Object-oriented programming

CSC148, INTRODUCTION TO COMPUTER SCIENCE

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Key terms and phrases

class

instance (of a class)

instance attribute

method

initializer

dot notation

self

Accessing an instance attribute

```
def whatever(self, x):
   y = expression
         vs
   self.y = expression
```

Must use self to get at instance attributes!

Re-assigning self

```
def mutate(self, x):
   self = NewObject(x)
```

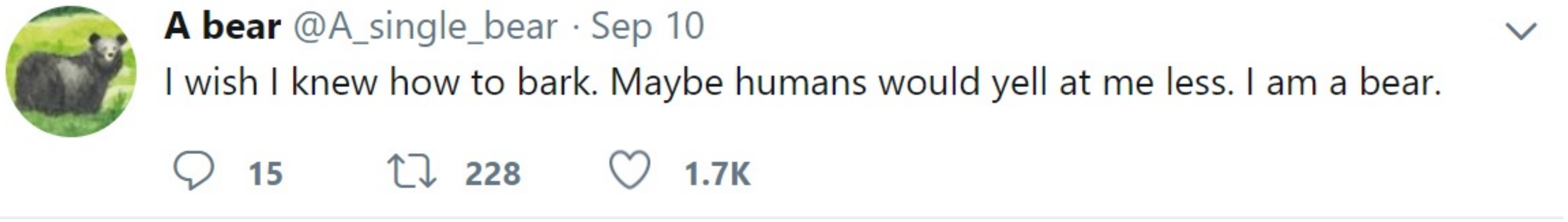
Re-assigning `self` doesn't mutate anything!

Composition of classes

HOW DO WE DESIGN CODE IN WHICH DIFFERENT CLASSES INTERACT WITH EACH OTHER?

Users are objects too

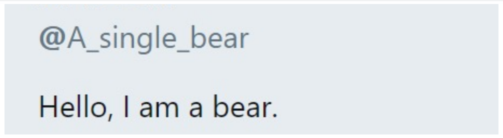
A Twitter user has an id, a biography, and tweets (among other things).



A bear @A_single_bear · Sep 10

I wish I knew how to bark. Maybe humans would yell at me less. I am a bear.

15 228 1.7K



@A_single_bear

Hello, I am a bear.

The start of a **User** class

```
class User:
    """A Twitter user.

    === Attributes ===
    userid: the userid of this Twitter user.
    bio: the bio of this Twitter user.
    tweets: a list of the tweets that this user has made.
    """
    userid: str
    bio: str
    tweets: List[Tweet]
```

User and Tweet

Composition

a relationship between two classes where instances of one class contain references to instances of the other

“has” relationship, e.g. “user has tweets”

Representation invariants

HOW DO WE DOCUMENT PROPERTIES THAT MUST BE TRUE FOR EVERY INSTANCE OF A GIVEN CLASS?

Tweets can have at most 280 characters

Every instance attribute has a *type annotation*, which restricts the kind of value this attribute can have.

But we often want to restrict attributes values even further; what do we call these restrictions, and how do we communicate them?

Representation invariant

A **representation invariant** is a property of the instance attributes that every instance of a class must satisfy.

Example

- (in words) This tweet’s content is at most 280 characters.
- (in code) `len(self.content) <= 280`

Today: two questions about RIs

1. Why should we care about representation invariants?

2. How do we enforce representation invariants?

Representation invariants as assumptions

A representation invariant is a property that every instance of a class must satisfy.

When given an instance of that class, we can *assume that every representation invariant is satisfied*.

Representation invariants as assumptions

```
class Tweet:
    def like(self, n: int) -> None:
        self.likes += n
```

`self` is an instance of `Tweet`, so we assume that all RIs are satisfied when this method is called.

The representation invariants of Tweet are ***preconditions for every Tweet method*.**

Representation invariants as responsibilities

A representation invariant is a property that every instance of a class must satisfy.

When a method returns, we must *ensure that every representation invariant is satisfied*.

Representation invariants as responsibilities

```
class Tweet:
 def like(self, n: int) -> None:
     """Record the fact that this tweet
     received <n> likes."""
```

The method must ensure that, at the end, `self.likes >= 0`.

The representation invariants of Tweet are ***postconditions for every Tweet method***.

Strategy 1: Preconditions

Require client code to call methods with “good” inputs.

Make no promises if it doesn’t.

Therefore, don’t need to check that preconditions are met.

Strategy 2: Ignore “bad” inputs

Accept a wide range of inputs, and if an input would cause a representation invariant to be violated, do nothing instead.

Also known as *failing silently*.

Strategy 3: Fix “bad” inputs

Accept a wide range of inputs, and if an input would cause a representation invariant to be violated, change it to a “reasonable” or default value before continuing with the rest of the function.

Discuss the pros and cons of each

Strategy 1: use preconditions

Strategy 2: ignore bad inputs

Strategy 3: fix bad inputs

Why we write down the RIs

The assumption part is handy, but is only legitimate if the responsibility part is fulfilled.

Writing down the Representation Invariants helps ensure:

- You remember these responsibilities
- Others on your team remember these responsibilities
- Now and a year from now when you/they are revising the code!

The Zen of Python

“Explicit is better than implicit.”

Privacy

Instance attributes and methods can be marked as **private** by spelling their name with a leading underscore, e.g. `_content`.

Marking an attribute/method as private signals that client code should not access it.

Privacy is about communication

A private attribute/method could be…

- very complicated
- subject to several representation invariants
- changed (in name, type, or meaning) at any time

Interface vs. Implementation