COMP 204: Sets, Commenting & Exceptions

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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:**
  ```python
  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.

  ```python
  >>> 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

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

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

```python
>>> 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.
# 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

```python
{
    '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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Bugs
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)
```

```bash
>>> 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`)

```python
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
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.

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.”

- 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 `^` pointing to the part in the line with the error.
- Game: spot the syntax errors!

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

---

²Noam 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.

³Noam Chomsky (1955)
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.

```
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.

```python
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?

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

```python
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.

```python
>>> 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'
```
When an exception is raised, you get a traceback message which tells you where the error was raised.

```python
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
                          # 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.

```python
#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 \((a[i], b[i])\).
Python executes the `try` block.

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

```python
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])
```