

Python

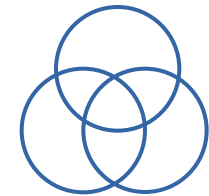
Sets

Thanks to all contributors:

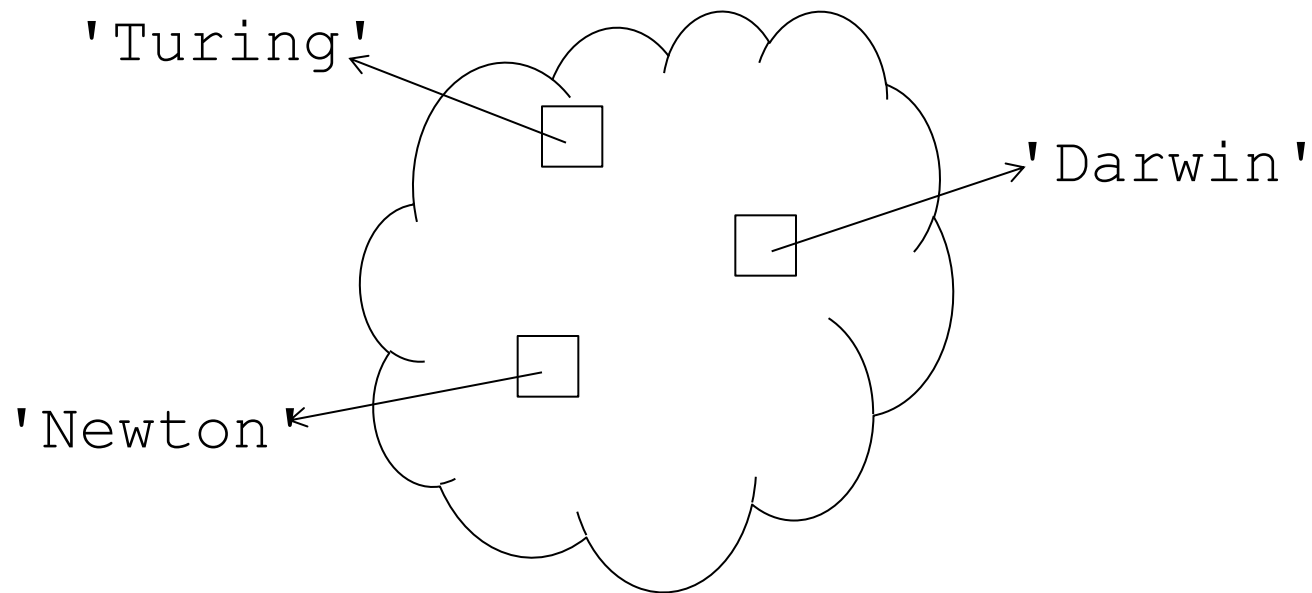
Ag Stephens, Alan Iwi and Tommy Godfrey.

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

$a \leq b$ `a.issubset(b)`

$a \geq b$ `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 }
```

<code>a b</code>	<code>a.union(b)</code>	<code>{2, 3, 4}</code>
<code>a & b</code>	<code>a.intersection(b)</code>	<code>{3}</code>
<code>a - b</code>	<code>a.difference(b)</code>	<code>{2}</code>
<code>a ^ b</code>	<code>a.symmetric_difference(b)</code>	<code>{2, 4}</code>

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}
```

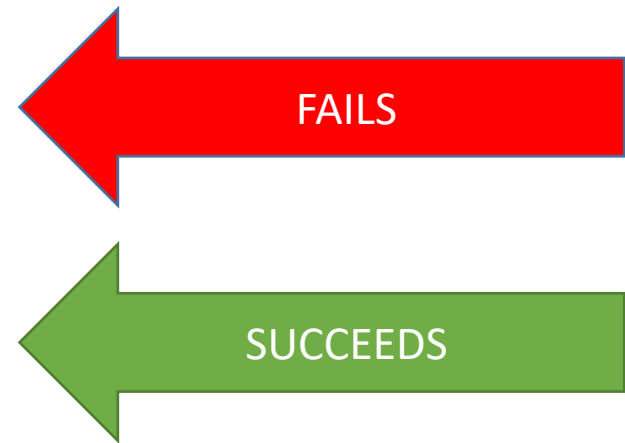
```
tup = ( 3, 4 )
```

```
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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Keys are:

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Keys are:

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- Unique

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Keys are:

- Immutable
- Unique
- Stored in order of entry

← Since Python 3.7
– before were
unordered

What is a *dictionary*?

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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Retrieve values by putting key in []

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Retrieve values by putting key in []

Just like indexing strings and lists

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
```


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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>>> birthdays['Nightingale']
```

```
KeyError: 'Nightingale'
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Test whether key is present using `in`

Key must be in dictionary *before* use

```
>>> 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

Use `for` to loop over keys

Unlike lists, where `for` loops over values

Use `for` to loop over keys

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

```
>>> 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("{} is {}m high".format(mountain, height))
```

```
Everest is 8848m high
```

```
K2 is 8611m high
```