OO: Creating Classes
Fraction.py Example

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CMPT140
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OO Review: user-defined types

- A class is a user-defined container type
  - Attributes and methods
- Let's define a Fraction type
  - A fraction has an integer numerator and integer denominator
  - Attributes?

    numer, denom
  - Methods?

    add, sub, mul, etc.
- See oofraction.py in our example directory

Creating a bare Fraction class

class Fraction:

- Constructor, with two parameters n and d:
  - Hide the instance attributes numer, denom:

```
def __init__(self, n, d):
    self.__numer = n
    self.__denom = d
```

  - Any potential problems/constraints?
  - Default values for n and d?
- String representation, for print():

```
def __str__(self):
    return "%d / %d" % (self.__numer, self.__denom)
```

Using the Fraction class

- This is enough for us to create a Fraction object
  - a.k.a. “create a Fraction instance”
  - a.k.a. “instantiate the Fraction class”

```
from oofraction import Fraction
f1 = Fraction(2, 3)
print(f1)           # “2 / 3”
```

- We can't do much with our Fraction object yet, so the next step is to implement some methods
- Multiple methods may want to check the constraint of denom ≠ 0: make a helper method

Helper func.: check constraints

- Constraint: denom should never be 0
- Don't want this method to be publicly accessible, so start name with '__' (double-underscore): hidden from view in Python
  - (In C++/Java, declare it 'private')

```
def __check(self):
```

- How to flag error? Use exceptions!

```
if denom == 0:
    raise ZeroDivisionError
```

  - Up to whoever is using this Fraction to handle the error

Set/get (mutator/accessor)

- We have hidden the attributes __numer and __denom from direct access by other programs
- We can permit read or write access to those attributes, but only through our methods:
  - Get method (accessor): def getN():
  - Set method (mutator): def setN():
- This way we can do safety checking, e.g., check if denom is being set to 0
- Other potential uses: security/permissions, who is modifying this attribute, logging, etc.

Python customizations

- Now we can define the methods add, mul, etc.!
- Certain method names are special in Python:
  - __init__: Called by the constructor when we setup a new instance
  - __str__: Called by print
  - __mul__: Overloads the (*) operator
  - __add__: Overloads the (+) operator
  - __truediv__: Overloads the (/) operator (// is 'floordiv')
  - __le__: Overloads the (<) operator
  - etc. (pretty much any operator can be overloaded!)
    - **See Python ref §3.3**

e.g.: Multiplication method

- Multiplication (*) operator takes two operands:
  - self (the current Fraction object) and other (the other Fraction being multiplied):

```
def __mul__(self, other):
```

  - e.g., if f2 and f2 are Fractions, then doing f1 * f2 is equivalent to f1.__mul__(f2)
  - self refers to f1, other refers to f2
- Create a new Fraction object as the product:

```
p = Fraction( self.getN() * other.getN(),
              self.getD() * other.getD() )
```

- Then reduce the fraction and return the product

Using customizations

- Now that we've written our multiplication method with the special name __mul__(), we can do:
  - f1 = Fraction(2, 3)
  - f2 = Fraction(1, 2)
  - print(f1) # 2 / 3
  - print(f2) # 1 / 2
  - print(f1 * f2) # 2 / 6
- The other operators /, +, -, and even < can be defined similarly: operator overloading (extending definition of '*' to Fraction type)

Making a testbed

- Include a testbed in our module that shows off all the features of our new class Fraction:

```
def runtests():
```

- Make a list of all the test cases, as strings:

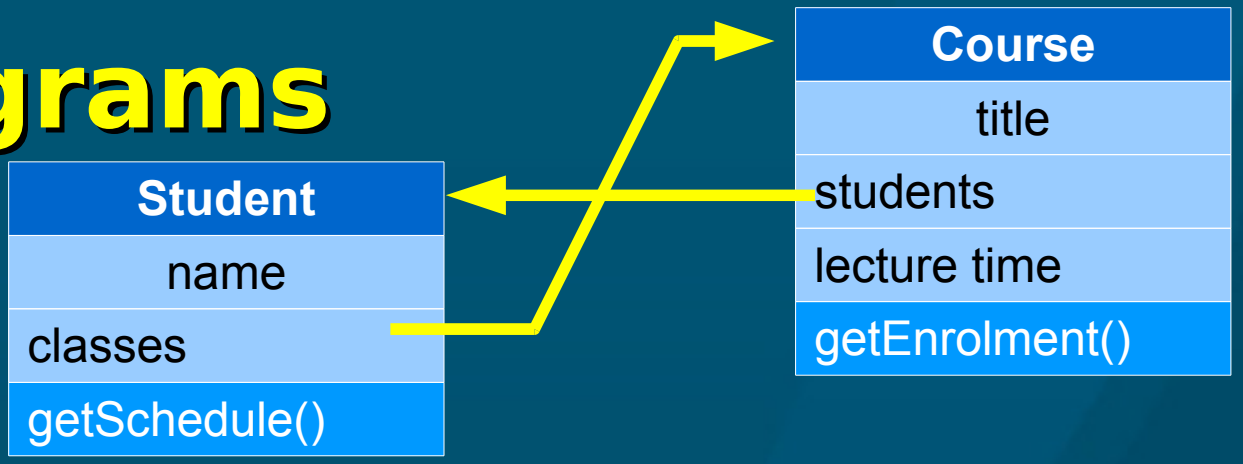
```
tests = [ “Fraction(2,3) + Fraction(1,3)”, …
```

- Print each test and use eval() to execute it:

```
for test in tests:
    print( test, '=', eval(test) )
```

- May also specify expected result for each test:
  - Automated unit testing to check for errors

OO class diagrams



- An OO program is a collection of classes
  - Create objects: instances of the classes
  - Objects pass messages to each other
- A class diagram shows the classes and their relationships to each other:
  - Name of class
  - Attributes (public and private)
  - Methods (public and private)