Importing Code

```python
>>> 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', ... '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.
FUNCTIONS
    acos(x, /)
    ...
```

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).

```python
>>> import sys
>>> sys.path
'/usr/lib/python3.9/dist-packages']
```

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

```bash
$ 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 changed.

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

Standard Modules

Python has a lot of standard library modules

There are 217 standard modules

Any of them can be used via the import statement.

We have already used:

```python
sys
os
re
subprocess
# etc
```
Non-Standard Modules

As a rule of thumb, someone else has already solved every problem. It’s a good idea to look for existing code. There are about 460,000 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 contain 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. Or other repositories that have been configured.
To install a package, you can use the following command:

```bash
$ python3 -m pip install <package_name>
```

You can also install a package from a local directory or git:

```bash
$ python3 -m pip install <package>.whl
$ python3 -m pip install git+<package_url>
```

pip also updates and uninstalls package.

```bash
$ python3 -m pip install --upgrade <package_name>
$ python3 -m pip uninstall <package_name>
```

By default, Python installs package in the global (per user) Python environment. This is usually very messy. It is preferable to keep your package within the project that is using them. This can be done by creating a virtual environment.
In python a virtual environment is a directory that contains a copy of the Python interpreter. It can be used to isolate your project from the rest of the system.

To create a virtual environment, use the following command:

```bash
$ python3 -m venv <venv_name>
```

It's common to simply name your virtual environment `venv`.

Once you have a virtual environment, you can activate it by running the following command:

```bash
$ . <venv_name>/bin/activate
```

OR on Windows:

```bash
$ <venv_name>/Scripts/activate
```

without activating a virtual environment you are still in the global environment.

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

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 version 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

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

Other forms of versioning also work with this format

- year.month.day
  - 2023.03.12
- year.quarter.version
  - 2023.1.7
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 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 essentially a string comparison.
where as `==` takes into account semantic information.

```python
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.

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

<table>
<thead>
<tr>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.0</td>
</tr>
<tr>
<td>3.1.1</td>
</tr>
<tr>
<td>3.1.2</td>
</tr>
<tr>
<td>3.1.4</td>
</tr>
<tr>
<td>3.1.5</td>
</tr>
<tr>
<td>3.1.6</td>
</tr>
</tbody>
</table>

version specifiers can be used with `pip`.

```bash
$ 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 packages 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.
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

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

pip can generate a requirements.txt file with version specifiers.
$ pip 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 works exactly like requirements.txt except that a package in constraints.txt will only be installed if they are also in requirements.txt.

$ pip install -r requirements.txt -c constraints.txt

```bash
# requirements.txt
requests
beautifulsoup4
regex
```

```bash
# 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
```