Sets

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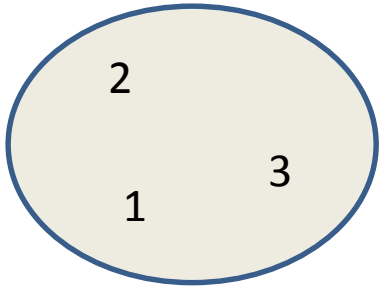
Sets

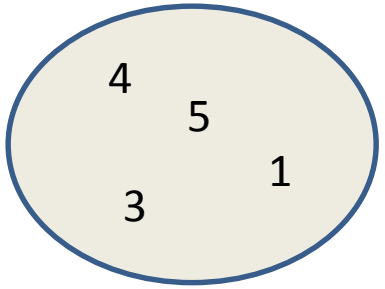
- Mathematical set: a collection of values, without duplicates or order
- Order does not matter

  { 1, 2, 3 } == { 3, 2, 1 }
- No duplicates

  { 3, 1, 4, 1, 5 } == { 5, 4, 3, 1 }
- For every data structure, ask:
  - How to create
  - How to query (look up) and perform other operations
    - (Can result in a new set, or in some other datatype)
  - How to modify

  Answer: http://docs.python.org/2/library/stdtypes.html#set





Two ways to create a set

1. Direct mathematical syntax:

```
odd = { 1, 3, 5 }
prime = { 2, 3, 5 }
```

Note: Cannot use "**{}**" to express empty set: it means something else ☹.

2. Construct from a **list:** (also from a tuple or string)

```
odd = set( [1, 3, 5] )
prime = set( [2, 3, 5] )
empty = set( [] ) # or set( )
```

Python always **prints** using this syntax above

Set operations

```
odd = { 1, 3, 5 }
prime = { 2, 3, 5 }
```

- membership ∈ Python: **`in`** **`4 in prime`** ⇒ False
- union ∪ Python: **`|`** **`odd | prime`** ⇒ { 1, 2, 3, 5 }
- intersection ∩ Python: **`&`** **`odd & prime`** ⇒ { 3, 5 }
- difference \ or - Python: **`-`** **`odd - prime`** ⇒ { 1 }

Think in terms of **set operations**,
not in terms of iteration and element operations
– Shorter, clearer, less error-prone, faster

Although we can do iteration over sets:

```
# iterates over items in arbitrary order
for item in myset:
    …
```

But we *cannot* index into a set to access a specific element.

Modifying a set

- **Add** one element to a set:

```
myset.add(newelt)
myset = myset | { newelt }
```

- **Remove** one element from a set:

```
myset.remove(elt)    # elt must be in myset or raises err
myset.discard(elt)   # never errs
myset = myset - { elt }
```

What would this do?

```
myset = myset - elt
```

- Remove and return an arbitrary element from a set:

```
myset.pop()
```

Note: **`add`**, **`remove`** and **`discard`** all return **`None`**

See in python tutor

Practice with sets

```
z = {5, 6, 7, 8}
y = {1, 2, 3, "foo", 1, 5}
k = z & y
j = z | y
m = y - z
n = z - y
p = z
q = set(z)
z.add(9)
```

List vs. set operations (1)

Find the common elements **in both** list1 and list2:

```
out1 = []
for i in list2:
    if i in list1:
        out1 .append(i)

# Aside: We will learn about list comprehensions later
out1 = [i for i in list2 if i in list1]
```

Find the common elements **in both** set1 and set2:

```
set1 & set2
```

Much shorter, clearer, easier to write with sets!

List vs. set operations(2)

Find elements in **either** list1 or list2 (**or both**) (without duplicates):

```
out2 = list(list1)                    # make a copy
for i in list2:
    if i not in list1:        # don't append elements already in out2
        out2.append(i)
```

Another way:

```
out2 = list1+list2
for i in out1:              # out1 = common elements in both lists
    out2.remove(i)        # Remove common elements
```

Find the elements in **either** set1 or set2 (**or both**):

```
set1 | set2
```

List vs. set operations(3)

Find the elements in **either** list **but not in both**:

```
out3 = []
for i in list1+list2:
    if i not in list1 or i not in list2:
        out3.append(i)
```

Find the elements in **either** set **but not in both**:

```
set1 ^ set2
```

Not every value may be placed in a set

- Set *elements* must be **immutable** values
  - int, float, bool, string, *tuple*
  - *not*: list, set, dictionary
- The set itself is **mutable** (e.g. we can add and remove elements)
- **Goal**: only set operations change the set
  - after "`myset.add(x)`", `x in myset` ⇒ True
  - `y in myset` always evaluates to the same value

  Both conditions should hold until `myset` is changed
- **Mutable elements can violate these goals**
- **Aside:** *frozenset* must contain immutable values and is itself immutable (cannot add and remove elements)