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Python

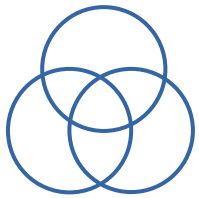
Sets

Thanks to all contributors:

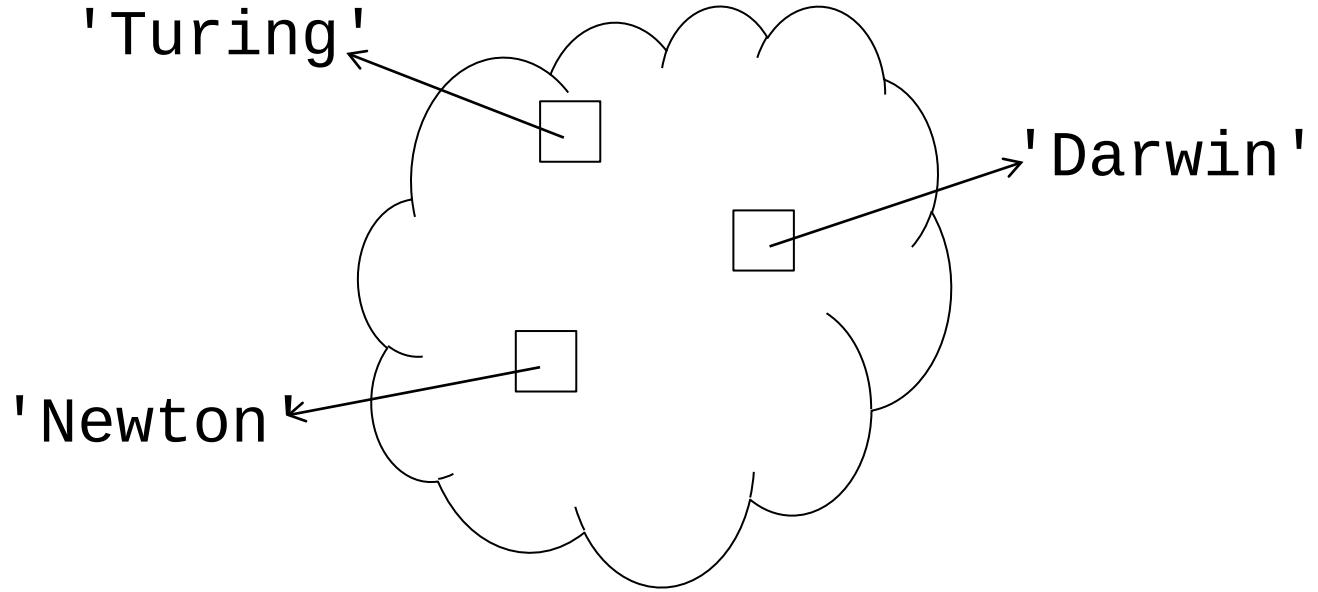
Ag Stephens, Alan Iwi and Tommy Godfrey.

Sets in Python

- A type of collection (as are lists and tuples).
- Main differences from a list:
  - Unordered collection:
    - not indexed by number
    - printing / looping over set gives elements in no particular order
- Collection of distinct items:
  - The same element can only appear once.
- Analogous to sets in mathematics.



Note: entries are *not* in any particular order



Why use sets? An example.

- Suppose we have meteorological data at various measurement sites.
- We want to ask questions such as:
  - which sites have both wind ***and*** temperature data?
  - which sites have either wind ***or*** temperature data?
- We can store information in sets, e.g.:
  - the set of sites that have wind data
  - the set of sites that have temperature data
- Answer these questions intuitively and efficiently using Python set operations like **intersection** or **union**.

How to construct sets in python

- Using `{...}` from specified items, e.g.: `{2, 3, 4}`
- Using `set(...)` from anything you can loop over, e.g.
  - `set([0, 1, 2, 3])`
  - `set('fred')` ← *loop over characters*
  - but not: ~~`set(0, 1, 2, 3)`~~ ← *needs 1 thing to loop over*
- For an empty set, use: `set()`
  - because `{}` means something else

Sets are mutable

```
>>> a = {10, 11, 12}

>>> a.add(13)

>>> a.remove(11)

>>> print(a)
set([10, 12, 13])
```

← NB not ordered

```
>>> a.clear()
```

← remove all items

Find unique items in a collection

```
letters = set()
for char in 'ichthyosaur':
    letters.add(char)
print(letters)
```

```
set(['a', 'c', 'i', 'h', 'o', 's', 'r', 'u', 't', 'y'])
```

Note 'h' only appears once, and no particular order

- or simply:

```
letters = set('ichthyosaur')
```

Set operations

- `len(a)` gives the number of elements

- Many operations on two sets exist
  - comparisons
  - combinations
  - many ***operators*** have equivalent ***methods***
  - see following slides

Set comparisons

- return `True` or `False`

```
a <= b    a.issubset(b)
a >= b    a.issuperset(b)
```

```
a < b     strict subset
a > b     strict superset
a == b    identical
```

Set combiners

- returning a new set

```
a = { 2, 3 }
b = { 3, 4 }

a | b     a.union(b)                    {2, 3, 4}
a & b     a.intersection(b)                {3}
a - b     a.difference(b)                  {2}
a ^ b     a.symmetric_difference(b)     {2, 4}
```

Set operators vs methods

- operators will **ONLY** work on two sets
- equivalent methods will work with anything you can loop over

```
set1 = { 2, 3 }
set2 = { 3, 4 }
print(set1 - set2)
{2}
tup = ( 3, 4 )
print(set1 - tup)
TypeError
print(set1.difference(tup))
{2}
```

Python

Dictionaries

What is a *dictionary?*

A collection of key/value pairs

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Since Python 3.7 – before were unordered

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A collection of key/value pairs

Keys are:

- Immutable

- Unique

- Stored in order of entry

No restrictions on values

What is a *dictionary?*

A collection of key/value pairs

Keys are:

- Immutable – they *cannot* be changed

- Unique

- Stored in order of entry

No restrictions on values

- Don't have to be immutable or unique

Create a dictionary by putting key:value pairs in {}

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```
>>> birthdays = {'Newton' : 1642, 'Darwin' : 1809}
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>>> birthdays = {'Newton' : 1642, 'Darwin' : 1809}
```

Retrieve values by putting key in []

Just like indexing strings and lists

```
>>> print(birthdays['Newton'])
1642
```

Create a dictionary by putting key:value pairs in {}

```
>>> birthdays = {'Newton' : 1642, 'Darwin' : 1809}
```

Retrieve values by putting key in []

Just like indexing strings and lists

```
>>> print(birthdays['Newton'])
1642
```

Just like using a phonebook or dictionary

Add another value by assigning to it

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```
>>> birthdays['Turing'] = 1612 # that's not right
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Overwrite value by assigning to it as well

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>>> birthdays['Turing'] = 1612 # that's not right
```

Overwrite value by assigning to it as well

```
>>> birthdays['Turing'] = 1912
>>> print(birthdays)
{'Turing' : 1912, 'Newton' : 1642, 'Darwin' : 1809}
```

Key must be in dictionary *before* use

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```
>>> birthdays['Nightingale']
KeyError: 'Nightingale'
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```

Test whether key is present using `in`

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>>> birthdays['Nightingale']
KeyError: 'Nightingale'
```

Test whether key is present using `in`

```
>>> 'Nightingale' in birthdays
False
>>> 'Darwin' in birthdays
True
```

Use `for` to loop over keys

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Unlike lists, where `for` loops over values

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Unlike lists, where `for` loops over values

```
>>> for name in birthdays:
...     print(name, birthdays[name])
```

```
Newton 1642
Darwin 1809
Turing 1912
```

Useful methods on dictionaries

`.keys()`, `.values()`, `.setdefault(<key>, <default>)`, `.items()`

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```
>>> person = {"name": "Sarah", "height": 2}
>>> person.keys()
dict_keys(['name', 'height'])
>>> person.values()
dict_values(['Sarah', 2])
```

Useful methods on dictionaries

`.keys()`, `.values()`, `.setdefault(<key>, <default>)`, `.items()`

```
>>> person = {"name": "Sarah", "height": 2}
>>> person.keys()
dict_keys(['name', 'height'])
>>> person.values()
dict_values(['Sarah', 2])

>>> person.setdefault('profession', 'Astrophysicist')
'Astrophysicist'
>>> person
{'name': 'Sarah', 'height': 2,
'profession': 'Astrophysicist'}
```

Useful methods on dictionaries:

`.items()` returns a sequence of tuples:

`(<key>, <value>), (<key>, <value>), …`

```
>>> heights = {"Everest": 8848, "K2": 8611}
>>> heights.items()
dict_items([('Everest', 8848), ('K2', 8611)])

>>> for (mountain, height) in heights.items():
        print(f"{mountain} is {height}m high")

Everest is 8848m high
K2 is 8611m high
```