Consistent importing

Jan Bielecki

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Jan Bielecki

Senior Full Stack Developer

2015
First Python code
(internship)

2019
Using Python
professionally

2021
Modelling systems
in energy industry

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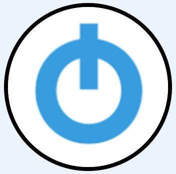
consistent_importing.pdf

Ørsted

Global leader in offshore wind



Ørsted vs All

~10.2/~83 GW
(~12%)

Offshore vs All

~83 GW/ 19 TW
(~0.4%)

Rightsizing

~8000 (2025)
~6000 (2027)

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consistent_importing_all_slides.pdf

I. Why am I talking about this?

Re-exporting definitions through __init__.py

```python
# model/geometry/node.py
class Node: ...
# model/geometry/__init__.py
from .node import Node, function_a
from .edge import Edge, function_b
# model/__init__.py
from .geometry import Node, Edge, function_a, function_b
from .other_module import SomeOtherClass
# gui/__init__.py
from model import Node, Edge, function_a, function_b, SomeOtherClass
```

✓ Pros:

- Encapsulation/Single entry point
- Short imports
- **Acyclic package dependencies**

✗ Cons:

- Maintenance overhead
- IDE is confused
- Hard to automate consistency

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# gui/__init__.py
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Consistency reduces decision fatigue

"... the more decisions you make throughout the day, the worse you are at making them."[2]

Python importing without consistency

II. How importing in Python works?

Python interpreter

```
(base) jan@jan-Inspiron-3543:~/consistent_importing$ python
Python 3.12.8 [GCC 11.2.0] on linux
>>> def hello_world() -> None:
...     print("Hello from hello_world function!")
...
>>> hello_world()
Hello from hello_world function!
>>> exit()
(base) jan@jan-Inspiron-3543:~/consistent_importing$ python
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  File "", line 1, in
NameError: name 'hello_world' is not defined
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Python module

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# my_module.py
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print("Hello from my_module!")
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Python 3.12.8 [GCC 11.2.0] on linux
>>> import my_module
Hello from my_module!
>>> dir(my_module)  # properties and methods of the object
[..., '__name__', '__package__', '__spec__', 'hello_world']
>>> my_module.hello_world()
Hello from hello_world function!
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Python module

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Python package

```
├── main.py
├── gui
│   ├── __init__.py
│   └── plots
│       ├── __init__.py
│       └── graph
│           └── __init__.py
└── model
    ├── __init__.py
    └── geometry
        ├── node.py
        ├── edge.py
        └── __init__.py
```

sys.path

```
(.venv) ~\consistent_importing> python
>>> import sys
>>> print(sys.path)
[
 '',
 'C:\\Desktop\\projects\\consistent_importing',
 'C:\\Local\\Programs\\Python\\Python313\\DLLs',
 'C:\\Local\\Programs\\Python\\Python313\\Lib',
 'C:\\Desktop\\projects\\consistent_importing\\.venv\\Lib\\site-packages',
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```

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 ...
]
```

sys.path manipulation (execute a module vs execute a script)

```
(.venv) ~\consistent_importing> python -m src.gui_model.main
[
 '~\\consistent_importing',
 ...
 '~\\consistent_importing\\.venv' ]
Success!
(.venv) ~\consistent_importing> python src\gui_model\main.py
[
 '~\\consistent_importing\\src\\gui_model',
 ...
 '~\\consistent_importing\\.venv' ]
Success!
```

```python
# src\gui_model\main.py

from pprint import pprint

pprint(sys.path)
print("Success!")
```

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sys.path manipulation (if the previous approach is not enough)

```
(.venv) ~\consistent_importing> PYTHONPATH="/example:anything-can-be-here" python
>>> import sys; print(sys.path)
['',
 '/example',
 '/home/projects/consistent_importing/anything-can-be-here'
 '/home/projects/consistent_importing/.venv/lib/python3.12/site-packages',
 ...]
>>> sys.path.append(True); print(sys.path)
['',
 '/example',
 '/home/projects/consistent_importing/anything-can-be-here'
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```

Package vs Namespace Package

```
───my_package (/some/path)
      │   __init__.py
      ├───plot
      │   __init__.py
      ├───model
      │       __init__.py
...
───my_package (/some/another_path)
      │   __init__.py
      ├───plot
      │   __init__.py
      ├───computation
      │       __init__.py
  ...
```

```
(.venv) ~\consistent_importing> python
>>> import sys
>>> sys.path
[
  '/some/path',
  '/some/another_path'
]
>>> import my_package.model
hello from path.my_package.model
>>> import my_package.computation
Traceback (most recent call last):
  File "", line 1, in
    import my_package.computation
ModuleNotFoundError: No module named 'my_package.computation'
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───my_package (/some/path)
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```
(.venv) ~\consistent_importing> python
>>> import sys
>>> sys.path
[
  '/some/path',
  '/some/another_path'
]
>>> import my_package.model
hello from path.my_package.model
>>> import my_package.computation
Traceback (most recent call last):
  File "", line 1, in
    import my_package.computation
ModuleNotFoundError: No module named 'my_package.computation'
```

Package vs Namespace Package

```
───my_package (/some/path)
    │   __init__.py
    ├──plot
    │   __init__.py
    ├──model
    │       __init__.py
...
───my_package (/some/another_path)
    │   __init__.py
    ├──plot
    │   __init__.py
    ├──computation
    │       __init__.py
  ...
```

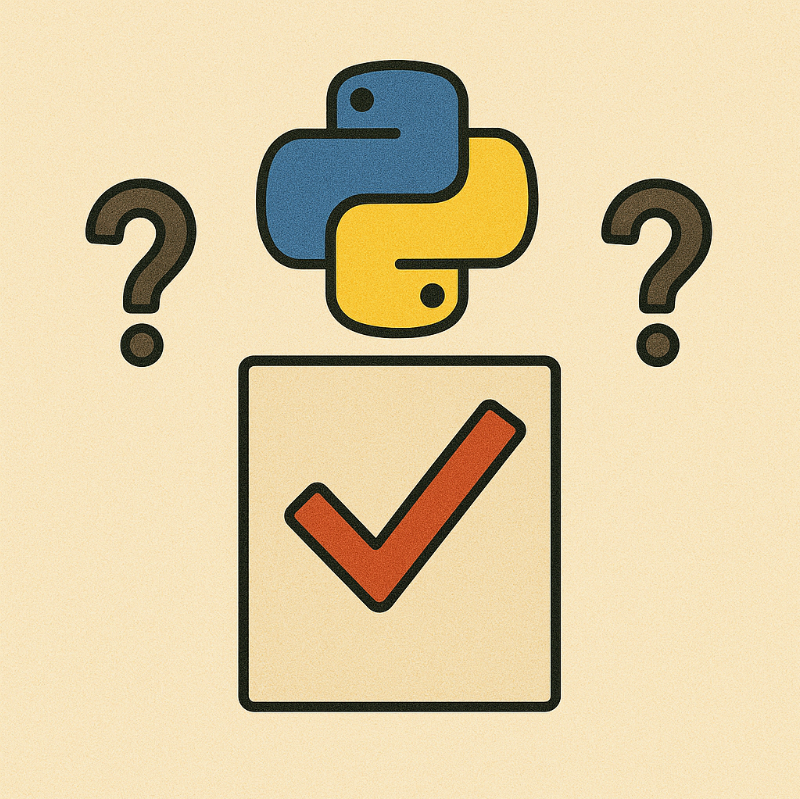
```
(.venv) ~\consistent_importing> python
>>> import sys
>>> sys.path
[
  '/some/path',
  '/some/another_path'
]
>>> import my_package.model
hello from path.my_package.model
>>> import my_package.computation
Traceback (most recent call last):
  File "", line 1, in
    import my_package.computation
ModuleNotFoundError: No module named 'my_package.computation'
```

Package vs Namespace Package

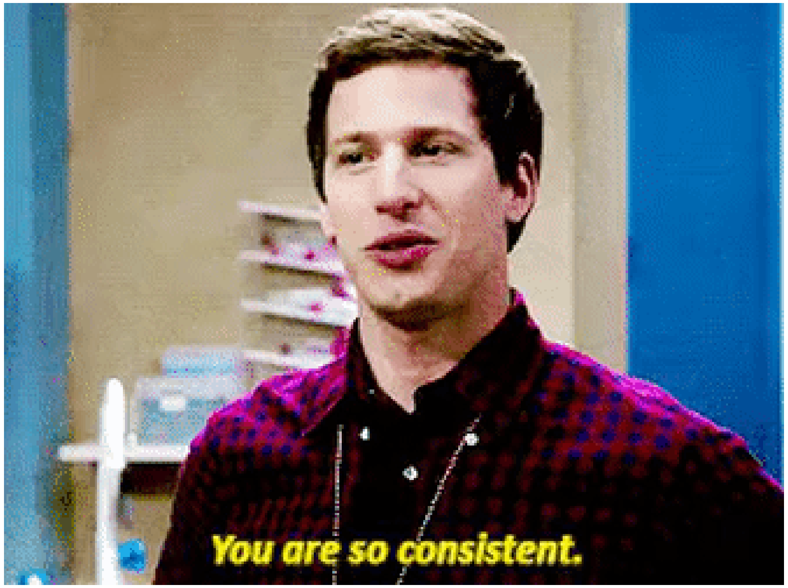
```
───my_package (/some/path)
    │   __init__.py
    ├───plot
    │   __init__.py
    ├───model
    │       __init__.py
...
───my_package (/some/another_path)
    │   __init__.py
    ├───plot
    │   __init__.py
    ├───computation
    │       __init__.py
  ...
```

```
(.venv) ~\consistent_importing> python
>>> import sys
>>> sys.path
[
  '/some/path',
  '/some/another_path'
]
>>> import my_package.model
hello from path.my_package.model
>>> import my_package.computation
Traceback (most recent call last):
  File "", line 1, in
    import my_package.computation
ModuleNotFoundError: No module named 'my_package.computation'
```

III. What is the best importing strategy?



1. (PEP) Sort imports



Benefit: Consistent order of import statements

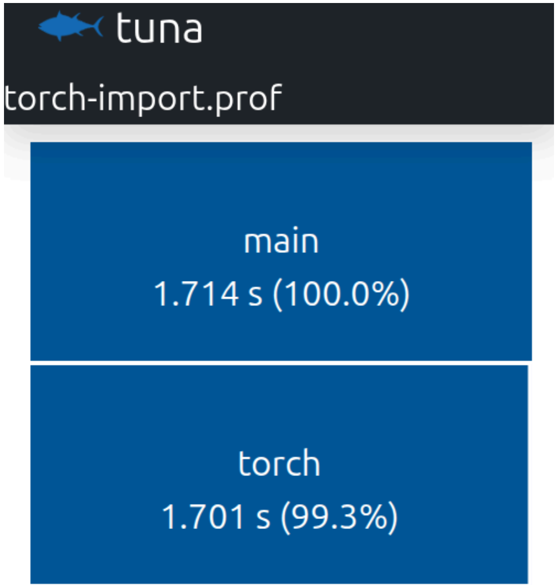
2. (PEP) Place imports at the top of a file

Benefit: Being crystal clear about created dependencies

2. (EXCEPTION) Lazy imports of heavy modules

```
python -X importtime -c 'import torch' 2> torch-import.prof
uvx tuna torch-import.prof
```

```python
# src/evaluation.py

def evaluate_model(model: Model) -> None:
  import torch  # noqa: PLC0415
  ...

# src/__main__.py

from src.evaluation import evaluate_model

def main() -> None:

  if do_evaluate:
    evaluate_model(model)

  ...
```



Benefit: Reduction of startup time at some conditions

2. (EXCEPTION) Use TYPE_CHECKING for heavy types

```python
# src/model.py
from typing import TYPE_CHECKING

# lazy import to reduce startup time
if TYPE_CHECKING:
    import torch


class Model:
    def add_module(self, module: "torch.Module") -> None:
        print(f"Adding module: {module}")
        ...
```

Benefit: Reduction of startup time at some conditions

3. (PEP) Absolute imports

- Absolute imports are recommended, as they are usually more readable and tend to be better behaved (or at least give better error messages) if the import system is incorrectly configured (such as when a directory inside a package ends up on `sys.path`):

  ```
  import mypkg.sibling
  from mypkg import sibling
  from mypkg.sibling import example
  ```

  However, explicit relative imports are an acceptable alternative to absolute imports, especially when dealing with complex package layouts where using absolute imports would be unnecessarily verbose:

  ```
  from . import sibling
  from .sibling import example
  ```

  Standard library code should avoid complex package layouts and always use absolute imports.

Benefit: More informative and less ambiguous

4. Avoid using Namespace Packages

```
──my_package (/some/path)
  │   __init__.py
  ├──plot
  │   __init__.py
  ├──model
  │       __init__.py
...
──my_package (/some/another_path)
  │   __init__.py
  ├──plot
  │   __init__.py
  ├──computation
  │       __init__.py
 ...
```

```
(.venv) ~\consistent_importing> python
>>> import sys
>>> sys.path
[
  '/some/path',
  '/some/another_path'
]
>>> import my_package.model
hello from path.my_package.model
>>> import my_package.computation
Traceback (most recent call last):
  File "", line 1, in
    import my_package.computation
ModuleNotFoundError: No module named 'my_package.computation'
```

Benefit: Avoid uncertain behavior of namespace packages

5. (PEP) Avoid using wildcard imports

```python
# base_implementation.py
def fast_add(a: float, b: float) -> float:
    return a + b

def fast_multiply(a: float, b: float) -> float:
    return a * b

# cython_accelerated_implementation.py (optional module)
def fast_add(a: float, b: float) -> float: ...

# public_api.py
from base_implementation import *  # noqa: F403

try:  # (cython_accelerated_implementation.py could be missing)
    from cython_accelerated_implementation import *  # noqa: F403
except ImportError:
    pass

# main.py
from public_api import fast_add
from public_api import fast_multiply
```

Benefit: Avoid ambiguity and namespace pollution

5. (PEP) Avoid using wildcard imports

```python
# base_implementation.py
def fast_add(a: float, b: float) -> float:
    return a + b

def fast_multiply(a: float, b: float) -> float:
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def fast_add(a: float, b: float) -> float: ...

# public_api.py
from base_implementation import *  # noqa: F403

try:  # (cython_accelerated_implementation.py could be missing)
    from cython_accelerated_implementation import *  # noqa: F403
except ImportError:
    pass

# main.py
from public_api import fast_add
from public_api import fast_multiply
```

Benefit: Avoid ambiguity and namespace pollution

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    pass

# main.py
from public_api import fast_add
from public_api import fast_multiply
```

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try:  # (cython_accelerated_implementation.py could be missing)
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from base_implementation import *  # noqa: F403

try:  # (cython_accelerated_implementation.py could be missing)
    from cython_accelerated_implementation import *  # noqa: F403
except ImportError:
    pass

# main.py
from public_api import fast_add
from public_api import fast_multiply
```

Benefit: Avoid ambiguity and namespace pollution

6. (PEP) Imports should be grouped

```python
# standard library imports
import filecmp
import shutil
from pathlib import Path

# related third party imports
import pandas as pd
import pytest
import numpy as np

# local application/library specific imports
from common.constants import current_version
from common.constants import default_model_type
from dashboard.model.model import Model
from dashboard.model.model import ModelType
from source.db import DB
from source.connector.adapter import TimeSeriesAdapter
```

Benefit: Immediate visual separation of different types of dependencies

6. (PEP) Imports should be grouped

```python
# standard library imports
import filecmp
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import pandas as pd
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from common.constants import current_version
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from dashboard.model.model import Model
from dashboard.model.model import ModelType
from source.db import DB
from source.connector.adapter import TimeSeriesAdapter
```

Benefit: Immediate visual separation of different types of dependencies

7. (PEP) Import one definition per line


```python
import filecmp
import shutil
from pathlib import Path

import pandas as pd
import pytest
import numpy as np

from common.constants import current_version
from common.constants import default_model_type
from dashboard.model.model import Model
from dashboard.model.model import ModelType
from source.db import DB
from source.connector.adapter import TimeSeries
```

Benefit: Reduction of version control conflicts

7. (PEP) Import one definition per line


```python
import filecmp
import shutil
from pathlib import Path

import pandas as pd
import pytest
import numpy as np

from common.constants import current_version
from common.constants import default_model_type
from dashboard.model.model import Model
from dashboard.model.model import ModelType
from source.db import DB
from source.connector.adapter import TimeSeries
```

Benefit: Reduction of version control conflicts

8. Direct imports from the defining module

```python
# pkg_a/module_a.py


class ClassA:
    pass


# pkg_b/module_b.py

from pkg_a.module_a import ClassA


class ClassB:
    def compare(self, other: ClassA) -> bool:
        return str(self) == str(other)
```

```python
# main.py

from pkg_b.module_b import ClassA
from pkg_b.module_b import ClassB

class_b_instance = ClassB()
class_a_instance = ClassA()
print(class_a_instance)
print(class_b_instance)
```

Benefit: Being explicit about dependencies ("Explicit is better than implicit")

8. (EXCEPTION) Encapsulation (or "convenience imports")

```
│   main.py
├── os_ops
│   ├── _windows
│   │   ├── __init__.py
│   │   ├── path.py
│   │   └── ...
│   ├── _linux
│   │   ├── __init__.py
│   │   ├── path.py
│   │   └── ...
│   └── __init__.py
└── __init__.py
```

```python
# main.py
from os_ops import copy_file

copy_file(
  "source.txt",
  "destination.txt"
)
```

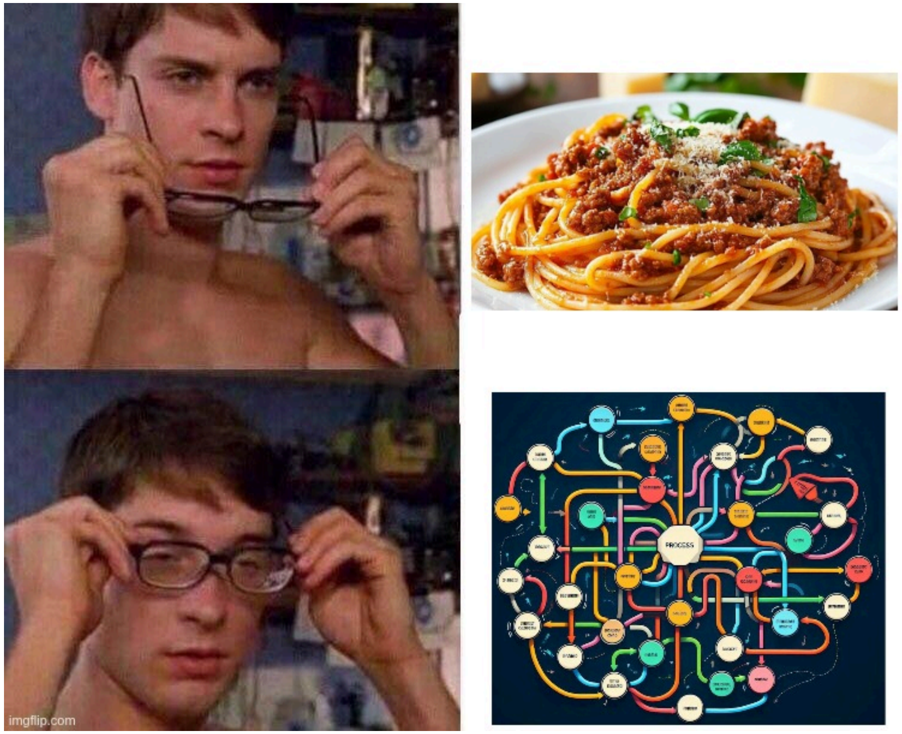
```python
# os_ops/__init__.py

import os

if os.name == 'nt':
    from ._windows.path import copy_file
elif os.name == 'posix':
    from ._linux.path import copy_file
else:
    raise OSError(f"Unsupported OS: {os.name}")
```

Benefits: Proxy advantages, short imports

9. Follow Acyclic Dependencies Principle (ADP)



Benefits: Loose coupling

IV. How internal dependencies impact a package architecture?

Why to care about clean modular structure?

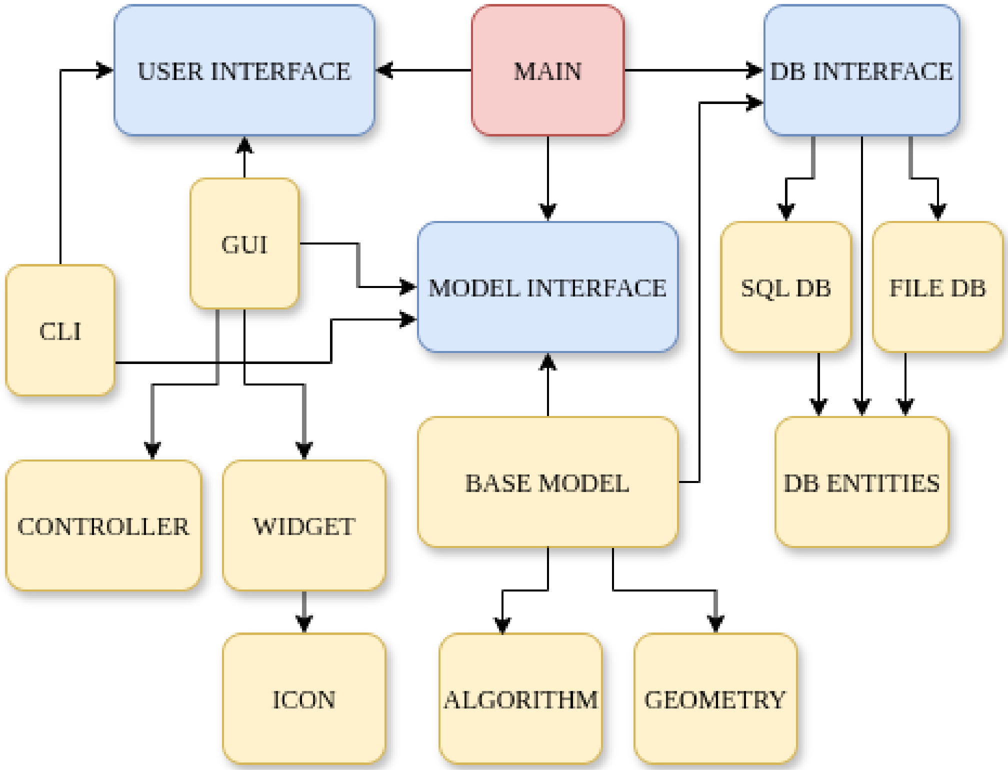
```
│   main.py
├───gui
│   │   __init__.py
│   └───widget
│       │   __init__.py
│       └───icon
│               __init__.py
...
└───base_model
    │   __init__.py
    └───geometry
            node.py
            edge.py
            __init__.py
...
```

```
# running tests inside a specific package
python -m pytest base_model/geometry

# linting a specific package
ruff check gui/widget/icon
```

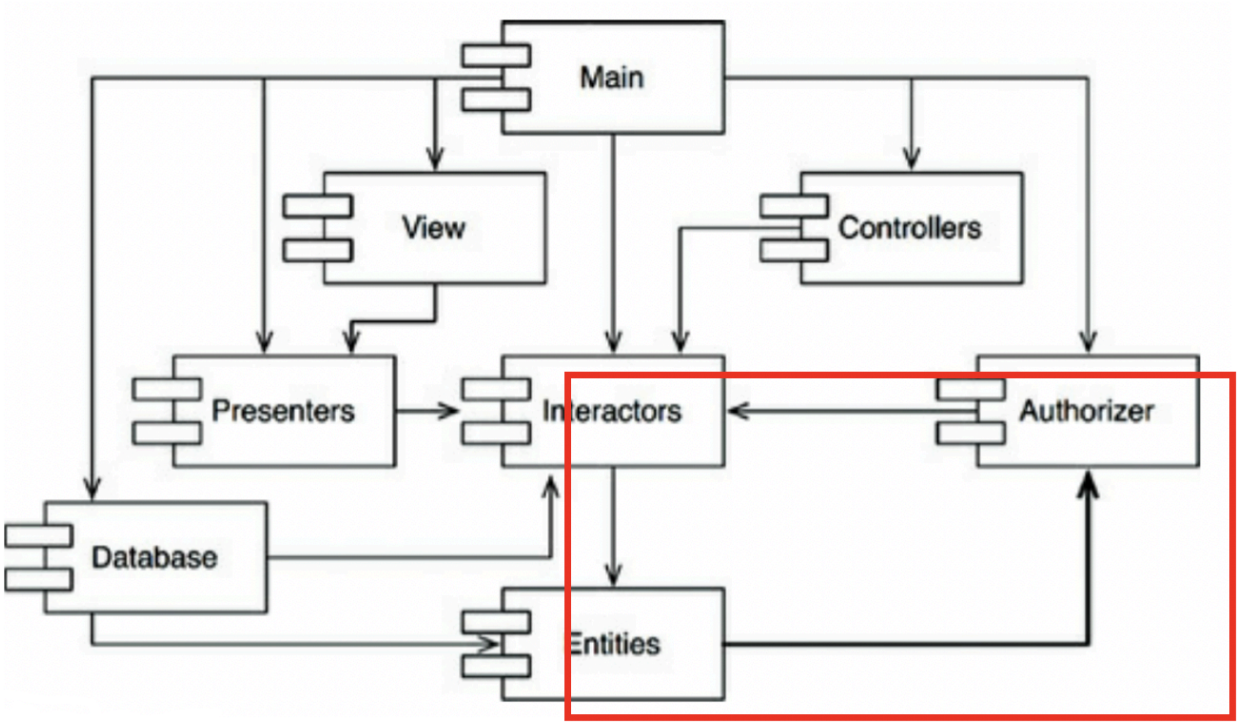
Benefit: Individual package as a separated component (divide and conquer)

Why to care about clean modular structure?



Benefit: Make the code easier to understand, increased maintainability

Why to care about clean modular structure?



Benefit: Easier to change one component without affecting another because of loose coupling

Python circular imports. A bug or a feature?

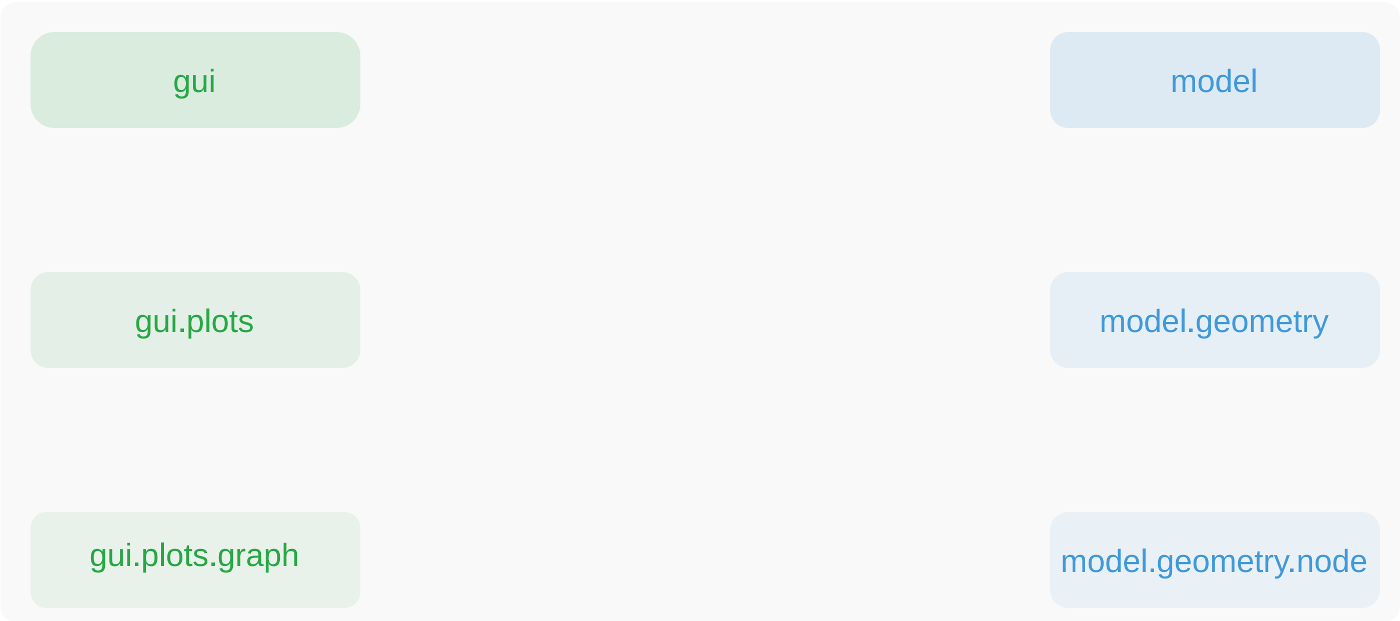
```
File "gui/__init__.py", line 1, in
    from model import Node
  File "model/__init__.py", line 1, in
    from .geometry import Node
  File "model/geometry/__init__.py", line 3, in
    from gui import Graph
    ^^^^^^^^^^^^^^^^^^^^^
ImportError: cannot import name 'Graph' from partially initialized module 'gui'
(most likely due to a circular import) (/gui/__init__.py)
```

Circular imports most of the time signal a design issue, but sometimes are used intentionally for plugin systems or late binding.

Re-exporting definitions through __init__.py

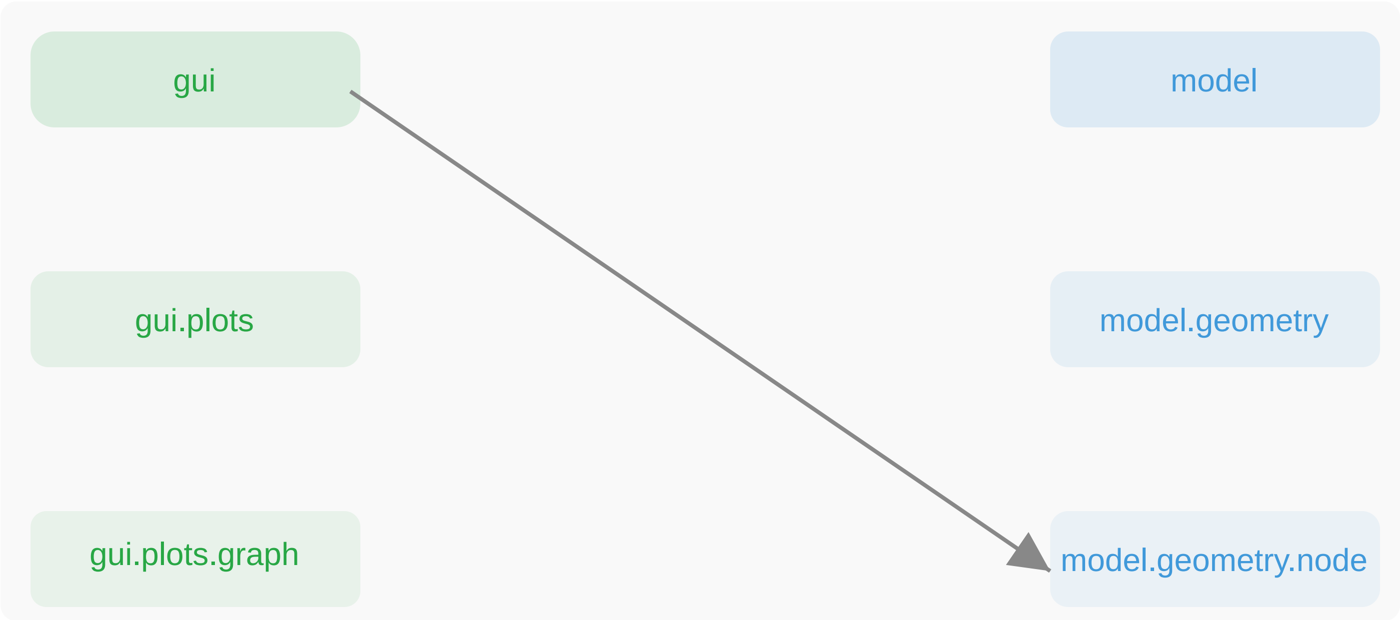
```python
# model/geometry/node.py
class Node: ...
# model/geometry/__init__.py
from .node import Node, function_a
from .edge import Edge, function_b
# model/__init__.py
from .geometry import Node, Edge, function_a, function_b
from .other_module import SomeOtherClass
# gui/__init__.py
from model import Node, Edge, function_a, function_b, SomeOtherClass
```

Circular dependencies between packages



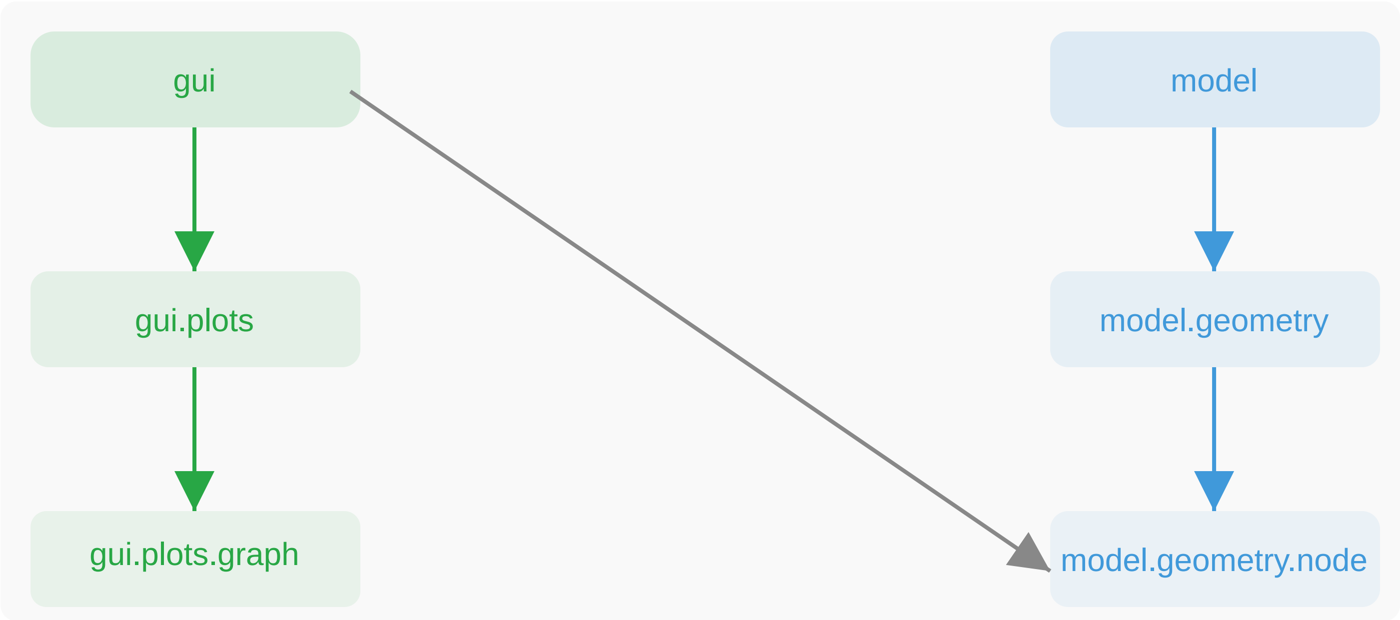
Lets consider packages "model" and "gui" having some subpackages (no imports yet)

Circular dependencies between packages



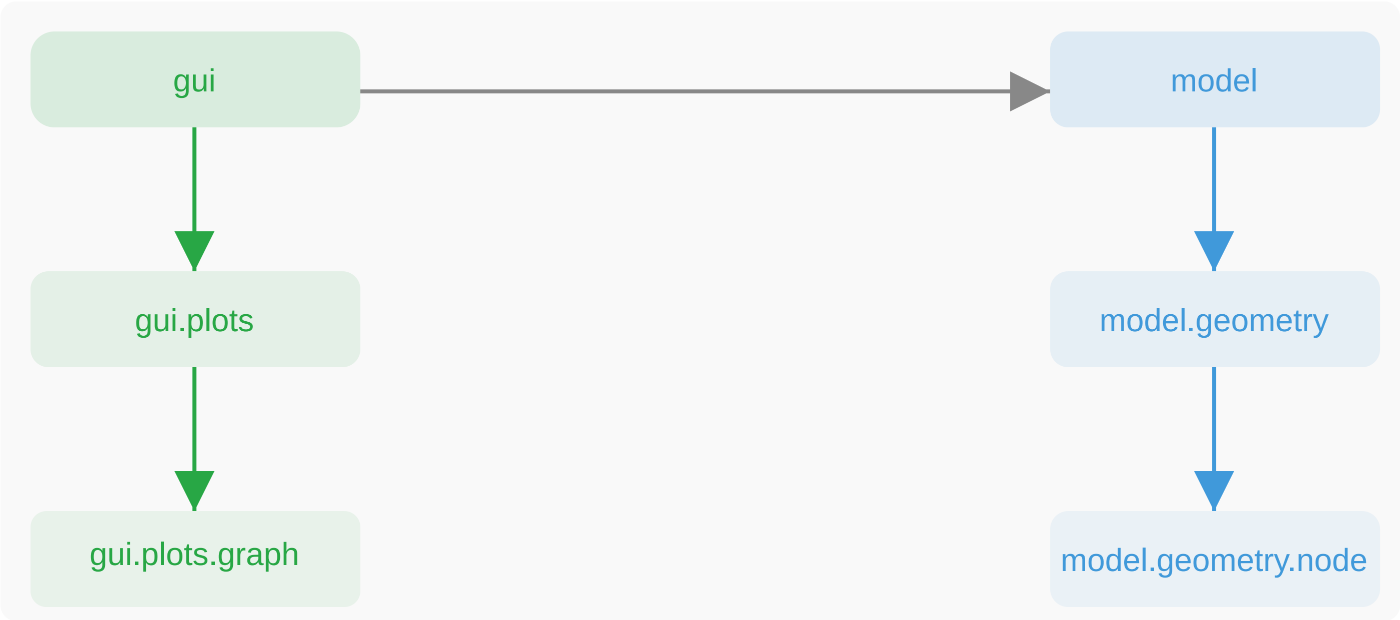
Package "gui" imports Node class from package "model" (module "model.geometry.node").

Circular dependencies between packages



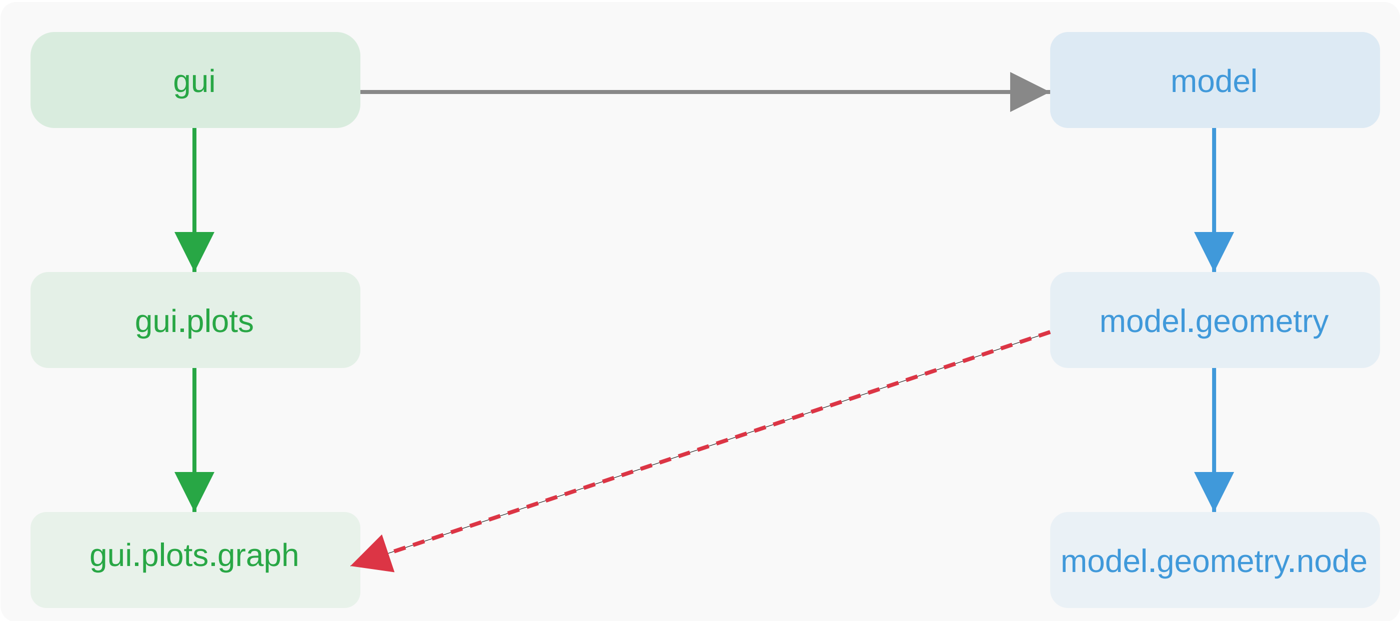
Package "gui" imports Node class from module "model.geometry.node".
Packages "model" and "gui" re-exporting everything through __init__.py.

Circular dependencies between packages



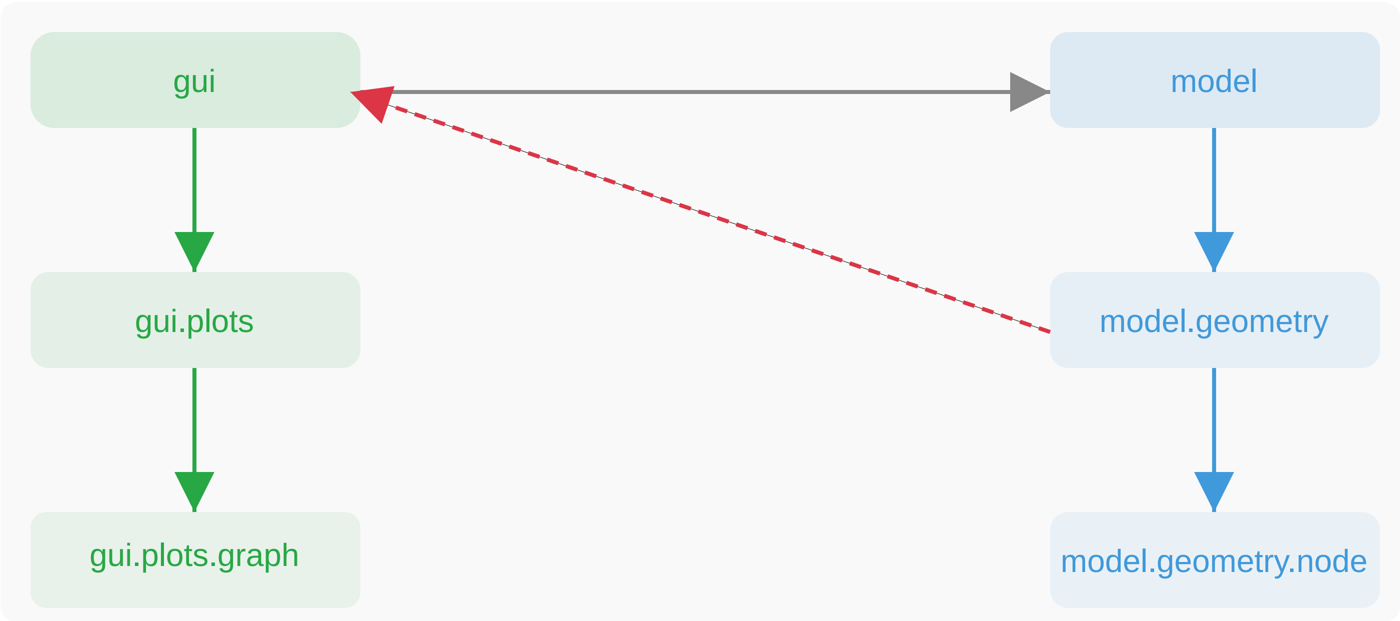
Package "gui" imports Node class from package "model". Packages "model" and "gui" re-exporting everything through __init__.py.

Circular dependencies between packages



Attempting to add a dependency from "model" to "gui" directly from the the module "gui.plots.graph".

Circular dependencies between packages



Attempting to add a dependency from "model" to "gui", using re-exported entity, creates a circular dependency.

Circular dependencies between packages

```python
# model/geometry/node.py
class Node: ...

# model/geometry/__init__.py
from .node import Node

# model/__init__.py
from .geometry import Node

# gui/__init__.py
from model import Node

# model/geometry/__init__.py
from gui import Graph
```

```
File "gui/__init__.py", line 1, in
    from model import Node
  File "model/__init__.py", line 1, in
    from .geometry import Node
  File "model/geometry/__init__.py", line 3, in
    from gui import Graph
    ^^^^^^^^^^^^^^^^^^^^^
ImportError: cannot import name 'Graph' from partially initialized module 'gui'
(most likely due to a circular import) (/gui/__init__.py)
```

V. How can we enforce the selected strategy in CI?

Ruff

```python
from functools import partial
import sys

import pandas as pd
from pydantic import BaseModel
from pydantic import Field

from my_another_package.graph import Graph
from my_another_package.graph import Node
from my_package.model import model
```

```toml
# ruff.toml
[lint]
select = [
    "I",  # isort                                    (1)
    "PLC0415",  # import-outside-top-level           (2)
    "TID252",  # relative-imports                    (3)
    "INP001",  # implicit-namespace-package          (4)
    "F403",  # undefined-local-with-import-star-usage (5)
]
[lint.isort]
known-first-party = ["my_another_package"]  #        (6)
force-single-line = true  #                          (7)
```

Ruff

```python
from functools import partial
import sys

import pandas as pd
from pydantic import BaseModel
from pydantic import Field

from my_another_package.graph import Graph
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import sys

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select = [
    "I",  # isort                                      (1)
    "PLC0415",  # import-outside-top-level             (2)
    "TID252",  # relative-imports                      (3)
    "INP001",  # implicit-namespace-package            (4)
    "F403",  # undefined-local-with-import-star-usage (5)
]
[lint.isort]
known-first-party = ["my_another_package"]  #          (6)
force-single-line = true  #                            (7)
```
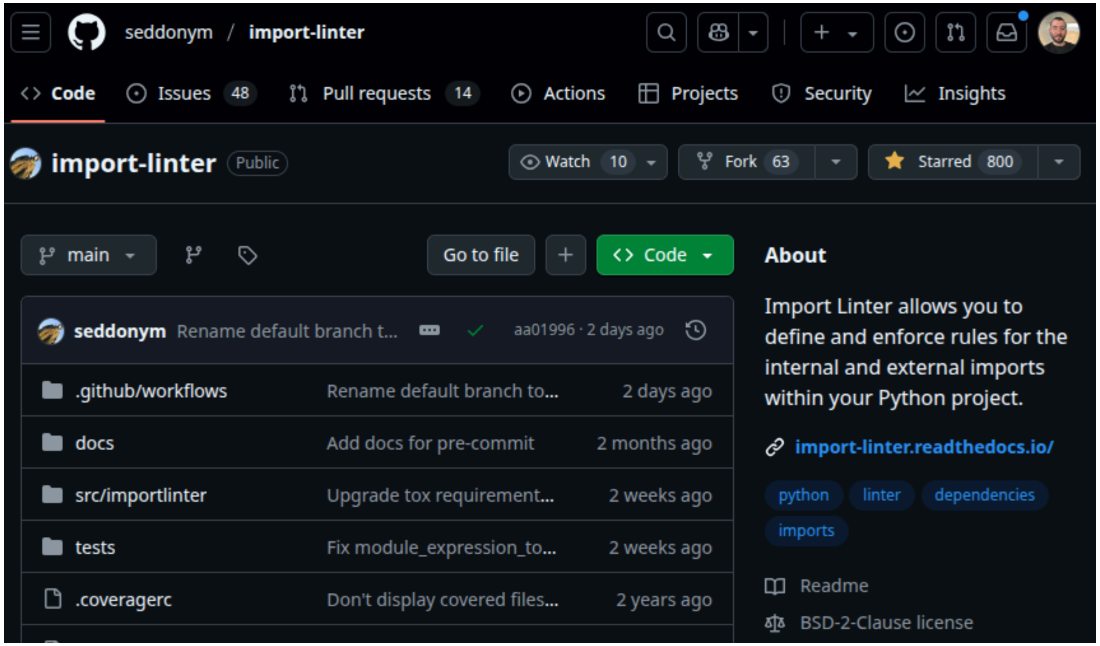

Import Linter



"Import Linter allows you to define and enforce rules for the internal and external imports within your Python project."

Import Linter - Forbidden modules

```
[importlinter]
root_package = mypackage

[importlinter:contract:1]
name = GUI cannot be imported from other packages
type = forbidden
source_modules =
  mypackage.model
  mypackage.db
forbidden_modules =
  mypackage.gui
```

```
(mypackage) jan@jan-Inspiron-3543:~$ lint-imports

=============
Import Linter
=============

Analyzed 134 files, 699 dependencies.
-------------------------------------

GUI cannot be imported from other packages KEPT

Contracts: 1 kept, 0 broken.
```

Import Linter - Layers

```
[importlinter]
root_package = my_package

[importlinter:contract:1]
name = Hierarchical architecture
type = layers
layers =
  mypackage.gui
  mypackage.model
  mypackage.db
```

```
(my_package) jan@jan-Inspiron-3543:~$ lint-imports

=============
Import Linter
=============

Analyzed 134 files, 699 dependencies.
-------------------------------------

Hierarchical architecture KEPT

Contracts: 1 kept, 0 broken.
```

Import Linter - Acyclic dependencies

```
pip install import-linter@git+https://github.com/K4liber/import-linter@issue/221_tree_contract
```

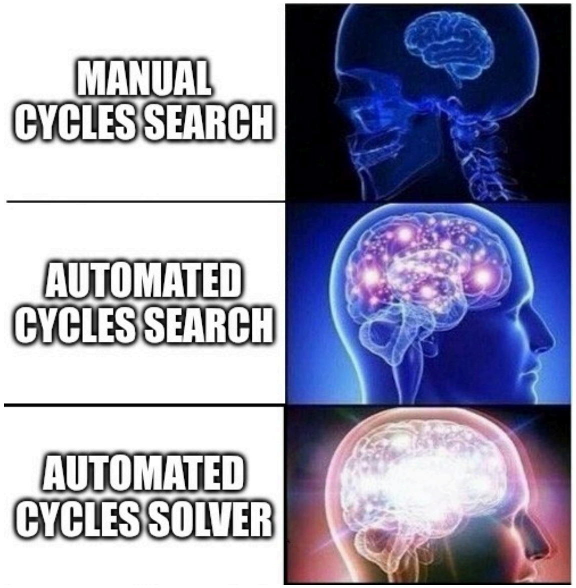
```
# .importlinter

[importlinter]
root_package = django

[importlinter:contract:1]
name=Acyclic dependecies
type=acyclic
packages=
  django
consider_package_dependencies = true
group_by_family = true
```

```
(django) jan@jan-Inspiron-3543:~$ lint-imports --verbose
```

Import Linter - Acyclic dependencies

```
Number of dependency cycles found for a contract 'Acyclic dependecies': 252
Package level cycles: 148
Module level cycles: 104

...

Package django contains a (package) dependency cycle:

  1. django.conf depends on django.views:

      - django.conf.urls -> django.views.defaults (l. 2)

  2. django.views depends on django.template:

      - django.views.defaults -> django.template (l. 9)

  3. django.template depends on django.urls:

      - django.template.defaulttags -> django.urls (l. 468)

  4. django.urls depends on django.conf:

      - django.urls.resolvers -> django.conf.urls (l. 744)

...
```

Import Linter - Cycles solver



Show cycle breakers using "minimum weighted feedback arc set" algorithm

Summary

1. Importing in Python can be done in many different ways
2. Choosing one, consistent way, will reduce decision fatigue
3. Clean modular structure of your Python code matters
4. Following Acyclic Dependencies Principle (ADP) leads to a better software design
5. Using tools like Ruff and Import Linter facilitate checks automation

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