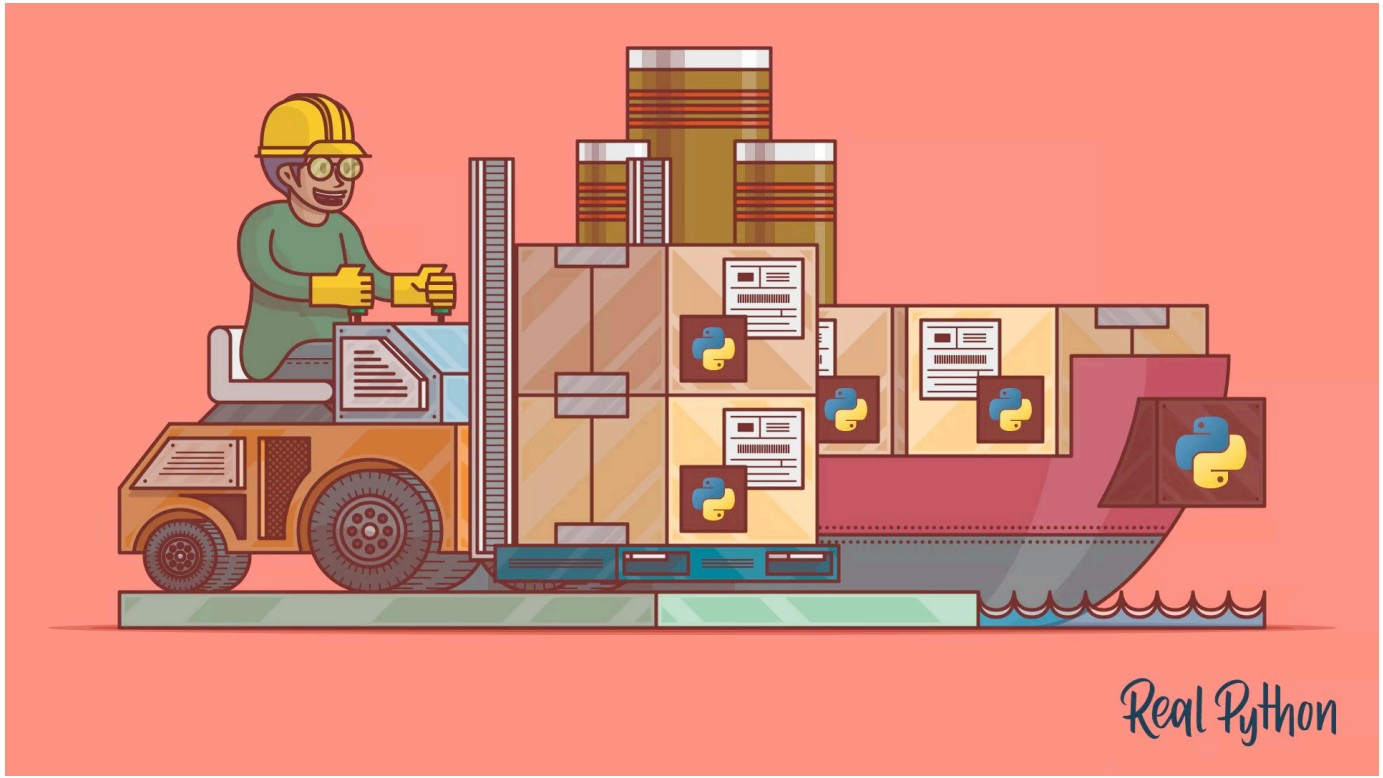
ADVANCED PYTHON IMPORT TECHNIQUES



YOU WILL LEARN ABOUT:

1. All the variations of the `import` statement
2. The difference between modules, packages, and namespaces
3. How to create installable packages
4. What the import system does when you load a module
5. The problems with circular imports
6. How to dynamically load modules
7. A way to bundle your code as a runnable zip file

VERSIONS

Note:

- Sample code tested using:
  - Python 3.12

OVERVIEW

- For anything but the smallest program you want to organize your code
- Python uses the file system to define a hierarchy of modules and packages
- The import keyword can be used in a variety of ways to load modules and objects
- Your scripts can be bundled up for re-use as installable packages or as runnable zip files
- Modules and packages can be dynamically loaded

NEXT UP...

Variations on the `import` keyword

TABLE OF CONTENTS

MODULES, PACKAGES, AND NAMESPACES

- To organize your code you want to group it together
- **Namespace (general):** abstract container for holding logical groupings
  - Prevents name clashes
- Python mostly uses directory structure to define groupings
- **Module:** organizational unit in Python
  - Typically corresponds to a single Python file
- **Package:** a module with submodules or recursively sub-packages
  - Directory with a `__init__.py` file
  - Bundled for installation and re-use
- **Namespace Package (specific):** virtual package that can be split into parts

MODULES, PACKAGES, AND NAMESPACES

- Python ships with many modules and packages
- Packages can be installed as third-party containers
- The **import** keyword brings a package or module into your namespace
  - Namespace of a Python file (module)
  - Namespace of a REPL session

NEXT UP...

Packages

TABLE OF CONTENTS

PACKAGES

- A directory structure containing a `__init__.py` file
- By default submodules or sub-packages don’t get imported when the parent does
- The `__init__.py` file can contain code
  - Importing submodules or sub-packages into the parent namespace

NEXT UP...

Shadowing

TABLE OF CONTENTS

SHADOWING

- Python uses references to point at objects
- You can create a new reference with the same name and point it elsewhere
- Overrides the existing definition: “shadowing” it
- Even modules are objects, and in most cases they can be shadowed

NEXT UP...

Installable packages

TABLE OF CONTENTS

INSTALLABLE PACKAGES

- You can bundle up a package in order to share or re-use it
- Includes the Python package directory and metadata
- These same bundles are what you install from PyPI
- You can install a bundle locally
- Packaging in Python has been historically complicated

INSTALLABLE PACKAGES

- Current best practices (2024):
  - `pyproject.toml`
  - Put your modules in a `src` directory
  - Third party tools:
    - `setuptools==72.1.0`
    - `build==1.2.1`
    - `twine==5.1.1`

NEXT UP...

The problem with relative imports

TABLE OF CONTENTS

ABSOLUTE VS RELATIVE IMPORTS

- An **absolute import** use a fully qualified module name
- A **relative import** references things locally
  - Through a dot:

```
# inside americas.north
from . import canada
```

  - Through the local name:

```
# inside americas
from north import canada
```

RELATIVE IMPORTS

- Relative imports:
  - Mean less typing
  - Are problematic within packages or zip files
  - Aren’t recommended

NEXT UP...

Namespace packages

TABLE OF CONTENTS

NAMESPACE PACKAGES

- Not all programming languages use a file based packaging mechanism
- Some languages are more declarative
  - Example: all network related modules can go in a package named “network” even from different distributors
- Python 3.3 introduced **implicit namespace packages**
  - A way to group things that aren’t in the same bundle
  - No `__init__.py` file!

NEXT UP...

Module cache

TABLE OF CONTENTS

MODULE CACHE

- When you import a module, Python caches it
- Subsequent imports for the same module do nothing
- Whole module gets imported and cached even when you are adding a single item into the namespace

RELOAD

- Modules are cached
- Changes to a module won’t take effect
- You can explicitly reload a module

NEXT UP...

Circular imports

TABLE OF CONTENTS

MODULES THAT IMPORT MODULES

- Modules can import other modules
- A imports B which imports A
- Circular imports
- Mostly not a problem since modules are cached
- Corner cases can causes issues

NEXT UP...

Dynamic imports

TABLE OF CONTENTS

DYNAMIC IMPORTS

- Sometimes you want to import a module based on input from the user
  - Conditionally import based on data
  - Plugins
- `importlib.import_module()`

IMPORTING RESOURCES

- Complex programs often ship with data
  - Internal configuration files
  - Assets (sounds, images, etc)
  - Data
- You can use `__file__` to find them, or
- You can use `importlib.resources`

NEXT UP...

Python runs zips

TABLE OF CONTENTS

PYTHON RUNS ZIPS

- Python can run code inside a zip file
- The `zipapp` utility helps you create a runnable zip file
  - Automatically creates a `__main__.py` in the zip

RUNNING YOUR ZIP

- In Windows, the `.pyz` extension is already considered runnable and associated with the Python interpreter
- On *nix systems you need to associate a runnable
  - Like a shebang (#!)

```
$ python -m zipapp goodbye -m talk:main -p "/usr/bin/env python"
```

- This does not include Python in the zip!

NEXT UP...

Tips and tricks

TABLE OF CONTENTS

HANDLING PACKAGES ACROSS VERSIONS

- Some built-in packages have been back-ported as third party libraries
- Depending on what Python version a user is running they may need different modules

```
try:
    from importlib import resources
except ModuleNotFoundError:
    import importlib_resources as resources
```

```
import sys
if sys.version_info >= (3, 7):
    from importlib import resources
else:
    import importlib_resources as resources
```

PACKAGE ALTERNATIVES

- Some packages are drop-in replacements for built-in packages

```
try:
    import ujson as json
except ModuleNotFoundError:
    import json
```

- Use a `mock` instead

SCRIPTS VS LIBRARIES

- Loading a module runs any bare code in the module
- Scripts are modules

```
def main():
    print("Do something!")

if __name__ == "__main__":
    main()
```

PROFILING IMPORTS

- The CPython interpreter will give you performance information about import load times
- Use `-X importtime`

```
$ python -X importtime -c "import math"
import time: self [us] | cumulative | imported package
import time:       223 |        223 |   _io
import time:        28 |         28 |   marshal
import time:       188 |        188 |   posix
import time:       250 |        687 | _frozen_importlib_external
...
import time:       564 |        564 | math
```

IMPORTS STYLE GUIDE

- PEP 8 has recommendations about imports:
  - Keep imports at the top of the file
  - Write imports on separate lines
  - Organize imports into groups:
    - first standard library imports, then
    - third-party imports, and
    - finally local application or library imports
  - Order imports alphabetically within each group
  - Prefer absolute imports over relative imports
  - Avoid wildcard imports like from module `import *`
- Some linters apply these style guidelines

IMPORTS STYLE GUIDE

```
# Standard library imports
import sys
from typing import Dict, List

# Third party imports
import feedparser
import html2text

# Reader imports
from reader import URL
```

NEXT UP...

Summary

TABLE OF CONTENTS

SUMMARY

- You organize your code in Python into modules and packages
- The namespace is where everything currently defined lives
- To use a module you invoke the `import` keyword bringing it into the namespace
- A package is a directory with a `__init__.py` file
- A `__init__.py` file is still Python
    - Can be used to import other modules or objects into the namespace

SUMMARY

- You can replace an item in the namespace with another using the same name
  - Shadow built-ins
- You can name a module the same as a built-in and use it instead
- Packages can be bundled for re-use
  - Provide metadata using a `pyproject.toml` file
  - Install locally using `pip install -e`

SUMMARY

- Relative importing is connected to your current location
  - Problematic with bundled packages or `pyz` files
- Imports are cached:
  - Importing something twice does nothing
  - Changing the code and re-importing it doesn't work
  - You can reload a module using tools in `importlib`
- Modules and resources can be loaded dynamically
- Python can run code inside a zip file

MORE FROM REAL PYTHON

- Python import: Advanced Techniques and Tips

  https://realpython.com/python-import/ (tutorial)

  - Examples:
    - Using namespace packages as interfaces
    - Reading resources (x2)
    - Factory methods for plugins
    - Using modules as singletons
  - Finders and loaders

MORE FROM REAL PYTHON

- How to Publish an Open-Source Python Package to PyPI
  - https://realpython.com/courses/pypi-publish-python-package/ (course)
  - https://realpython.com/pypi-publish-python-package/ (tutorial)
- What's a Python Namespace Package, and What's It For?
  - https://realpython.com/python-namespace-package/ (tutorial)
- Python 3.8: Cool New Features for You to Try
  - https://realpython.com/python38-new-features/#importlibmetadata (tutorial)
  - https://realpython.com/lessons/importlibmetadata/ (course)
- Python Zip Imports: Distribute Modules and Packages Quickly
  - https://realpython.com/python-zip-import/ (tutorial)

Thanks!

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