COMP 204: Sets, Commenting & Exceptions

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Reminder

- CSUS is holding a midterm review session on Monday, October 15th, from 6-9pm. The Facebook group is here: https://www.facebook.com/events/1721064144671158/
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.

```
>>> 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)

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

- Set union (Elements found in A or B)

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

- These can be applied to multiple sets

  ```python
  >>> 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 = 0
for c in "bob":
    if c not in bob:
        uniques += 1

# 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.
  - 'genome' set of DNA strings.

- 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'}
}
```
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`.
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)
```

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

▷ A complete description of Python’s coding style guidelines is here
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.

1Wikipedia
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!

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

```python
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: 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"]
```
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
    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])`. 
**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])
```
Try/except: a more realistic example

- Often exceptions are caused by external users giving the program data it is not expecting.

```python
# not handling exceptions
while True:
    # if user gives invalid input program crashes
    x = int(input("Give me a number: "))

# handling exceptions
while True:
    try:
        x = int(input("Give me a number: "))
        break
    except TypeError:
        print("Not a number! Try again.")
```
Try/except/else: when no exception occurs

- An else block after a try/catch executes only if the try does not cause an exception.

```python
while True:
    try:
        a = int(input("Give me a numerator: "))
        b = int(input("Give me a denominator: "))
    except:
        print("Not a number! Try again."")
    else:
        print(f"{a} divided by {b} is {my_divide(a, b)}")
    break
```
Why not just do this?

```python
while True:
    try:
        a = int(input("Give me a numerator: "))
        b = int(input("Give me a denominator: "))
        print(f"{a} divided by {b} is {my_divide(a, \b)}")
        break
    except:
        print("Not a number! Try again.")
```
And finally, the **finally** statement

- The **finally** block **always** executes after the **try**-**except**-**else** blocks.

- Useful when:
  1. The **except** or **else** block itself throws an exception.
  2. The **try** throws an unexpected exception.
  3. A control flow statement in the **except** skips the rest.

- Why is it useful? Often there are statements you need to perform before your program closes. If there is an exception you forgot to handle, the finally will still execute.
```python
while True:
    try:
        a = int(input("Give me a numerator: "))
        b = int(input("Give me a denominator: "))
    except:
        print("Not a number! Try again.")
        break
    else:
        result = my_divide(a, b)
    finally:
        print("hello from finally!")
        print("hello from the other siiiiiide")
```
Okay one last thing: **assert**

- The **assert** statement is a shortcut to raising exceptions.
- Sometimes you don’t want to execute the rest of your code unless some condition is true.

```python
def divide(a, b):
    assert b != 0
    return a / b
```

- If the **assert** evaluates to True then an **AssertionError** exception is raised.
- **Pro**: quick and easy to write
- **Con**: exception error may not be so informative.
- Used mostly for debugging and internal checks than for user friendliness.
Logical errors

- When according to Python your code is fine and runs without errors but it does not do what you intended.
- Example: spot the logical error

```python
#1
def my_max(mylist):
    for bla in mylist:
        my_max = 0
        if bla > my_max:
            my_max = bla
    return my_max
```

- There’s nothing to do to avoid logical errors other than testing your code thoroughly and having a good algorithm.
- Logical errors are often silent but deadly.