Module

- Collection of things
  - function definition, classes, variables, and executable statements
- executed when module is imported
- modules have private symbol tables
- avoids name clash for global variables
- accessible as *module.globalname*
- file name is module name + .py

Module

- Collection of stuff in *foo*.py file
  - functions, classes, variables
- Importing modules:
  - import time

    time.sleep(3)
  - from time import sleep

    sleep(3)
- Can import all names defined by module
  - from graphics import *

Module

Import with rename:

- import graphics as g

  g.GraphWin(“test”, 500, 500)

- from time import sleep as delay

  delay(3)

Module Search Path

- current directory
- list of directories specified in PYTHONPATH environment variable
- uses installation-default if not defined, e.g., .:/usr/local/lib/python
- uses sys.path

['', '/usr/lib/python2.7', '/usr/lib/python2.7/plat-x86_64-linux-gnu', '/usr/lib/python2.7/lib-tk', '/usr/lib/python2.7/lib-old', '/usr/lib/python2.7/lib-dynload', '/home/rekha/.local/lib/python2.7/site-packages', '/usr/local/lib/python2.7/dist-packages', '/usr/lib/python2.7/dist-packages']

Module Listing

Use `dir()` for each module to see what is inside it to import.

```
import graphics
dir(graphics)
```

['BAD_OPTION', 'Circle', 'DEFAULT_CONFIG', 'Entry', 'GraphWin', 'GraphicsError', 'GraphicsObject', 'Image', 'Line', 'OBJ_ALREADY_DRAWN', 'Oval', 'Point', 'Polygon', 'Rectangle', 'Text', 'Transform', 'UNSUPPORTED_METHOD', '_BBox', '__builtins__', '__doc__', '__file__', '__name__', '__package__', '__version__', '_root', '_update_lasttime', 'color_rgb', 'os', 'sys', 'test', 'time', 'tk', 'update']

Packages[P/Q/M]

Collection of modules in directory

- Each (sub)package is represented as directory.
- Must have __init__.py file which can be empty
- May contain subpackages

Direcory structure under package.P.Q.M_without_imports

```
. ->  test.py    P
./P ->          __init__.py   Q
./P/Q ->                   __init__.py   M
./P/Q/M ->                          __init__.py   Foo.py
```

#contents of Foo.py

```
def foo():
  print 'Hi, there!'

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

#contents of __init__.py

#test cases

- from P.Q.M.Foo import foo
  foo()
- import P.Q.M.Foo
  P.Q.M.Foo.foo()
- import P.Q.M.Foo as MyFoo
  MyFoo.foo()
- from P.Q.M import Foo
  Foo.foo()

Error: do not work

- from P.Q import M
  M.Foo.foo() #Foo?
- from P import Q
  Q.M.Foo.foo() #M?
- import P
  P.Q.M.Foo.foo() #Q?

Packages[P/Q/M]

Collection of modules in directory

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- Must have __init__.py file which can be empty
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Direcory structure under package.P.Q.M_with_imports

```
. ->  test.py    P
./P ->           __init__.py    Q
./P/Q ->                        __init__.py   M
./P/Q/M ->                                    __init__.py   Foo.py
```

#contents of Foo.py

```
def foo():
   print 'Hi, there!'

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

#contents of ./__init__.py

```
import P
```

#contents of ./P/__init__.py

```
import Q
```

#contents of ./P/Q/__init__.py

```
import M
```

#contents of ./P/Q/M/__init__.py

```
import Foo
```

#test cases

- from P.Q.M.Foo import foo
  foo()
- import P.Q.M.Foo
  P.Q.M.Foo.foo()
- import P.Q.M.Foo as MyFoo
  MyFoo.foo()
- from P.Q.M import Foo
  Foo.foo()

It does work

- from P.Q import M
  M.Foo.foo()
- from P import Q
  Q.M.Foo.foo()
- import P
  P.Q.M.Foo.foo()

Packages [P|Q|M]

In __init__.py, set the __all__ variable which tells which modules should be loaded on import *.

```
test_all.py
package_all:
        __init__.py
        M:
          Foo.py
          __init__.py
        P:
          Foo.py
          __init__.py
        Q:
          Foo.py
          __init__.py
```

```
#contents of package_all/__init__.py

__all__ = ["P","M"]     #Q missing
```

```
#contents of package_all/P/Foo.py
def foo():
  print '---- Hello P!'

foo()
```

```
#contents of package_all/P/__init__.py
```

```
#contents of package_all/Q/__init__.py
```

```
#contents of package_all/M/__init__.py
```

```
#contents of test_all.py
from package_all import *
P
M

#ERROR: "Q" not in__all__ list
Q
```

Packages[P|Q|M]

__init__.py has initialization code for the package.

```
test_init_with_imports.py
package_init:
                    __init__.py
                    M:
                      Foo.py
                      __init__.py
                    P:
                      Foo.py
                      __init__.py
                    Q:
                      Foo.py
                      __init__.py
```

```
#contents of package_init/P/__init__.py
import Foo
```

```
#contents of package_init/Q/__init__.py
import Foo
```

```
#contents of package_init/M/__init__.py
import Foo
```

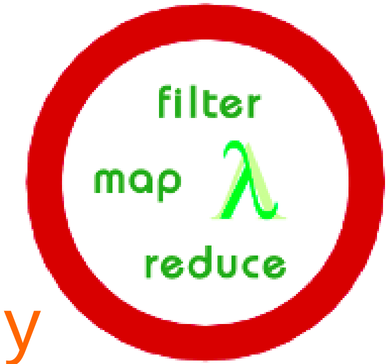
```
#contents of package_init/__init__.py
__all__ = ["P","M"]
import P
import Q
import M
```

```
import package_init
#No error as subpackages imported from __init__.py
package_init.P.Foo.foo()
package_init.Q.Foo.foo()
package_init.M.Foo.foo()
```

```
from package_init import *

P.Foo.foo()
M.Foo.foo()
Q.Foo.foo() #error – Q not in __all__
```

Lambda Functions



- small anonymous functions created on the fly
- mainly used in combination with the higher order functions filter(), map() and reduce().
- Lambda argument_list: expression

lambda x,y : x+y

lambda vrs. def

```python
def add(x, y):
    return x + y

Ladd = lambda x, y: x+y
```

Why use lambda functions?

When using verbose function declaration it is often the case that the function's verbose declaration can be verbose, even for functions that don't require such verbosity.

Verbose

```
def ispos(n):
    return n > 0
b = filter(ispos, aList)
```

```
b = []
for a in aList:
    if a > 0:
        b.append(a)
```

Vs.

```
b = filter(lambda n: n > 0, aList)
```

Not Verbose

Also, there are some valid concerns about namespace clutter and verbosity.

Lambda Functions (map)

Map (function, sequence)

- function is applied on each item in the sequence
- A newly formed list is returned

```
a = [1,2,3,4]

b = [17,12,11,10]

print map(lambda x,y:x+y, a,b)
```

Lambda Functions(filter)

filter(function, sequence)

- function returns a boolean as filter criteria
- a newly formed list is returned

```
fib = [0,1,1,2,3,5,8,13,21,34,55]

print filter(lambda x: x % 2, fib)

print filter(lambda x: x % 2 == 0, fib)
```

Lambda Functions(reduce)

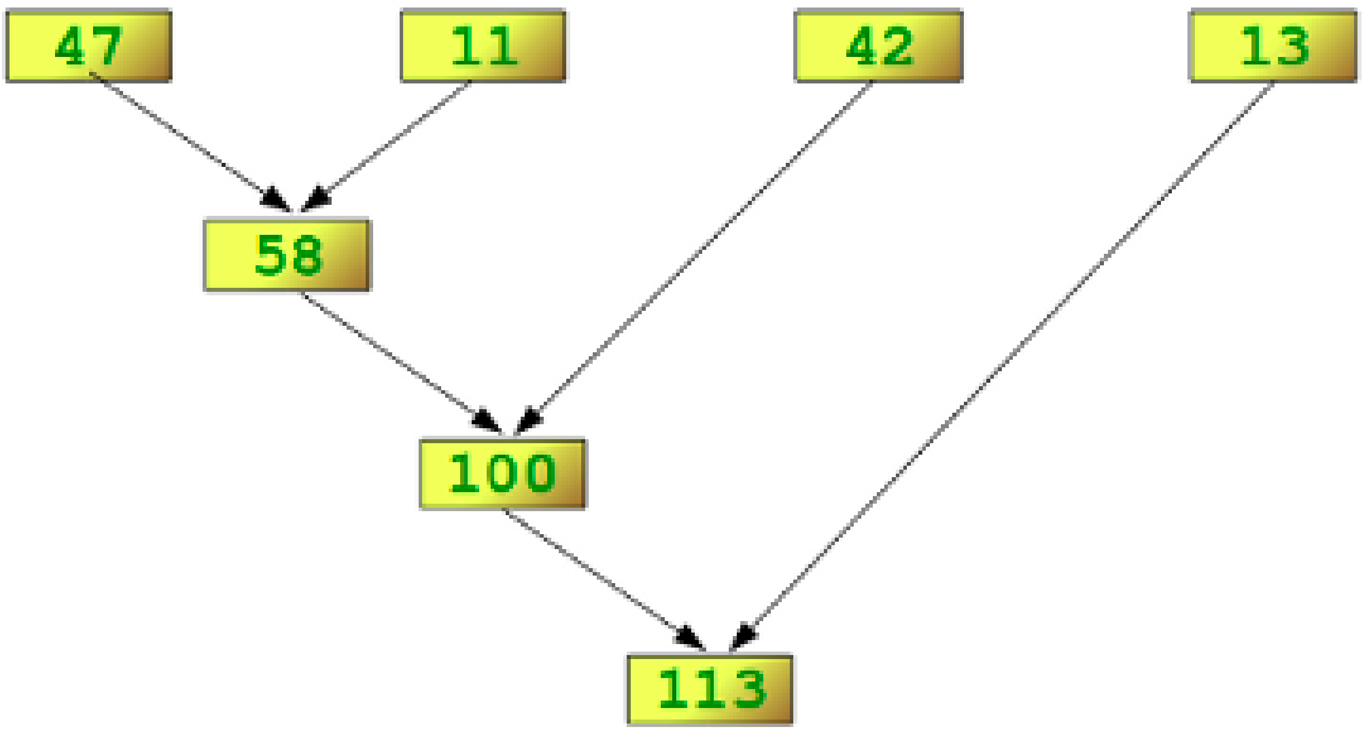
reduce(function, sequence)

- return a single value
- call binary function on the first two items
  then on the result and next item
- iterates

```
print reduce(lambda a,b: a if (a > b) else b,
        [47,11,42,102,13])
```

Lambda Functions(reduce)

print reduce(lambda x,y: x+y, [47,11,42,13])



List Comprehension

List Comprehensions allow us to do all sorts of things:

- Single-function single-line code
- Apply a function to each item of an iterable
- Filter using conditionals
- Cleanly nest loops

List Comprehension

To double the values in a list and assign to a new variable:

```
winning_lottery_numbers = [0, 4, 3, 2, 3, 1]
fake_lottery_numbers = []

for number in winning_lottery_numbers:
    fake_lottery_numbers.append(2 * number)



fake_lottery_numbers =
[2*n for n in winning_lottery_numbers]
```

List Comprehension

Create lists without `map,filter,lambda`

Syntax:

- expression followed by for clause
- zero or more for or of clauses

```
vec = [2,4,6]

print [3*x for x in vec]            #[6, 12, 18]

print [{x: x**2} for x in vec]   #[{2: 4}, {4: 16}, {6: 36}]
```

List Comprehension(cross product)

```
vec1 = [2,4,6]

Vec2 = [4,3,-9]

#[8,6,-18, 16,12,-36, 24,18,-54]

print [x*y for x in vec1 for y in vec2]

#[8,12,-54]

print [vec1[i]*vec2[i] for i in range(len(vec1))]
```

List Comprehension(condition-filtering)

Syntax:

```
[<expression> for <value> in <collection> if <condition>]
```

```
vec = [2,4,6]
print [3*x for x in vec if x > 3]      #[12, 18]
print [3*x for x in vec if x < 2]      #[]
```