COMP(2041|9044) 25T1 — Python Modules

https://www.cse.unsw.edu.au/~cs2041/25T1/

Importing Code

```
>>> import math
>>> math.log(math.e)
1.0
>>> dir(math)  # a module is itself an object
['__doc__', '__loader__', '__name__', '__package__', '__spec__', 'acos',
 ↪  'acosh', 'asin', 'asinh', 'atan', 'atan2', 'atanh', 'cbrt', 'ceil',
 ↪  'comb', 'copysign', 'cos', 'cosh', 'degrees', 'dist', 'e', 'erf', 'erfc',
 ↪  'exp', 'exp2', 'expm1', 'fabs', 'factorial', 'floor', 'fmod', 'frexp',
 ↪  'fsum', 'gamma', 'gcd', 'hypot', 'inf', 'isclose', 'isfinite', 'isinf',
 ↪  'isnan', 'isqrt', 'lcm', 'ldexp', 'lgamma', 'log', 'log10', 'log1p',
 ↪  'log2', 'modf', 'nan', 'nextafter', 'perm', 'pi', 'pow', 'prod',
 ↪  'radians', 'remainder', 'sin', 'sinh', 'sqrt', 'tan', 'tanh', 'tau',
 ↪  'trunc', 'ulp']
>>> help(math)  # generated from docstrings
NAME
    math
DESCRIPTION
    This module provides access to the mathematical functions
    defined by the C standard.
```


Importing Code

Python module - a file containing function definitions and other Python.

```
import math                  # access names from math as math.name, e.g
 ↪  math.sin
from math import sin         # access math.sin as sin
from math import sin as sine # access math.sin as sine
from math import *           # access all names from math without prefix
 ↪  (avoid)
import math as m             # access names from math as m.name, e.g m.sin
```

Finding Modules

Python module - a file containing function definitions and other Python.

`import` searches the current directory and a series of standard directories and zip files for modules. **`sys.path`** contains the list (you can append directories you also want searched).

```
>>> import sys
>>> sys.path
['', '/usr/lib/python39.zip', '/usr/lib/python3.9',
 ↪  '/usr/lib/python3.9/lib-dynload',
'/usr/local/lib/python3.9/dist-packages', '/usr/lib/python3/dist-packages',
'/usr/lib/python3.9/dist-packages']
```

environment variable ***PYTHONPATH*** added to ***sys.path***

```
$ PYTHONPATH=/home/z1234657/modules python3
...
>>> sys.path
['', '/home/z1234657/modules', '/usr/lib/python311.zip',
 ↪  '/usr/lib/python3.11', ...
```


Namespaces

Python modules prevent accidental name collision when using modules from many sources

Python modules can control what names are exported by default (*****)

Beware - Python does not prevent deliberate access or changes to any part of a module. Even internal names (not exported) can be be changed.

```
>>> import circle
>>> circle.area(radius=2)
12.566370614359172
>>> import math
>>> math.pi = 4
>>> circle.area(radius=2)
16
```


Standard Modules

Python has over 200 standard modules available via an import statement.

We have already used:

```
import os
import re
import sys
import subprocess
```

Non-Standard Modules

Before wrting code, look for existing code.

There are over 500,000 packages available on PyPI.

PyPI is the [Py]thon [P]ackage [I]ndex

PyPI is a website that allows you to search for and register your own packages.

Any packages listed on the index can be installed via `pip`.

Packages

A package is a collection of files.

These files contains the source code of, and installation instructions for, one (or more) modules.

The most common format for python packages is called a `wheel`.

A `wheel` is basically just a `.zip` file that contains files in a specially crafted format.

Most of the time you don't need to worry about `wheels` (or other package types)
as they are automatically downloaded and installed.

pip

`pip` is the standard package manager for Python.

`pip` stands for [P]ip [I]nstalls [P]ackages.

`pip` can install any package on PyPI (and be configured to also search other repositories)

pip

```
# To install a package, you can use the following command:
$ pip3 install <package_name>
# or
$ python3 -m pip install <package_name>

# You can also install a package from a local directory
$ pip3 install <package>.whl
# or from git:
$ pip3 install git+<package_url>

# pip also updates packages
$ pip3 install --upgrade <package_name>

# and uninstalls packages
$ pip3 uninstall <package_name>
```


venv

By default Python installs packages system-wide, which even on a single-user system can creates conflicts: Project A needs version X of a package and project B needs version Y of a package.

A virtual environment allows package to be installed just for the project using them.

In python a virtual environment is a directory that contains a copy of the Python interpreter.

It can be using to isolate your project from the rest of the system.

```
# create a virtual environment:
$ python3 -m venv <new_directory_name>
# then activate it
$ . <new_directory_name>/bin/activate
# or on Windows:
$ <new_directory_name>/Scripts/activate
```

Once activated, the `python`, `python3`, `pip`, etc commands will be run from within the virtual environment.

versioning

Python packages should be versioned using PEP440.

The full syntax for a PEP440 version is:

```
[N!]N(.N)*[{a|b|rc}N][.postN][.devN]
```

most commonly only the `N(.N)*` part is used.

This defines a verion of format `X.Y.Z`

Eg:

```
1.0.0
2.0
3.9.2
4.2
7.4.67.3.32
```

This is called a `final release`

versioning

It is most common to use three numbers `major.minor.micro`

Where:
the `major` version is incremented when there is a forward incompatible change.
the `minor` version is incremented when there is a backward incompatible change.
the `micro` version is incremented when there is a non-breaking change (eg bug fix).

If any number isn't specified, it is assumed to be 0.
Eg, all the following are the same:

```
5.7
5.7.0
5.7.0.0
5.7.0.0.0
# etc
```


version specifiers

version specifiers determine which version of a package to use.
without a version specifier, any version (usually the latest) is used.

An exact version is specified by using the == operator.
A minimum version is specified by using the >= operator (or exclusively >).
A maximum version is specified by using the <= operator (or exclusively <).
A excluded version is specified by using the != operator.
A strict version is specified by using the === operator.
A compatible version is specified by using the ~= operator.

version specifiers == vs ===

== is used to specify an exact version.
=== is used to specify a strict version.

=== is esentialy a string comparison.
where as == takes into account semantic information.

```
1.0 ==  1.0.0 # True
1.0 === 1.0.0 # False
```

version specifiers ~=

~= is used to specify a compatible version.

a compatible version of X.Y is >= X.Y, == X.*

That is: the minor version is greater than or equal, and the major version is the same.

version specifiers

multiple version specifiers can be used to restrict the version of a package.

```
~= 3.1.0, < 3.1.7, != 3.1.3
```

```
3.1.0
3.1.1
3.1.2
3.1.4
3.1.5
3.1.6
```


version specifiers

version specifiers can be used with pip.

```
$ python3 -m pip install 'regex~=2022.7.0,>2022.7.23,!=2022.7.24'
```

by default, pip will install the latest version of a package.

requirements.txt

It can be very annoying to keep track of all the packages you need to install.

So instead, we can put them in a file, conventionally called `requirements.txt`.

The `requirements.txt` file is a simple text file that contains a list of package to install.

These can either not have a version specifier.
Ie. just a list of package.

Or they can have a version specifiers.
Ie. when you want to replicate an environment.

requirements.txt

```
requests
beautifulsoup4
regex
```

```
requests ~= 2.0.0, <= 2.25, != 2.26.0, != 2.27.1
beautifulsoup4 >= 5.4, < 5.10
regex ~= 2022.7.0, > 2022.7.23, != 2022.7.24
```


requirements.txt

```
# `pip` can install package from a `requirements.txt` file directly.
$ pip3 install -r requirements.txt

# `pip` can generate a `requirements.txt` file with version specifiers.
$ pip3 freeze > requirements.txt
```

`pip freeze` gives you a list of *all* packages and their versions.

Even those that were not directly installed (indirect requirements).

This can clutter up your `requirements.txt` file.

So `pip` also supports a `constraints` file.

constraints.txt

`constraints.txt` works exactly like `requirements.txt`
except that a package in `constraints.txt` will only be installed if they are also in `requirements.txt`.

```
$ pip3 install -r requirements.txt -c constraints.txt
$ cat  requirements.txt
requests
beautifulsoup4
regex
$ cat constraints.txt
beautifulsoup4==4.11.1
certifi==2022.6.15
charset-normalizer==2.1.0
idna==3.3
regex==2022.7.25
requests==2.28.1
soupsieve==2.3.2.post1
urllib3==1.26.11
```