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PeerWise supports students in the creation, sharing, evaluation and discussion of assessment questions

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## What is PeerWise?

Students use PeerWise to create and to explain their understanding of course related assessment questions, and to answer and discuss questions created by their peers.



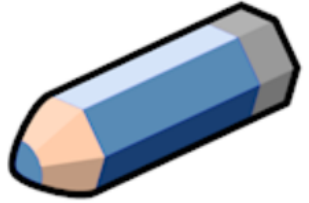
## Any subject

PeerWise is used in a wide range of subjects, including Anthropology, Chemistry, Computer Science, Population Health, Pharmacy, Medicine, and many more...

### Registration

Welcome to PeerWise! Registration is very simple, and consists of the following 4 steps:

- Step 1:** choose a name
- Step 2:** choose a password
- Step 3:** enter the "Course ID" for the course you would like to join **← 18596**
- Step 4:** enter your "Identifier" to join the course **← your AU ID**



**4**

participation.

section.

### Answered question

... ✓ Your answer agrees with the answer

This question has been answered by

What does the following code print

```
numbers = [1, 2, 3]
print(numbers[1])
```

### Alternatives

OPTION	ALTERNATIVE
A	[1, 2, 3]
B	1
<b>C</b>	2

You can add your own personal alternative and clicking the "Add tag" button

Tag:

Add tag

Remove all tags

### Explanation

The following explanation has been provided relating to this question:


Lists are indexed from zero, so [1] gives us the second element instead of the first

### Topics

The following topics have been indicated as being relevant to this question:

indexing

### Comments

There are not yet any comments for this question. 

Write a new comment



- Students (lecturers, TAs, ...) can post multiple-choice questions together with answer options and explanations
- Students (and others) can
  - try to answer questions
  - add comments to questions
  - grade the quality and difficulty of questions
- Questions can be sorted by e.g. rating, difficulty, #answers, ...
- Activity on PeerWise releases badges



# Course overview

Basic programming  
Advanced / specific python  
Libraries & applications

1. Introduction to Python	10. Functions as objects	19. Linear programming
2. Python basics / if	11. Object oriented programming	20. Generators, iterators, with
3. Basic operations	12. Class hierarchies	21. Modules and packages
4. Lists / while / for	13. Exceptions and files	22. Working with text
5. Tuples / comprehensions	14. Doc, testing, debugging	23. Relational data
6. Dictionaries and sets	15. Decorators	24. Clustering
7. Functions	16. Dynamic programming	25. Graphical user interfaces (GUI)
8. Recursion	17. Visualization and optimization	26. Java vs Python
9. Recursion and Iteration	18. Multi-dimensional data	27. Final lecture

10 handins

1 final project (last 1 month)

# Decorators

- @

# Python decorators are just syntactic sugar

Python

```
@dec2
@dec1
def func(arg1, arg2, ...):
    pass
```

≡

Python

```
def func(arg1, arg2, ...):
    pass

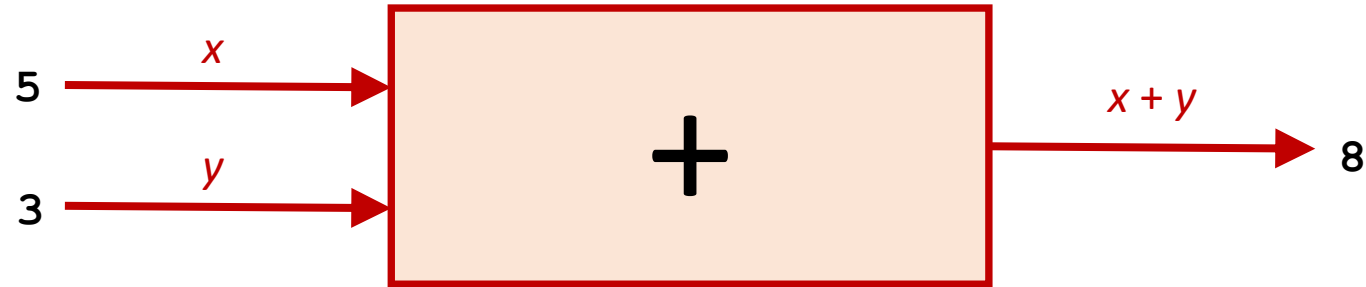
func = dec2(dec1(func))
```

'pie-decorator' syntax

dec1, dec2, ... are functions (decorators) taking a *function as an argument* and *returning a new function*

Note: decorators are listed bottom up in order of execution

# Recap functions



# Contrived example : Plus one (I-II)

plus\_one1.py

```
def plus_one(x):  
    return x + 1  
  
def square(x):  
    return x ** 2  
  
def cube(x):  
    return x ** 3  
  
print(plus_one(square(5)))  
print(plus_one(cube(5)))
```

Python shell

```
| 26  
| 126
```

Assume we *always* need to call `plus_one` on the result of `square` and `cube` (don't ask why!)

plus\_one2.py

```
def plus_one(x):  
    return x + 1  
  
def square(x):  
    return plus_one(x ** 2)  
  
def cube(x):  
    return plus_one(x ** 3)  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 26  
| 126
```

We could call `plus_one` inside functions (but could be more `return` statements in functions)



# Contrived example : Plus one (III-IV)

plus\_one3.py

```
def plus_one(x):  
    return x + 1  
  
def square(x):  
    return x ** 2  
  
def cube(x):  
    return x ** 3  
  
square_original = square  
cube_original = cube  
  
square = lambda x: plus_one(square_original(x))  
cube = lambda x: plus_one(cube_original(x))  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 26  
| 126
```

Overwrite square and cube with decorated versions

plus\_one4.py

```
def plus_one(x):  
    return x + 1  
  
def plus_one_decorator(f):  
    return lambda x: plus_one(f(x))  
  
def square(x):  
    return x ** 2  
  
def cube(x):  
    return x ** 3  
  
square = plus_one_decorator(square)  
cube = plus_one_decorator(cube)  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 26  
| 126
```

Create a decorator function plus\_one\_decorator

# Contrived example : Plus one (V-VI)

plus\_one5.py

```
def plus_one(x):  
    return x + 1  
  
def plus_one_decorator(f):  
    return lambda x: plus_one(f(x))  
  
@plus_one_decorator  
def square(x):  
    return x ** 2  
  
@plus_one_decorator  
def cube(x):  
    return x ** 3  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 26  
| 126
```

Use Python **decorator syntax**

plus\_one6.py

```
def plus_one_decorator(f):  
    def plus_one(x):  
        return f(x) + 1  
    return plus_one  
  
@plus_one_decorator  
def square(x):  
    return x ** 2  
  
@plus_one_decorator  
def cube(x):  
    return x ** 3  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 26  
| 126
```

Create **local function** instead of using `lambda`

# Contrived example : Plus one (VII)

plus\_one7.py

```
def plus_one_decorator(f):  
    def plus_one(x):  
        return f(x) + 1  
    return plus_one  
  
@plus_one_decorator  
@plus_one_decorator  
def square(x):  
    return x ** 2  
  
@plus_one_decorator  
@plus_one_decorator  
@plus_one_decorator  
def cube(x):  
    return x ** 3  
  
print(square(5))  
print(cube(5))
```

Python shell

```
| 27  
| 128
```

- A function can have an arbitrary number of decorators (also the same repeated)

# Handling arguments

run\_twice1.py

```
def run_twice(f):  
    def wrapper():  
        f()  
        f()  
    return wrapper  
  
@run_twice  
def hello_world():  
    print("Hello world")  
  
hello_world()
```

Python shell

```
| Hello world  
| Hello world
```

“wrapper” is a common name for the function returned by a decorator

run\_twice2.py

```
def run_twice(f):  
    def wrapper(*args):  
        f(*args)  
        f(*args)  
    return wrapper  
  
@run_twice  
def hello_world():  
    print("Hello world")  
  
@run_twice  
def hello(txt):  
    print("Hello", txt)  
  
hello_world()  
hello("Mars")
```

Python shell

```
| Hello world  
| Hello world  
| Hello Mars  
| Hello Mars
```

**args** holds the arguments in a tuple given to the function to be decorated

# Question – What does the decorated program print ?

`decorator_quizz.py`

```
def double(f):  
    def wrapper(*args):  
        return 2 * f(*args)  
    return wrapper
```

```
def add_three(f):  
    def wrapper(*args):  
        return 3 + f(*args)  
    return wrapper
```

```
@double
```

```
@add_three
```

```
def seven():  
    return 7
```

```
print(seven())
```

■ 7

■ 10

■ 14

■ 17



■ 20

■ Don't know

# Example: Enforcing argument types

- Defining decorators can be (slightly) complicated
- Using decorators is easy

```
integer_sum1.py
```

```
def integer_sum(*args):  
    assert all([isinstance(x, int) for x in args]),\  
           "all arguments must be int"  
    return sum(args)
```

```
Python shell
```

```
> integer_sum(1, 2, 3, 4)  
| 10  
> integer_sum(1, 2, 3.2, 4)  
| AssertionError: all arguments must be int
```

```
integer_sum2.py
```

```
def enforce_integer(f): # decorator function  
    def wrapper(*args):  
        assert all([isinstance(x, int) for x in args]),\  
               "all arguments must be int"  
        return f(*args)  
    return wrapper  
  
@enforce_integer  
def integer_sum(*args):  
    return sum(args)
```

```
Python shell
```

```
> integer_sum(1, 2, 3, 4)  
| 10  
> integer_sum(1, 2, 3.2, 4)  
| AssertionError: all arguments must be int
```

# Decorators can take arguments

Python

```
@dec(argA, argB, ...)  
def func(arg1, arg2, ...):  
    pass
```

≡

Python

```
def func(arg1, arg2, ...):  
    pass  
func = dec(argA, argB, ...)(func)
```

*dec* is a function (decorator) that takes a *list of arguments* and *returns a function* (to decorate `func`) that takes a *function as an argument* and *returns a new function*

# Example: Generic type enforcing

print\_repeated.py

```
def enforce_types(*decorator_args):
    def decorator(f):
        def wrapper(*args):
            assert len(args) == len(decorator_args), \
                ("got %s arguments, expected %s" % (len(args), len(decorator_args)))
            assert all([isinstance(x, t) for x, t in zip(args, decorator_args)]), \
                "unexpected types"

            return f(*args)

        return wrapper

    return decorator

@enforce_types(str, int) # decorator with arguments
def print_repeated(txt, n):
    print(txt * n)

print_repeated("Hello ", 3)
print_repeated("Hello ", "world")
```

Python shell

| Hello Hello Hello

| AssertionError: unexpected types



# Example: A timer decorator

time\_it.py

```
import time

def time_it(f):
    def wrapper(*args, **kwargs):
        t_start = time.time()
        result = f(*args, **kwargs)
        t_end = time.time()
        t = t_end - t_start
        print("%s took %.2f sec" % (f.__name__, t))
        return result

    return wrapper

@time_it
def slow_function(n):
    sum_ = 0
    for x in range(n):
        sum_ += x
    print("The sum is:", sum_)

for i in range(6):
    slow_function(1_000_000 * 2**i)
```

Python shell

```
| The sum is: 499999500000
| slow_function took 0.27 sec
| The sum is: 1999999000000
| slow_function took 0.23 sec
| The sum is: 7999998000000
| slow_function took 0.41 sec
| The sum is: 31999996000000
| slow_function took 0.81 sec
| The sum is: 127999992000000
| slow_function took 1.52 sec
| The sum is: 511999984000000
| slow_function took 3.12 sec
```

# Built-in @property

- decorator specific for class methods
- allows accessing `x.attribute()` as `x.attribute`, convenient if `attribute` does not take any arguments (also readonly)

## rectangle1.py

```
class Rectangle:
    def __init__(self, width, height):
        self.width = width
        self.height = height

# @property
    def area(self):
        return self.width * self.height
```

## Python shell

```
> r = Rectangle(3, 4)
> print(r.area())
| 12
```

## rectangle2.py

```
class Rectangle:
    def __init__(self, width, height):
        self.width = width
        self.height = height

    @property
    def area(self):
        return self.width * self.height
```

## Python shell

```
> r = Rectangle(3, 4)
> print(r.area)
| 12
```

# Class decorators

Python

```
@dec2  
@dec1  
class A:  
    pass
```

≡

Python

```
class A:  
    pass  
  
A = dec2(dec1(A))
```

# @functools.total\_ordering (class decorator)

time\_it.py

```
import functools

@functools.total_ordering
class Student():
    def __init__(self, name, student_id):
        self.name = name
        self.id = student_id

    def __eq__(self, other):
        return (self.name == other.name
                and self.id == other.id)

    def __lt__(self, other):
        my_name = ', '.join(reversed(self.name.split()))
        other_name = ', '.join(reversed(other.name.split()))
        return (my_name < other_name
                or (my_name == other_name and self.id < other.id))

donald = Student('Donald Duck', 7)
gladstone = Student('Gladstone Gander', 42)
grandma = Student('Grandma Duck', 1)
```

Automatically creates  
<, <=, >, >= if at least  
one of the functions  
is implemented and  
== is implemented

Python shell

```
> donald < grandma
| True
> grandma >= gladstone
| False
> grandma <= gladstone
| True
> donald > gladstone
| False
```

# Summary

- *@decorator\_name*
- Python decorators are just syntactic sugar
- Adds functionality to a function without having to augment each call to the function or each return statement in the function
- There are decorators for functions, class methods, and classes
- There are many decorators in the Python Standard Library
- Decorators are easy to use
- ...and (slightly) harder to write