Python Programming

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Chapter 6

Modules

Topics Covering

- **Python Code files**
  - **import**
  - **from import**
  - **import ***
- **Python Packages**
  - **Directory vs Package**
  - **__init__.py**
  - **__all__**
  - **namespace**
- **Preventing unwanted code execution**
  - **___name__**
- **Recursive imports**

* **Hiding symbols from import ***

"A module in python is a set of re-usable classes, functions and variables."

There are two types of modules in python

1. Python Code Files

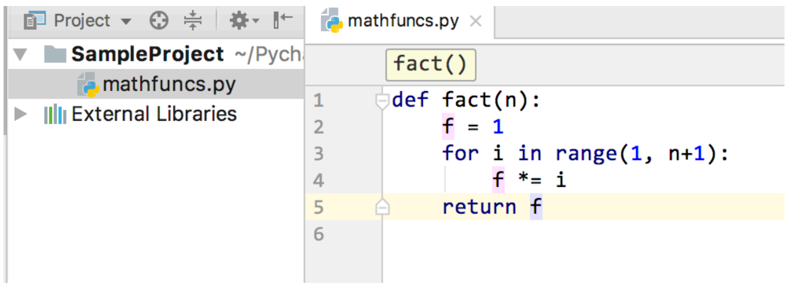
2. packages

1. Python Code files

"Every python code file ('.py' file) is a module."

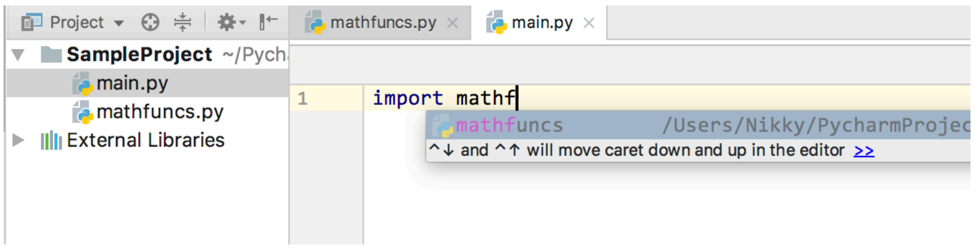
let's create a project, 'SampleProject' in pycharm.

There is a python file 'mathfuncs.py' and we defined a function 'fact' in it.



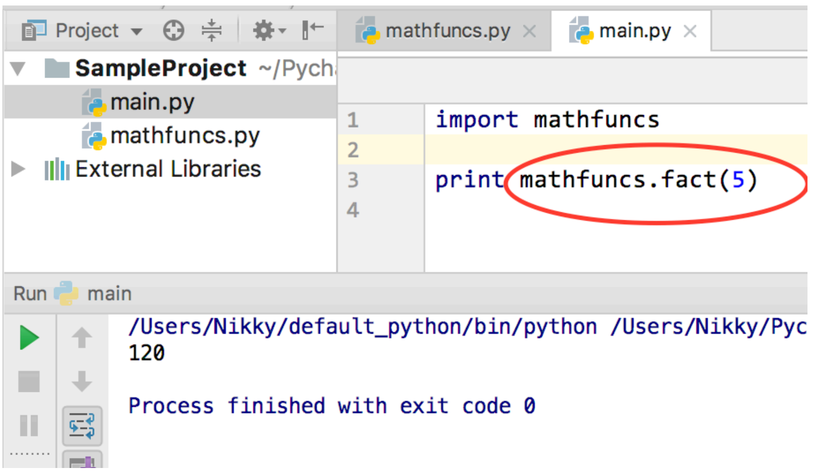
```
def fact(n):
    f = 1
    for i in range(1, n+1):
        f *= i
    return f
```

if we want to reuse the function ‘fact’, in any other python file, we have to import the file as module, using **import** statement.


Project
SampleProject ~/Pych
main.py
mathfuncs.py
External Libraries
mathfuncs.py
main.py
mathfuncs /Users/Nikky/PycharmProjec
^↓ and ^↑ will move caret down and up in the editor >>

```
import mathf
```

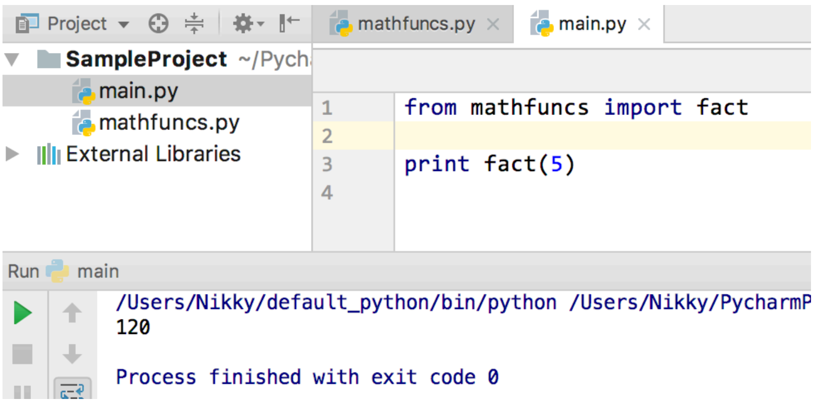
To access ‘fact’ function, we have to use ‘.’ (dot) after module name.



```
import mathfuncs

print mathfuncs.fact(5)
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/Pyc
120

Process finished with exit code 0
```

Another way of importing. ‘from’ keyword is used to import only specific functions in the module ‘mathfuncs’ without using module name.



```
from mathfuncs import fact

print fact(5)
```

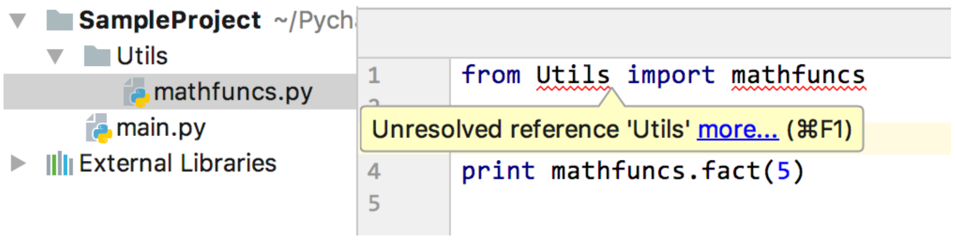
```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmP
120

Process finished with exit code 0
```

using **from** <module> **import** func1, func2, ... we can import multiple functions from a module.

2. Package:

Package is folder in the python project folder structure, which is having **__init__.py.** This is the main difference between a folder and a package in python. Packages are modules.

lets create a folder ***Utils*** in the Sample Project.



```
from Utils import mathfuncs
```

Unresolved reference 'Utils' more... (⌘F1)

```
print mathfuncs.fact(5)
```

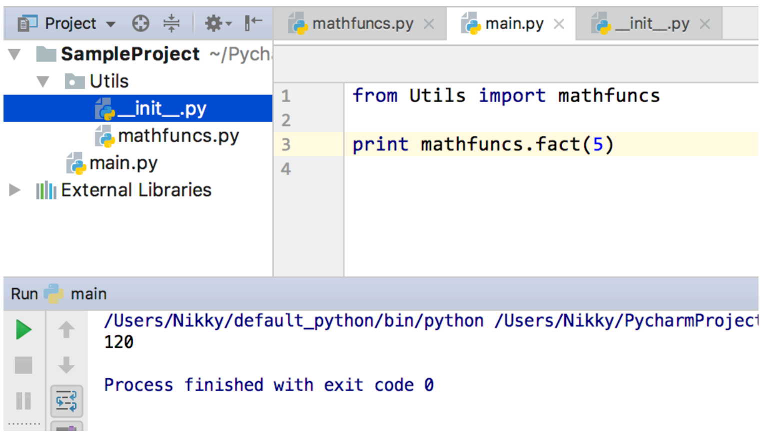
Let's place **mathfuncs.py** inside **Utils** folder. Now, if we try to import fact in **main.py**, we see above error *'No module named Utils'*. Because Utils is just a folder, not a module. Only package or a python file is importable.

*To convert a folder to a package, explicitly we have to create **__init__.py** file, under **Utils** folder. E.g., all the functions are available, if we have module, **'fact'** is available under **'mathfuncs'** module.*

- *All the file names are available under a package, to other files.*
- *All the function names, class names and variable names are available to other files from a python file.*

*Because, both are modules. A module has a namespace.<u>" A symbol table is maintained to each module, to group all the names under one roof, which is called **namespace**."</u>*

If we can access **'mathfuncs'**, we can also access **'fact'** and If we can access **'Utils'**, we can also access **'mathfuncs',** as **'mathfuncs'** and '**Utils'** are modules and they have **'fact'** and **'mathfuncs'** in their namespace**.**



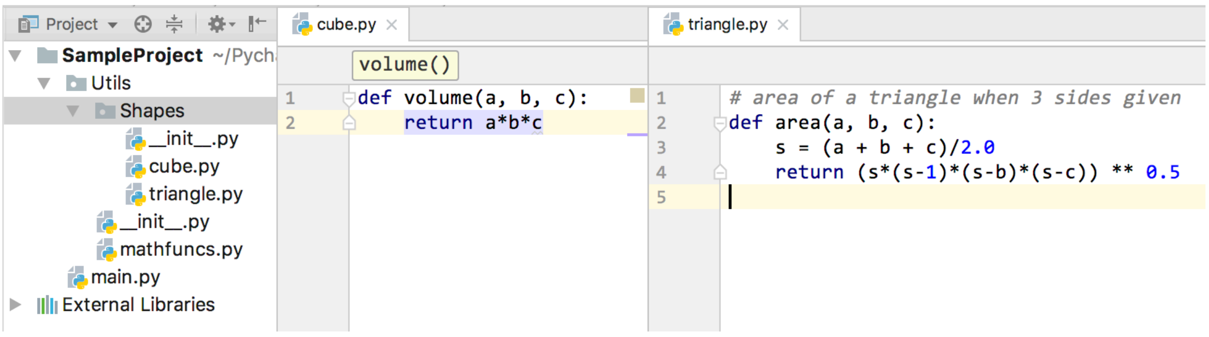
```
from Utils import mathfuncs

print mathfuncs.fact(5)
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProject
120

Process finished with exit code 0
```

We did not get the error this time as, **Utils** has been converted to a package.

__init__.py is just an empty file, which makes the folder as a package. But there are other uses too.

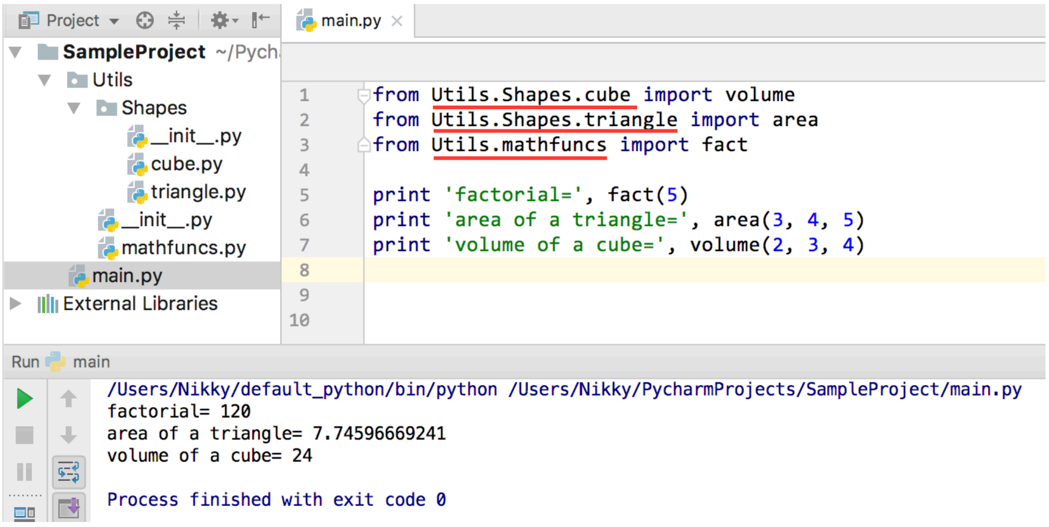
Let's take a little complex project structure,



```python
def volume(a, b, c):
    return a*b*c
```

```python
# area of a triangle when 3 sides given
def area(a, b, c):
    s = (a + b + c)/2.0
    return (s*(s-1)*(s-b)*(s-c)) ** 0.5
```

Shapes is another package with two files, **cube.py** and **triangle.py**. **volume ()** and **area ()** are the functions inside those files respectively. Now, how do we access **volume ()** and **area ()** from **main.py**.

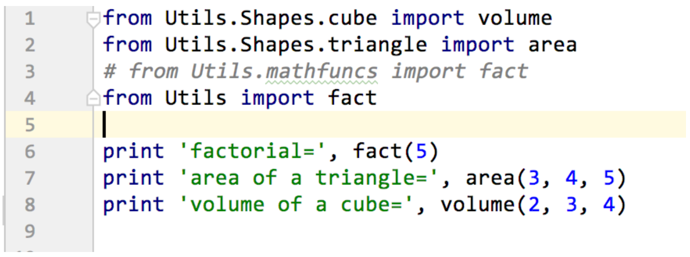


```python
from Utils.Shapes.cube import volume
from Utils.Shapes.triangle import area
from Utils.mathfuncs import fact

print 'factorial=', fact(5)
print 'area of a triangle=', area(3, 4, 5)
print 'volume of a cube=', volume(2, 3, 4)
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProjects/SampleProject/main.py
factorial= 120
area of a triangle= 7.74596669241
volume of a cube= 24

Process finished with exit code 0
```

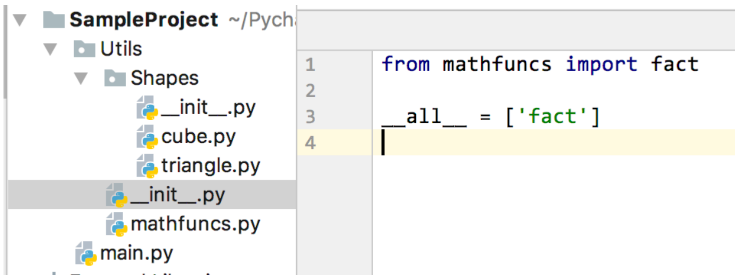
we have to use the long path name. Some developers do not want to expose the intermediate names, like **Shapes**, **cube**, **triangle** etc. What if, we could access all the functions directly from Utils namespace.

If we export fact() to Utils name space we can directly access fact from Utils as below.



```python
from Utils.Shapes.cube import volume
from Utils.Shapes.triangle import area
# from Utils.mathfuncs import fact
from Utils import fact

print 'factorial=', fact(5)
print 'area of a triangle=', area(3, 4, 5)
print 'volume of a cube=', volume(2, 3, 4)
```

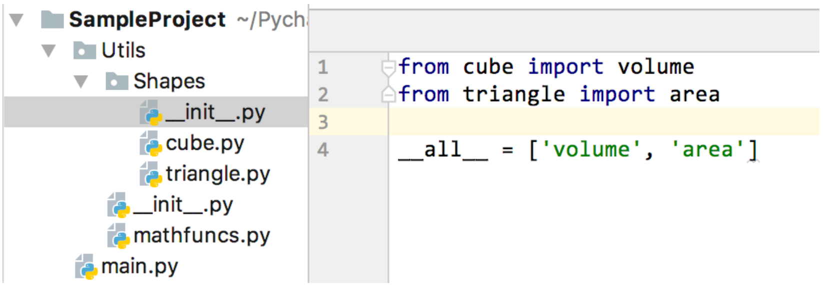
This is where we need **__init__.py** and **__all__** built-in variable.



```python
from mathfuncs import fact

__all__ = ['fact']
```

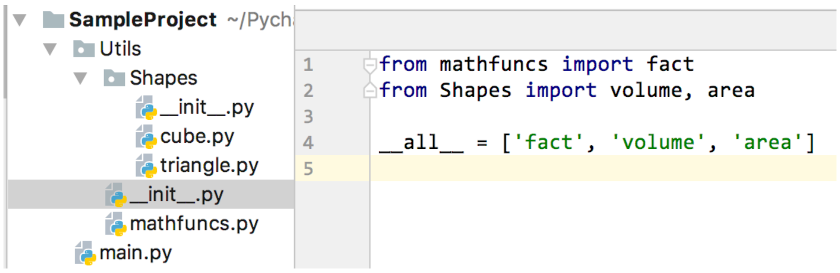
First, we have to import all symbols to __init__.py then add those symbols to __all__.

Now all those symbols in __all__ are available directly in Utils. To export all functions from Shapes to Utils namespace we have to make changes in both __init__.py files, one is in Shapes and another one is in Utils. __init__.py file acts as a bridge to export symbols to next higher levels, this reduces so much complexity when there are complex project structures. Let's make changes to Shapes/__init__.py.



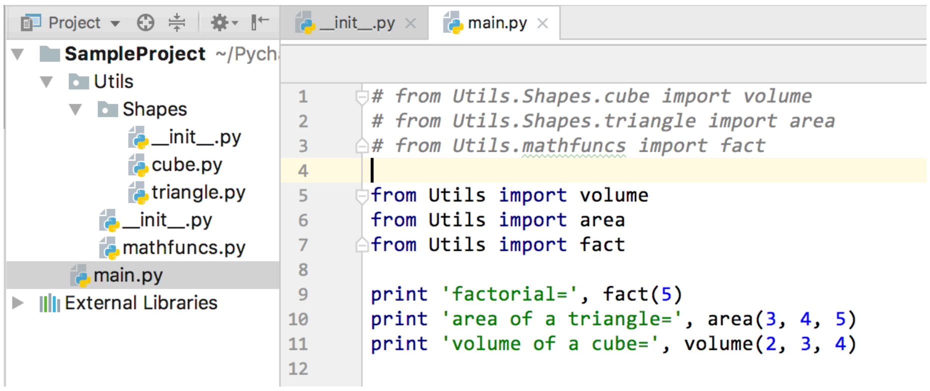
```python
from cube import volume
from triangle import area

__all__ = ['volume', 'area']
```

From now, volume, and area are available directly in Shapes namespace. Let's import them from Shapes and export to Utils namespace.



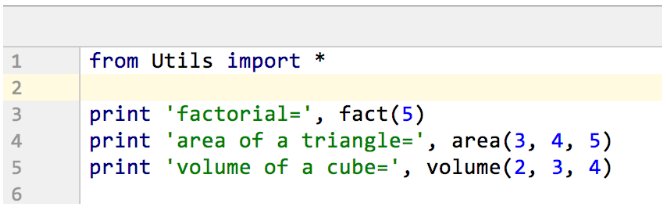
```python
from mathfuncs import fact
from Shapes import volume, area

__all__ = ['fact', 'volume', 'area']
```

If we observe, we are actually exporting symbols from leaf level to root level in a project structure, by just connecting each level with __init__.py and __all__. Now, we can directly import all the functions from Utils as below.



```python
# from Utils.Shapes.cube import volume
# from Utils.Shapes.triangle import area
# from Utils.mathfuncs import fact

from Utils import volume
from Utils import area
from Utils import fact

print 'factorial=', fact(5)
print 'area of a triangle=', area(3, 4, 5)
print 'volume of a cube=', volume(2, 3, 4)
```

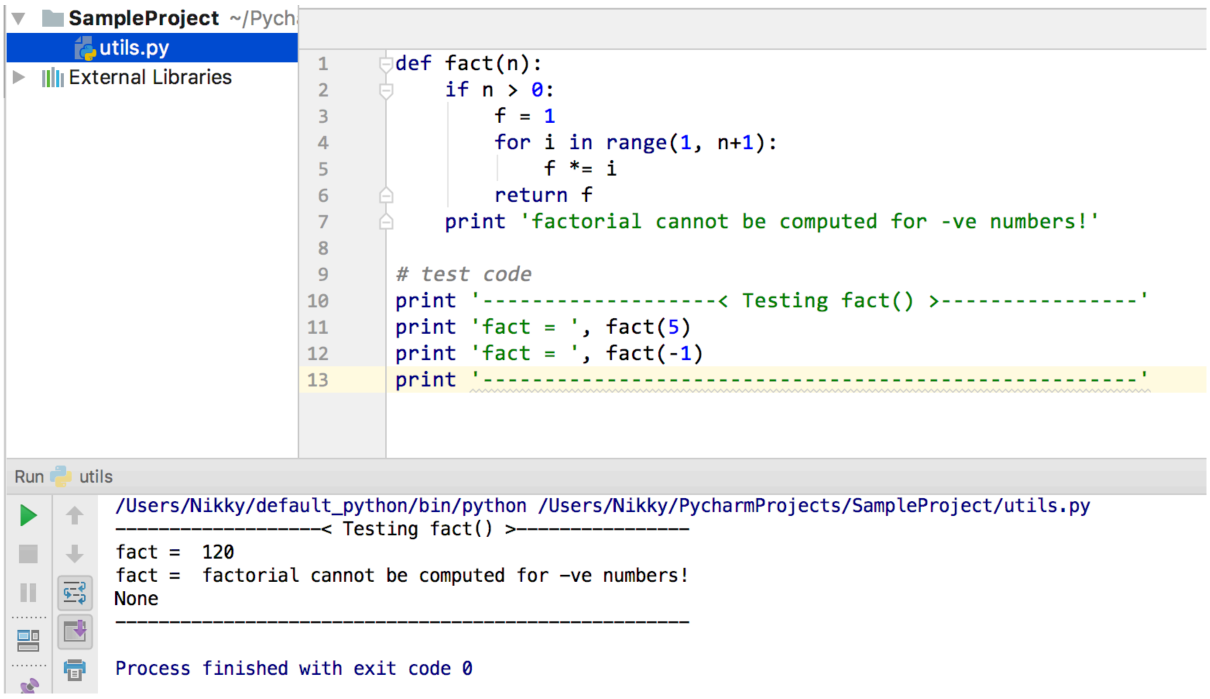
We can also import all symbols at once as below.



```python
from Utils import *

print 'factorial=', fact(5)
print 'area of a triangle=', area(3, 4, 5)
print 'volume of a cube=', volume(2, 3, 4)
```

3. Preventing execution of unwanted code

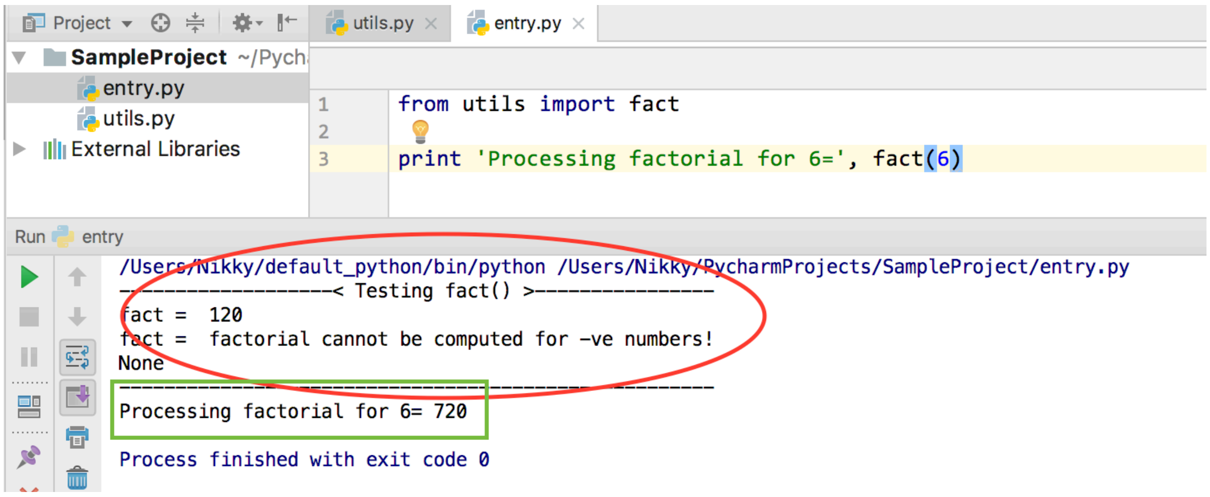
In the below example. I have developed a function fact() and tested it in the same file.



```
def fact(n):
    if n > 0:
        f = 1
        for i in range(1, n+1):
            f *= i
        return f
    print 'factorial cannot be computed for -ve numbers!'

# test code
print '------------------< Testing fact() >----------------'
print 'fact = ', fact(5)
print 'fact = ', fact(-1)
print '-----------------------------------------------------'
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProjects/SampleProject/utils.py
------------------< Testing fact() >----------------
fact =  120
fact =  factorial cannot be computed for -ve numbers!
None
-----------------------------------------------------

Process finished with exit code 0
```

Now I want to reuse the same function fact() in another module called entry.py. I imported fact into entry.py and executed some code.



```
from utils import fact

print 'Processing factorial for 6=', fact(6)
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProjects/SampleProject/entry.py
------------------< Testing fact() >----------------
fact =  120
fact =  factorial cannot be computed for -ve numbers!
None
-----------------------------------------------------
Processing factorial for 6= 720

Process finished with exit code 0
```

Why we are seeing unwanted output if we want to execute entry.py?

Because, all statements in a module are executed when module is loading first time.

When we are importing fact from Utils, all the statements (test code) are executed once.

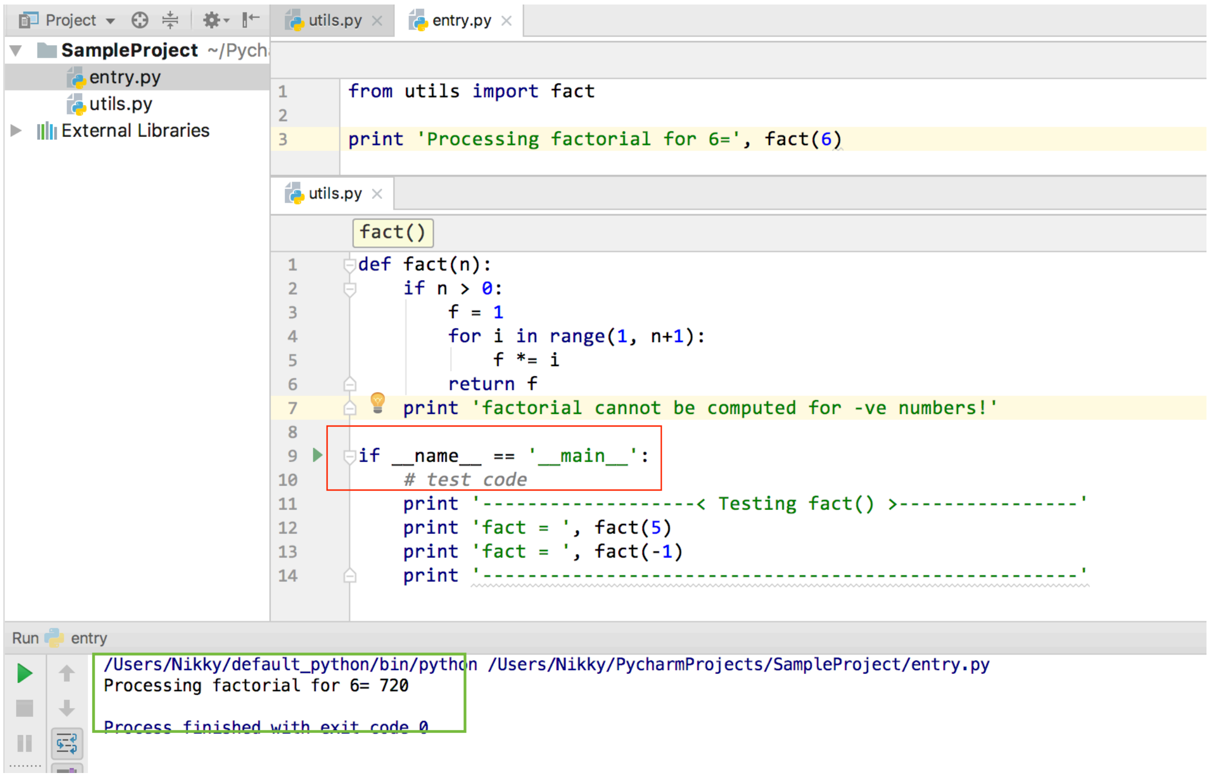
How to prevent this?

We should use __name__.

__name __: Within a module, the module's name (as a string) is available as the value of the global variable.

Every module has a separate __name__ global variable.

All the global statements should be conditionally executed using __name__, unless it is really required.



entry.py:

```
from utils import fact

print 'Processing factorial for 6=', fact(6)
```

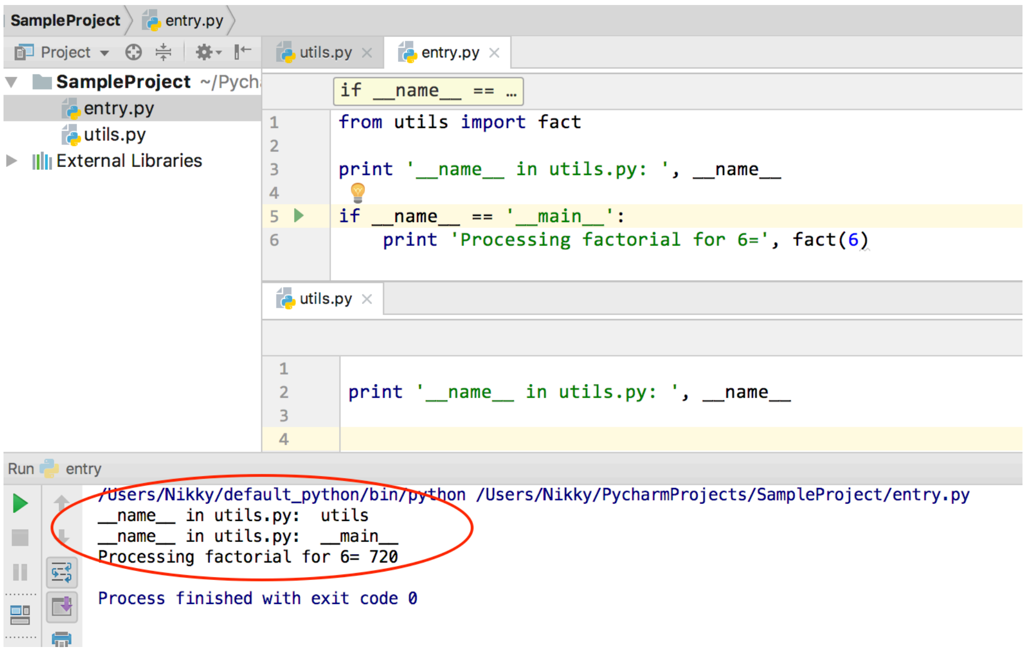
utils.py:

```
def fact(n):
    if n > 0:
        f = 1
        for i in range(1, n+1):
            f *= i
        return f
    print 'factorial cannot be computed for -ve numbers!'

if __name__ == '__main__':
    # test code
    print '------------------< Testing fact() >----------------'
    print 'fact = ', fact(5)
    print 'fact = ', fact(-1)
    print '-------------------------------------------------------'
```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProjects/SampleProject/entry.py
Processing factorial for 6= 720

Process finished with exit code 0
```

global variable, __name__'s value is '__main__' in the start-up module of every project. In all other modules __name__ value is set to its module name. Now if we execute entry.py we do not get the unwanted output.

Let's run entry.py and print __name__ value in both the modules. Check the output.



entry.py:

```
from utils import fact

print '__name__ in utils.py: ', __name__

if __name__ == '__main__':
    print 'Processing factorial for 6=', fact(6)
```

utils.py:

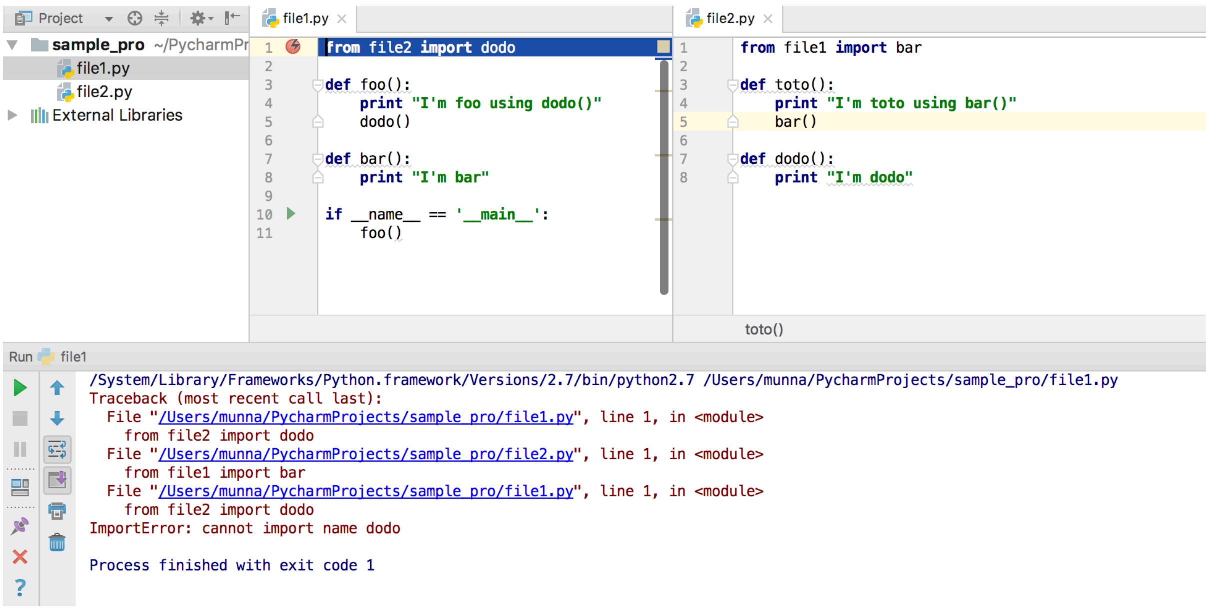
```

print '__name__ in utils.py: ', __name__

```

```
/Users/Nikky/default_python/bin/python /Users/Nikky/PycharmProjects/SampleProject/entry.py
__name__ in utils.py:  utils
__name__ in utils.py:  __main__
Processing factorial for 6= 720

Process finished with exit code 0
```

It is a good practice to keep all the global statements, which are not part of any function or class scope, inside ***if __name__*** == '__main__': block, which prevents unwanted code execution.

4. Recursive imports:

In the below example. file1.py has foo() and bar() functions. file2.py has toto() and dodo() functions. When



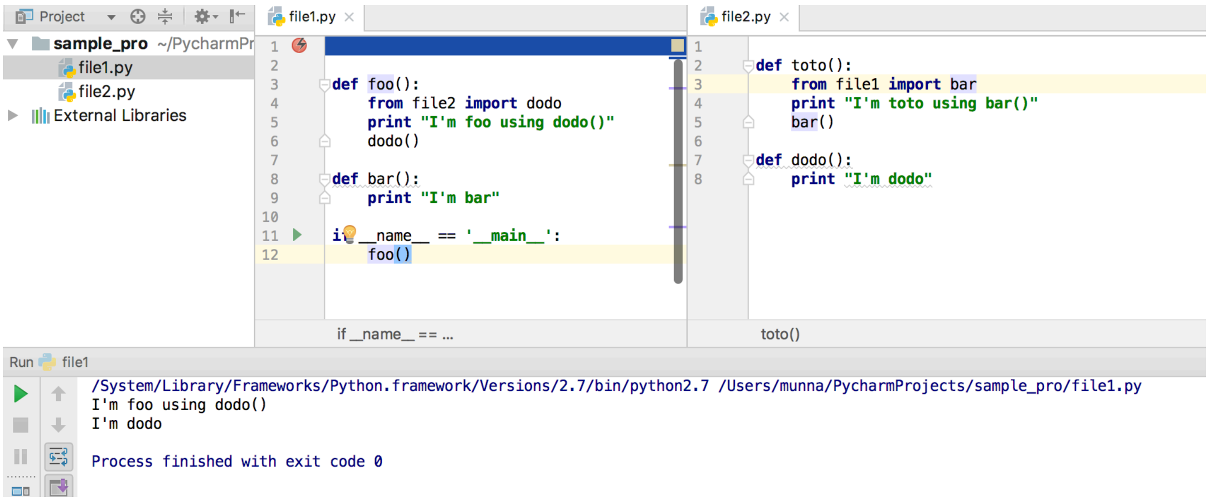
```
from file2 import dodo

def foo():
    print "I'm foo using dodo()"
    dodo()

def bar():
    print "I'm bar"

if __name__ == '__main__':
    foo()
```

```
from file1 import bar

def toto():
    print "I'm toto using bar()"
    bar()

def dodo():
    print "I'm dodo"
```

```
/System/Library/Frameworks/Python.framework/Versions/2.7/bin/python2.7 /Users/munna/PycharmProjects/sample_pro/file1.py
Traceback (most recent call last):
  File "/Users/munna/PycharmProjects/sample_pro/file1.py", line 1, in <module>
    from file2 import dodo
  File "/Users/munna/PycharmProjects/sample_pro/file2.py", line 1, in <module>
    from file1 import bar
  File "/Users/munna/PycharmProjects/sample_pro/file1.py", line 1, in <module>
    from file2 import dodo
ImportError: cannot import name dodo

Process finished with exit code 1
```

file1.py import dodo(), file2.py import bar() we get a recursive imports problem as below.

To avoid this problem, we should narrow the scope of imports. Keep 'Import bar' statement inside the toto() function of file2.py and similarly , keep 'import dodo' statement inside foo() function as below.

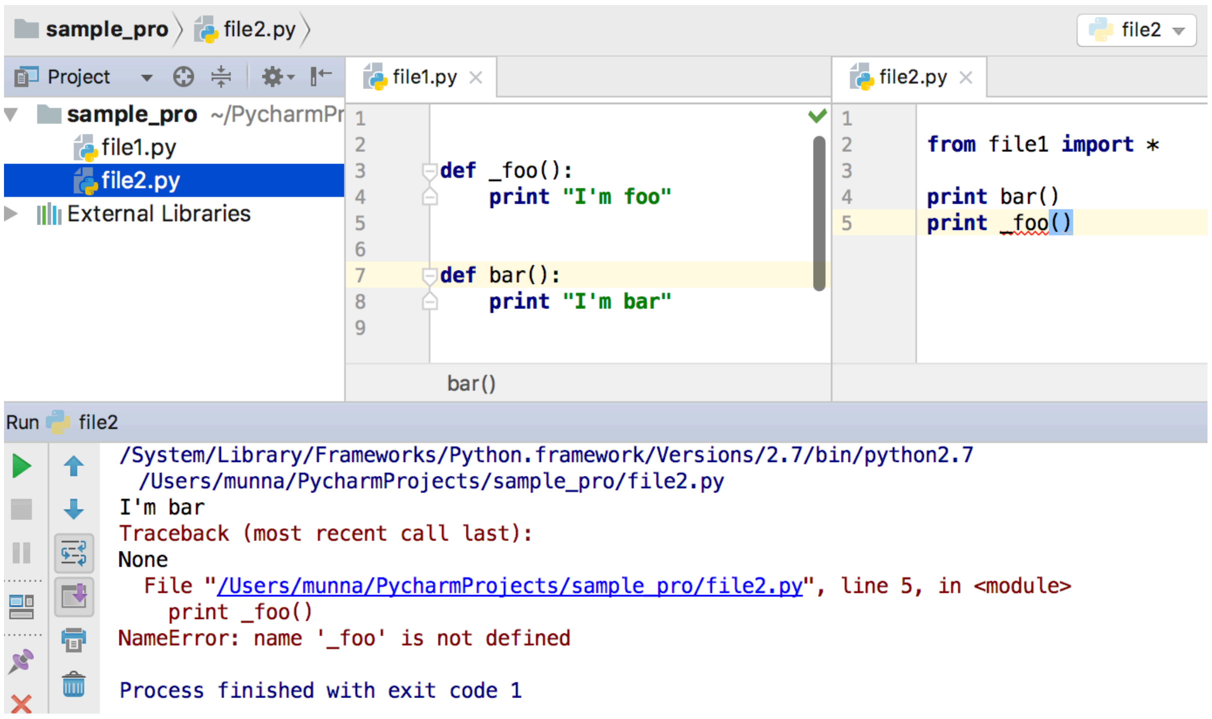


```

def foo():
    from file2 import dodo
    print "I'm foo using dodo()"
    dodo()

def bar():
    print "I'm bar"

if __name__ == '__main__':
    foo()
```

```

def toto():
    from file1 import bar
    print "I'm toto using bar()"
    bar()

def dodo():
    print "I'm dodo"
```

```
/System/Library/Frameworks/Python.framework/Versions/2.7/bin/python2.7 /Users/munna/PycharmProjects/sample_pro/file1.py
I'm foo using dodo()
I'm dodo

Process finished with exit code 0
```

5. Hiding symbols from import *



```python
def _foo():
    print "I'm foo"


def bar():
    print "I'm bar"
```

```python
from file1 import *

print bar()
print _foo()
```

```
/System/Library/Frameworks/Python.framework/Versions/2.7/bin/python2.7
  /Users/munna/PycharmProjects/sample_pro/file2.py
I'm bar
Traceback (most recent call last):
None
  File "/Users/munna/PycharmProjects/sample_pro/file2.py", line 5, in <module>
    print _foo()
NameError: name '_foo' is not defined

Process finished with exit code 1
```

We can hide functions, classes any identifiers from import *, by prefixing with '-' (underscore). Look at the above code, file2.py trying to import everything from file1.py, but failed to import __foo(), as it is prefixed with underscore.

Interview Questions

1. What is __name__
2. What is the use of __all__
3. How do you implement import *
4. How to avoid recursive imports
5. What is namespace in python
6. Difference between package and folder?
7. What is a module in python?