CSC148 winter 2016

special methods, property, composition, inheritance
week 2

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special methods, managed attributes

types within types... composition!

generalize classes with inheritance
rational fractions

\[ \text{rational: } \frac{n}{d}, \text{ where } n, d \text{ are integers and } d \neq 0 \]

Similarly to last week, we want to design an implement a class for rational numbers. We follow a design recipe for classes, which will be reinforced in this week’s lab.

Very thorough example for building a class
design class Rational

Although python has a built-in type for floating-point numbers, there is no built-in type for representing rational numbers:

*Rational* numbers are ratios of two integers \( p/q \), where \( p \) is called the numerator and \( q \) is called the denominator. The denominator \( q \) is non-zero. Operations on rationals include *addition*, *multiplication*, and comparisons:

\[ >, <, \geq, \leq, = \]

\[
\begin{align*}
\text{special} & \quad \text{Rational} \\
\text{num, denom} & \quad \text{__add__, __mul__}
\end{align*}
\]

...so we’ll have to create our own Rational class.
build class Rational

Define a class API:

1. choose a class name and write a brief description in the class docstring.
   
   Rational
   """A rational number"

2. write some examples of client code that uses your class
   
   \[ v = \text{Rational}(3, 4) \]

3. decide what services your class should provide as public methods, for each method declare an API (examples, header, type contract, description)
   
   ```python
   @type self: Rational
   @type other: Rational
   @rtype: Rational
   ```

   ```python
   --add-- (self, other)
   ```

4. decide which attributes your class should provide without calling a method, list them in the class docstring
continue building class Rational

Implement the class:

1. body of special methods `__init__`, `__eq__`, and `__str__`

   -- `add--`, etc.

2. body of other methods\(^1\)

---

\(^1\) use the CSC108 function design recipe
special, aka magic, methods

Python recognizes the names of special methods such as `_init_`, `_eq_`, `_add_`, and `_mul_` and has short-cuts (aliases) for them. This syntactic sugar doesn’t change the semantics (meaning) of these methods, but may allow more manageable code.

For example, suppose you create a list of Rational, and then want to sort it, or check to see whether an equivalent element is in it...

```
[\text{r1}, \text{r2}, \text{r3}, \text{r4}, \text{r5}].\text{sort()}\n```

needs <
managing attributes num and denom

Suppose that client code written by billions of developers uses Rational, but some of them complain that that class doesn’t protect them from silly mistakes like supplying non-integers for the numerator or denominator, or even zero for the denominator...

```
Rl. denom = 0
Rl. num = "fire"
```

After you have already shipped class Rational, you can write methods _get_num, _set_num, _get_denom, and _set_denom, and then use property to have Python use these functions whenever it sees num or denom

look at rational with properties. py
shapes with extras

I decide to devise the following class

*Squares have four vertices (corners) have a perimeter, an area, can move themselves by adding an offset point to each corner, and can draw themselves.*
use composition

Squares need drawing capabilities, so make sure each Square has a Turtle. Furthermore, the vertices of Squares are Points, and if we include those we’ll get the ability to add an offset point and calculate distance... All without writing code to duplicate the capabilities of Turtle or Point.

Here’s an implementation of Square
more Square-like classes

What if we decided to devise a RightAngleTriangle class with similar characteristics to Square? There is an implementation of RightAngleTriangle, but it has a problem:

There’s a lot of duplicate code. What do you suggest?
we could try:

1. cut-paste-modify Square → RightAngleTriangle?

2. include a Square in the new class to get at its attributes and services??

we really need a general Shape with the features that are common to both Square and RightAngleTriangle, and perhaps other shapes that come along
abstract class Shape

most of the features of Square are identical to RightAngleTriangle. Indeed I (blush) cut-and-pasted a lot...

the differences are the class names (Square, RightAngleTriangle) and the code to calculate the area.

put the common features into Shape, with unimplemented _set_area as a place-holder...

declare Square and RightAngleTriangle as subclasses of Shape, inheriting the identical features by declaring:

class Square(Shape): ...
inherit, override, or extend?

Subclasses use three approaches to recycling the code from their superclass, using the same name:

1. Methods and attributes that are used as-is from the superclass are **inherited** — examples?
2. Methods and attributes that replace what’s in the superclass are **overridden** — example?
3. Methods and attributes that add to what is in the superclass are **extended** — example?
write general code

client code written to use Shape will now work with subclasses of Shape — even those written in the future.

The client code can rely on these subclasses having methods such as move_by and draw.

Here is some client code that takes a list objects from subclasses of Shape, moves each object around, and then draws it.