:mod:`__main__` --- Top-level code environment

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>
> Unknown interpreted text role "mod".

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>
> Unknown directive type "module".
>
> ```
> .. module:: __main__
>    :synopsis: The environment where top-level code is run. Covers command-line
>              interfaces, import-time behavior, and ``__name__ == '__main__'``.
> ```

In Python, the special name `__main__` is used for two important constructs:

1. the name of the top-level environment of the program, which can be checked using the `__name__ == '__main__'` expression; and
2. the `__main__.py` file in Python packages.

Both of these mechanisms are related to Python modules; how users interact with them and how they interact with each other. They are explained in detail below. If you're new to Python modules, see the tutorial section :ref:`tut-modules` for an introduction.

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`__name__ == '__main__'`

When a Python module or package is imported, `__name__` is set to the module's name. Usually, this is the name of the Python file itself without the `.py` extension:

```
>>> import configparser
>>> configparser.__name__
'configparser'
```

If the file is part of a package, `__name__` will also include the parent package's path:

```
>>> from concurrent.futures import process
>>> process.__name__
'concurrent.futures.process'
```

However, if the module is executed in the top-level code environment, its `__name__` is set to the string `'__main__'`.

What is the "top-level code environment"?

`__main__` is the name of the environment where top-level code is run. "Top-level code" is the first user-specified Python module that starts running. It's "top-level" because it imports all other modules that the program needs. Sometimes "top-level code" is called an *entry point* to the application.

The top-level code environment can be:

- the scope of an interactive prompt:

  ```
  >>> __name__
  '__main__'
  ```

- the Python module passed to the Python interpreter as a file argument:

  ```
  $ python3 helloworld.py
  Hello, world!
  ```

- the Python module or package passed to the Python interpreter with the :option:`-m` argument:

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```
$ python3 -m tarfile
usage: tarfile.py [-h] [-v] (...)
```

- Python code read by the Python interpreter from standard input:

```
$ echo "import this" | python3
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
...
```

- Python code passed to the Python interpreter with the :option:`-c` argument:

```
$ python3 -c "import this"
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
...
```

In each of these situations, the top-level module's __name__ is set to '__main__'.

As a result, a module can discover whether or not it is running in the top-level environment by checking its own __name__, which allows a common idiom for conditionally executing code when the module is not initialized from an import statement:

```
if __name__ == '__main__':
    # Execute when the module is not initialized from an import statement.
    ...
```

```
.. seealso::

    For a more detailed look at how ``__name__`` is set in all situations, see
    the tutorial section :ref:`tut-modules`.
```

Idiomatic Usage

Some modules contain code that is intended for script use only, like parsing command-line arguments or fetching data from standard input. If a module like this was imported from a different module, for example to unit test it, the script code would unintentionally execute as well.

This is where using the if __name__ == '__main__' code block comes in handy. Code within this block won't run unless the module is executed in the top-level environment.

Putting as few statements as possible in the block below if __name__ == '__main__' can improve code clarity and correctness. Most often, a function named main encapsulates the program's primary behavior:

```
# echo.py

import shlex
import sys

def echo(phrase: str) -> None:
    """A dummy wrapper around print."""
    # for demonstration purposes, you can imagine that there is some
    # valuable and reusable logic inside this function
    print(phrase)

def main() -> int:
```

```
        """Echo the input arguments to standard output"""
        phrase = shlex.join(sys.argv)
        echo(phrase)
        return 0

if __name__ == '__main__':
    sys.exit(main())  # next section explains the use of sys.exit
```

Note that if the module didn't encapsulate code inside the `main` function but instead put it directly within the `if __name__ == '__main__'` block, the `phrase` variable would be global to the entire module. This is error-prone as other functions within the module could be unintentionally using the global variable instead of a local name. A `main` function solves this problem.

Using a `main` function has the added benefit of the `echo` function itself being isolated and importable elsewhere. When `echo.py` is imported, the `echo` and `main` functions will be defined, but neither of them will be called, because `__name__ != '__main__'`.

Packaging Considerations

`main` functions are often used to create command-line tools by specifying them as entry points for console scripts. When this is done, pip inserts the function call into a template script, where the return value of `main` is passed into :func:`sys.exit`. For example:

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>
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```
sys.exit(main())
```

Since the call to `main` is wrapped in :func:`sys.exit`, the expectation is that your function will return some value acceptable as an input to :func:`sys.exit`; typically, an integer or `None` (which is implicitly returned if your function does not have a return statement).

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>
> Unknown interpreted text role "func".

By proactively following this convention ourselves, our module will have the same behavior when run directly (i.e. `python3 echo.py`) as it will have if we later package it as a console script entry-point in a pip-installable package.

In particular, be careful about returning strings from your `main` function. :func:`sys.exit` will interpret a string argument as a failure message, so your program will have an exit code of `1`, indicating failure, and the string will be written to :data:`sys.stderr`. The `echo.py` example from earlier exemplifies using the `sys.exit(main())` convention.

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>
> Unknown interpreted text role "data".

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>
> Unknown directive type "seealso".
>
> ```
>     .. seealso::
>
>         `Python Packaging User Guide <https://packaging.python.org/>`_
>         contains a collection of tutorials and references on how to distribute and
>         install Python packages with modern tools.
> ```

`__main__.py` in Python Packages

If you are not familiar with Python packages, see section :ref:`tut-packages` of the tutorial. Most commonly, the `__main__.py` file is used to provide a command-line interface for a package. Consider the following hypothetical package, "bandclass":

```
bandclass
    â"œâ"€â"€ __init__.py
    â"œâ"€â"€ __main__.py
    â""â"€â"€ student.py
```

`__main__.py` will be executed when the package itself is invoked directly from the command line using the :option:`-m` flag. For example:

```
$ python3 -m bandclass
```

This command will cause `__main__.py` to run. How you utilize this mechanism will depend on the nature of the package you are writing, but in this hypothetical case, it might make sense to allow the teacher to search for students:

```python
# bandclass/__main__.py

import sys
from .student import search_students

student_name = sys.argv[2] if len(sys.argv) >= 2 else ''
print(f'Found student: {search_students(student_name)}')
```

Note that `from .student import search_students` is an example of a relative import. This import style can be used when referencing modules within a package. For more details, see :ref:`intra-package-references` in the :ref:`tut-modules` section of the tutorial.

Idiomatic Usage

The contents of `__main__.py` typically isn't fenced with `if __name__ == '__main__'` blocks. Instead, those files are kept short, functions to execute from other modules. Those other modules can then be easily unit-tested and are properly reusable.

If used, an `if __name__ == '__main__'` block will still work as expected for a `__main__.py` file within a package, because its `__name__` attribute will include the package's path if imported:

```
>>> import asyncio.__main__
>>> asyncio.__main__.__name__
'asyncio.__main__'
```

This won't work for `__main__.py` files in the root directory of a .zip file though. Hence, for consistency, minimal `__main__.py` like the :mod:`venv` one mentioned below are preferred.

`import __main__`

Regardless of which module a Python program was started with, other modules running within that same program can import the top-level environment's scope (:term:`namespace`) by importing the __main__ module. This doesn't import a __main__.py file but rather whichever module that received the special name '__main__'.

Here is an example module that consumes the __main__ namespace:

```python
# namely.py

import __main__

def did_user_define_their_name():
    return 'my_name' in dir(__main__)

def print_user_name():
    if not did_user_define_their_name():
        raise ValueError('Define the variable `my_name`!')

    if '__file__' in dir(__main__):
        print(__main__.my_name, "found in file", __main__.__file__)
    else:
        print(__main__.my_name)
```

Example usage of this module could be as follows:

```python
# start.py

import sys

from namely import print_user_name

# my_name = "Dinsdale"

def main():
    try:
        print_user_name()
    except ValueError as ve:
        return str(ve)

if __name__ == "__main__":
    sys.exit(main())
```

Now, if we started our program, the result would look like this:

```
$ python3 start.py
Define the variable `my_name`!
```

The exit code of the program would be 1, indicating an error. Uncommenting the line with my_name = "Dinsdale" fixes the program and now it exits with status code 0, indicating success:

```
$ python3 start.py
Dinsdale found in file /path/to/start.py
```

Note that importing __main__ doesn't cause any issues with unintentionally running top-level code meant for script use which is put in the `if __name__ == "__main__"` block of the start module. Why does this work?

Python inserts an empty __main__ module in :attr:`sys.modules` at interpreter startup, and populates it by running top-level code. In our example this is the `start` module which runs line by line and imports `namely`. In turn, `namely` imports __main__ (which is really `start`). That's an import cycle! Fortunately, since the partially populated __main__ module is present in :attr:`sys.modules`, Python passes that to `namely`. See :ref:`Special considerations for __main__ <import-dunder-main>` in the import system's reference for details on how this works.

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>
> Unknown interpreted text role "attr".

> **System Message: ERROR/3 (`D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\library\[cpython-main][Doc][library]__main__.rst`, line 339); *backlink***
>
> Unknown interpreted text role "ref".

The Python REPL is another example of a "top-level environment", so anything defined in the REPL becomes part of the __main__ scope:

```
>>> import namely
>>> namely.did_user_define_their_name()
False
>>> namely.print_user_name()
Traceback (most recent call last):
...
ValueError: Define the variable `my_name`!
>>> my_name = 'Jabberwocky'
>>> namely.did_user_define_their_name()
True
>>> namely.print_user_name()
Jabberwocky
```

Note that in this case the __main__ scope doesn't contain a __file__ attribute as it's interactive.

The __main__ scope is used in the implementation of :mod:`pdb` and :mod:`rlcompleter`.

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>
> Unknown interpreted text role "mod".