COMP 204: Sets, Commenting & Exceptions

Yue Li
based on material from Mathieu Blanchette, Carlos Oliver Gonzalez and Christopher Cameron

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Bugs

Sets: the unordered container for unique things

- Syntax: `myset = {1, 2, 3}` or `myset = set([1, 2, 3])` (careful, `myset = {}` is an empty dictionary)
- Sets never contain duplicates. Python checks this using the `==` operator.

```
>>> myset = set([1, 1, 2, 3])
set([1,2 , 3]) #only keep unique values
>>> myset.add(4)
set([1, 2, 3, 4])
>>> myset.add(1)
set([1, 2, 3, 4])
#get unique characters of string
>>> charset = set("AAACCGGGA")
{A, C, G}
```

- Sets can only contain immutable objects (like dictionary keys)
- Elements in sets do not preserve their order.

Useful set methods and operations

- Membership testing

```
>>> 4 in myset
False
```

- Set intersection (elements common to A and B, if A and B are sets)

```
>>> A = {"a", "b", "c"}
>>> B = {"a", "b", "d"}
>>> A & B # equivalent to: A.intersection(B)
set(["a", "b"])
```

- Click here for a full list of set functionality.

Useful set methods and operations

- Set difference (elements in A that are **not** in B)

```
>>> A - B
set(["c"]) #same as: A.difference(B)
```

- Set union (Elements found in A or B)

```
>>> A | B # equivalent to: A.union(B)
set(["a", "b", "c", "d"])
```

- These can be applied to multiple sets

```
>>> C = {"a", "c", "d", "e"}
>>> A & B & C # A.intersection(B, C)
set(["a"]) #elements common to A and all others
```

Practice problems

1. Write a program that counts the number of unique letters in a given string. E.g. `"bob"` should give `2`.
2. Write a program that checks whether a list of strings contains any duplicates. `['att', 'gga', 'att']` should return `True`

```python
# 1. long way
uniques = []
for c in "bob":
    if c not in uniques:
        uniques.append(c)
len(uniques)
#1. short way
len(set("bob"))
#2. long way
uniques = []
mylist = ['att', 'gga', 'att']
for item in mylist:
    if item not in uniques:
        uniques.append('att')
if len(uniques) != len(mylist):
    print("found duplicates")
#3. short way
if len(set(mylist)) != len(mylist):
    print("found duplicates")
```

Practice problem: putting it all together

- You're going to create your own dating app. Each user's profile is a dictionary with the following keys:
  - `'movies'` set of strings.
  - `'foods'` set of strings.
  - `'genes'` set of DNA strings.
  - `'gender'` 'M' or 'F'.
- The user database will also be a dictionary where each key is a person's name and the value is its profile dictionary.
- E.g. database['bob'] maps to

```
{
 'movies':{'legally blonde', 'mission impossible'},
 'foods': {'mexican', 'vegetarian'},
 'genes': {'AAC', 'AAT', "GGT", "GGA"},
 'gender':'M'
}
```

Your app will support 3 functions:

1. `add_user(name, profile, database)` creates a key for the user with its profile info and returns the updated database. (assume all names given are unique)
2. `compatibility_score(user_1, user_2, database)` Returns the compatibility score between two user profiles. Given as:
   - similarity(u1, u2) = # of movies in common + # of foods in common + genome diversity i.e. number of genes in u1 or u2 but not in both.
3. `most_compatible(user, database)` returns user with the highest compatibility score to `user`.

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Commenting: rules of thumb

- Comments should be informative but not overly detailed.
- Comments should be indented with the block they address

Which is better?

```python
#this line binds an empty list to the name 'students'
students = []
for s in students:
#loop over list and print
    print(s)
```

```python
#keep track of students in a list
students = []
#display student list
for s in students:
    print(s)
```

Commenting: Docstrings

- A triple quoted string directly under a function header is stored as function documentation.

```python
def my_max(lili):
    """ Input: an iterable
         return: max of list
    """
    return max(lili)
```

```
>>> help(my_max)
Help on function my_max in module __main__:

        my_max(lili)
                Input: an iterable
                return: max of list
```

Tips on coding style

- Be critical of your code. → is this the best it can be?
- Avoid hard-coding
  - `for i in range(len(mylist))` is better than
  - `for i in range(5)`
- Give objects meaningful names. Avoid names like `string, list, number, result, x, y`
- When lines get too long you are either doing something wrong or you should break the line
- Python coding culture: snake_case vs CamelCase (e.g., `my_var = 2; myVar=2`)

```
for mylistitem in [innerlistitem in
    originallist if innerlistitem / 2 + 4 > 9]:
    print("hi")
```

- A complete description of Python's coding style guidelines is here

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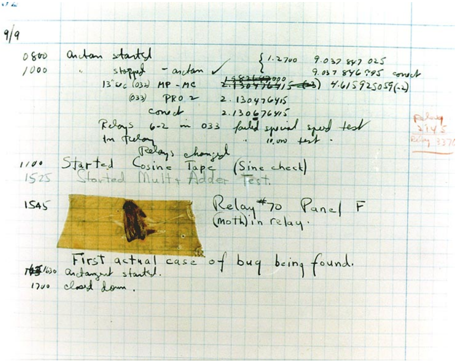
Bugs: when things break

- You will probably have noticed by now that things don't always go as expected when you try to run your code.
- We call this kind of occurrence a "bug".
- One of the first uses of the term was in 1946 when Grace Hopper's software wasn't working due to an actual moth being stuck in her computer.



9/9

0800 Arctan started

1000 " stopped - arctan ✓ {1.2700 9.037 847 025

9.037 846 995 conect

13" sec (032) MP - MC ~~1.982147000~~ ~~2.130476415 (-3)~~ 4.615925059(-2)

(033) PRO 2 2.130476415

conect 2.130676415

Relays 6-2 in 033 failed special speed test

in Relay " 10,000 test .

Relays changed

1100 Started Cosine Tape (Sine check)

1525 Started Mult+ Adder Test.

1545 Relay #70 Panel F

(moth) in relay.

First actual case of bug being found.

~~1545~~ 1630 Arctangent started.

1700 closed down.

Relay 2145

Relay 3370

[1]

[1] Wikipedia

Types of bugs

There are three major ways your code can go wrong.

1. Syntax errors
2. Exceptions (runtime)
3. Logical errors

Syntax Errors: “Furiously sleep ideas green colorless.”[2]

- When you get a syntax error it means you violated a writing rule and the interpreter doesn’t know how to run your code.
- Your program will crash without running any other commands and produce the message `SyntaxError` with the offending line and a ˆ pointing to the part in the line with the error.
- Game: spot the syntax errors!

```
print("hello)
x = 0
while True
    x = x + 1
mylist = ["bob" 2, False]
if x < 1:
print("x less than 1")
```

[2] Noam Chomsky (1955)

Exceptions: “Colorless green ideas sleep furiously”[3]

- If you follow all the syntax rules, the interpreter will try to execute your code.
- However, the interpreter may run into code it doesn't know how to handle so it raises an Exception
- The program has to deal with this Exception if it is not handled, execution aborts.
- Note: unlike with syntax errors, all the instructions before the interpreter reaches an exception **do** execute.
- Here is a list of all the built-in exceptions and some info on them.

[3] Noam Chomsky (1955)

Exceptions: ZeroDivisionError

- There are many types of exceptions, and eventually you will also be able to define your own exceptions.
- I'll show you some examples of common Exceptions.
- `ZeroDivisionError`

```
x = 6
y = x  / (x - 6) #syntax is OK, executing fails

File "test.py", line 2, in <module>
y = x / (x - 6)
ZeroDivisionError: integer division or modulo by zero
```

Exceptions: NameError

- Raised when the interpreter cannot find a name-binding you are requesting.
- Usually happens when you forget to bind a name, or you are trying to access a name outside your namespace.

```
def foo():
    x = "hello"
foo()
print(x)
Traceback (most recent call last):
  File "exceptions.py", line 4, in <module>
    print(x)
NameError: name 'x' is not defined
```

Exceptions: NameError

What's wrong with the following code?

```python
def foo(a,b):
    """
        Sum of 2 numbers

        Input:
            a, b: 2 numbers
        Returns:
            int sum of a,b
    """
    result = a + b
    print(result)
x=1
y=2
result = foo(x, y)/2
print(result)
```

Exceptions: IndexError

- Raised when the interpreter tries to access a list index that does not exist

```
mylist = ["bob", "alice", "nick"]
print(mylist[len(mylist)])

Traceback (most recent call last):
  File "exceptions.py", line 2, in <module>
    print(mylist[len(mylist)])
IndexError: list index out of range
```

Exceptions: TypeError

- Raised when the interpreter tries to do an operation on a non-compatible type.

```
>>> mylist = ["bob", "alice", "nick"]
>>> mylist + "mary"

Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: can only concatenate list (not "int") to list

# this is okay
>>> mylist * 2
["bob", "alice", "nick", "bob", "alice", "nick"]

# this is also okay
>>> "hi" * 2
'hihi'
```

Traceback

- When an exception is raised, you get a traceback message which tells you where the error was raised.

```
    def foo():
        return 5 / 0
    def fee():
        return foo()
    fee()

    Traceback (most recent call last):
  File "exception.py", line 5, in <module>
    fee()
  File "exception.py", line 4, in fee
    return foo()
  File "exception.py", line 2, in foo
    return 5 / 0
ZeroDivisionError: division by zero
```

Where do exceptions come from?

- Exceptions come from `raise` statements.
- Syntax: `raise [exception object]`
- You can choose to raise any exception object. Obviously a descriptive exception is preferred.
- You can even define your own exceptions but we leave this for a later lecture.

```python
def my_divide(a, b):
    if b == 0:
        raise ZeroDivisionError
    else:
        return a / b
def my_divide(a, b):
    if b == 0:
        raise TypeError # we can raise any exception we want
    else:
        return a / b
```

Handling Exceptions

- When an exception is raised, the exception is passed to the **calling block**.
- If the calling block does not handle the exception, the program terminates.

```
#unhandled exception
def list_divide(numerators, denominators):
    ratio = []
    for a, b in zip(numerators, denominators):
        ratio.append(my_divide(a, b))
    return ratio
list_divide([1, 2, 1, 0], [1, 1, 0, 2])
```

Life Hack 1

The `zip(*args)` function lets you iterate over lists simultaneously. Yields tuple at each iteration with $(a[i], b[i])$.

`try` and `except`

- Python executes the `try` block.
- If the code inside the `try` raises an exception, python executes the `except` block.

```python
#exception handled by caller
def list_divide(numerators, denominators):
    ratio = []
    for a, b in zip(numerators, denominators):
        try:
            ratio.append(my_divide(a, b))
        except ZeroDivisionError:
            print("division by zero, skipping")
            continue
    return ratio
list_divide([1, 2, 1, 0], [1, 1, 0, 2])
```