bogazici': 158, 'METU': 65}

for age in how_old.values():
    print(age)
```

Output:

```
28
158
65
```

Iterating over items

```
how_old = {'Koc': 28, 'Bogazici': 158, 'METU': 65}

for university, age in how_old.items():
    print(university, 'is', age, 'years old')
```

Output:

```
Koc is 28 years old
Bogazici is 158 years old
METU is 65 years old
```

Sorting keys, values, and items

```
how_old = {'Koc': 28, 'Bogazici': 158, 'METU': 65}

sorted(how_old.keys())
→ ['Bogazici', 'Koc', 'METU']

sorted(how_old.values())
→ [28, 65, 158]

sorted(how_old.items())
→ [('Bogazici', 157), ('Koc', 27), ('METU', 64)]
```

Built-in methods for dictionaries

- **`len()`:** Returns the number of key-value pairs inside the dictionary

- **`del statement`:** Removes a key-value pair

```
del dictionary[key]
```

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6.3}
print(len(d))
print(d)

del d['lucky']
print(len(d))
print(d)
```

```
4
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6.3}
3
{'cookie': 4, 'luna': 2, 'daisy': 6.3}
```

Built-in methods for dictionaries

- **`min()`** and **`max()`**: Find minimum and maximum keys/values/items, which must be comparable

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6.3}
print(max(d))
print(max(d.keys()))
print(max(d.values()))
print(max(d.items()))
```

```
luna
luna
6.3
('luna', 2)
```

Built-in methods for dictionaries

- **`min()`** and **`max()`**: Find minimum and maximum keys/values/items, which must be comparable

```
table = {'width' : 2.5, 'height' : 5, 'color' : 'brown'}
another = {'width' : 2.5, 34 : 'istanbul'}

print(max(table))
print(max(table.keys()))
print(max(table.items()))

# All of the following will give an error
# TypeError: '>' not supported between instances of 'str' and 'int'

print(max(table.values()))
print(max(another))
print(max(another.keys()))
print(max(another.items()))
```

```
width
width
('width', 2.5)
```

More built-in methods (summary)

Method	Description
`clear()`	Removes all the elements from the dictionary
`copy()`	Returns a copy of the dictionary
`get(key)`	Returns the value of the specified key
`items()`	Returns a list containing a tuple for each key value pair
`keys()`	Returns a list containing the dictionary's keys
`values()`	Returns a list of all the values in the dictionary
`pop(key)`	Removes the element with the specified key
`popitem()`	Removes the last inserted key-value pair
`dict.fromkeys(keys, value)`	Returns a dictionary with the specified keys and value
`update(pair_iterable)`	Updates the dictionary with the specified key-value pairs

get() and clear() methods

get()

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
v1 = d.get('cookie')
v2 = d.get('oscar')
v3 = d.get('cookie', -100)
v4 = d.get('oscar', 0)
print(v1)
print(v2)
print(v3)
print(v4)
```

Default value to return if the key is not found.

```
4
None
4
0
```

clear()

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
d.clear()
print(d)
```

```
{}
```

pop() method

pop()

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}

v1 = d.pop('lucky')
print('Removed value: ', v1)
print('After pop: ', d)

v2 = d.pop('luna', 0)
v3 = d.pop('bailey', 0)
print(v2)
print(v3)

v4 = d.pop('bailey')
```

```
Removed value:  3
After pop:  {'cookie': 4, 'luna': 2, 'daisy': 6}
2
0
```

```
    v4 = d.pop('bailey')

KeyError: 'bailey'
```

update() method

update()

```
d1 = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
d2 = {'bailey': 4, 'oscar':5, 'cookie': 99}
d1.update(d2)
print(d1)
```

```
{'cookie': 99, 'lucky': 3, 'luna': 2, 'daisy': 6, 'bailey': 4, 'oscar': 5}
```

fromkeys() method

fromkeys()

```
keys = ['a', 'e', 'i', 'o', 'u']
value1 = 1
vowels1 = dict.fromkeys(keys, value1)

value2 = 'next'
vowels2 = dict.fromkeys(keys, value2)

value3 = (1, 2)
vowels3 = dict.fromkeys(keys, value3)

print(vowels1)
print(vowels2)
print(vowels3)
```

```
{'a': 1, 'e': 1, 'i': 1, 'o': 1, 'u': 1}
{'a': 'next', 'e': 'next', 'i': 'next', 'o': 'next', 'u': 'next'}
{'a': (1, 2), 'e': (1, 2), 'i': (1, 2), 'o': (1, 2), 'u': (1, 2)}
```

Copying dictionaries

- The `copy()` function and the `=` operator are different

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
dcopy1 = d
print(dcopy1)
dcopy1['oscar'] = 5
print(d)
print(dcopy1)
```

```
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6, 'oscar': 5}
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6, 'oscar': 5}
```

```
d = {'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
dcopy2 = d.copy()
print(dcopy2)
dcopy2['oscar'] = 5
print(d)
print(dcopy2)
```

```
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6}
{'cookie': 4, 'lucky': 3, 'luna': 2, 'daisy': 6, 'oscar': 5}
```

Example

- Write a function that finds all unique words in a given text. This function should store each unique word and its count as an item in a dictionary.

For example, for the following text

‘In midterm one I lost two points from question one and one point from question two’

It will produce the following dictionary

```
{'In': 1,         'midterm': 1, 'one': 3,     'I': 1,
 'lost': 1,       'two': 2,     'points': 1,  'from': 2,
 'question': 2,   'and': 1,     'point': 1}
```

```
def unique_words(text):
    s = text.split()
    d = {}

    for word in s:
        # Check if the word is already in dictionary
        if word in d:
            # Increment count of word by 1
            d[word] += 1
        else:
            # Add the word to dictionary with count 1
            d[word] = 1
    return d

def main():
    text = '''In midterm one I lost two points from
           question one and one point from question two'''

    d = unique_words(text)
    print(d)

main()
```

Example

- Now, add another function that returns the most frequent word in a given text. You may assume that the given text is not empty.

```
def find_most_frequent(text):
    d = unique_words(text)
    max_count = 0
    for i in d.keys():
        if d[i] > max_count:
            max_count = d[i]
            most_frequent = i
    return most_frequent

def main():
    text = '''In midterm one I lost two points from
           question one and one point from question two'''

    most_frequent = find_most_frequent(text)
    print(most_frequent)

main()
```

Example

- How many movies did you watch last year?
- Collect the data from all students (or we can just generate some random data)
- Analyze it by calculating the frequencies
- Store in a dictionary {number of movies watched: frequency}
  - See solution: 10-movies.py

Dictionary Comprehension

- An efficient and compact way to create dictionaries

  Syntax:

  new_dict = {*key:value_expr* for *member* in *iterable (if condition)*}

```
squares = {n : n**2 for n in range(1,6)}
```

```
{1: 1, 2: 4, 3: 9, 4: 16, 5: 25}
```

- Dict comprehension with conditional

```
even_squares = {n : n**2 for n in range(1,6) if n % 2 == 0}
```

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

Dictionary Comprehension

Building a dictionary of month days:

```
mnames = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun',
          'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec']
mdays = [31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31]

months = {}
for name, days in zip(mnames, mdays):
    months[name] = days
```

Alternative way with comprehension:

```
mnames = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun',
          'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec']
mdays = [31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31]

months = {name:days for name, days in zip(mnames, mdays)}
```

months =

```
{'Jan': 31, 'Feb': 28, 'Mar': 31, 'Apr': 30, 'May': 31, 'Jun': 30, 'Jul':
31, 'Aug': 31, 'Sep': 30, 'Oct': 31, 'Nov': 30, 'Dec': 31}
```