Sets

BBM 101 - Introduction to Programming I

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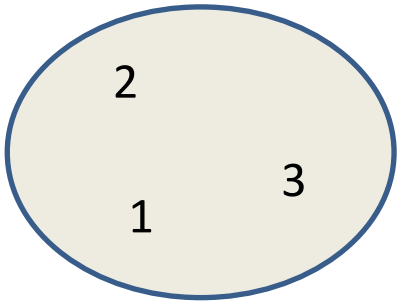
Slides based on material prepared by Ruth Anderson, Michael Ernst and Bill Howe in the course CSE 140 University of Washington

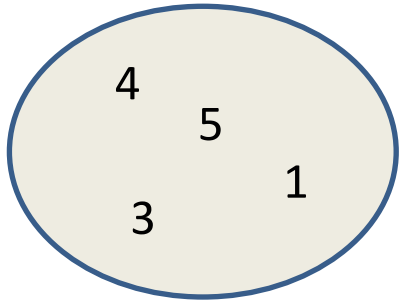
Sets

- 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

Creating a Set

- Construct from a **list:**

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

Python always **prints** using this syntax above

Set Operations

```
odd = set([ 1, 3, 5 ])
prime = set([ 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 | set([newelt])
```

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

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

What would this do?

```
myset = myset - set([newelt])
```

- Choose and remove some element from a set:

```
myset.pop()
```

Practice with Sets

```
z = set([5,6,7,8])
y = set([1,2,3,"foo",1,5])
k = z & y
j = z | y
m = y - z
z.add(9)
```

```
z: {8, 9, 5, 6, 7}
y: {1, 2, 3, 5, 'foo'}
k: {5}
j: {1, 2, 3, 5, 6, 7, 8, 'foo'}
m: {1, 2, 3, 'foo'}
```

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)
```

OR

```
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!

List vs. Set Operations (2)

Find the 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
       out2.append(i)           # already in out2
```

OR

```
out2 = list1+list2
for i in out1:                  # out1 (from previous example),
       out2.remove(i)           # common elements in both lists
                                # 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                    # symmetric difference
```

Not Every Value may be Placed in a Set - 1

- Set elements must be immutable values
  - int, float, bool, string, *tuple*
  - *not*: list, set, dictionary

- 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`** itself is changed

Not Every Value may be Placed in a Set - 2

- Mutable elements can violate these goals

```
list1 = ["a", "b"]
list2 = list1
list3 = ["a", "b"]
myset = { list1 }          ⇐ Hypothetical;
list1 in myset ⇒ True      actually illegal in Python
list3 in myset ⇒ True
list2.append("c")          ⇐ not modifying myset "directly"
list1 in myset ⇒ ???        modifying myset "indirectly" would
list3 in myset ⇒ ???        lead to different results
```