PyCon Greece

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Consistent importing

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2005
Game maker enthusiast

2015
First Python code (internship)

2019
Using Python at work

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consistent_importing_all_slides.pdf

Ørsted[1]

Global leader in offshore wind

~8000
All employees in 19 countries

~1000
IT employees

~100
Pythonistas

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Agenda

I. How importing in Python works?
II. How to import in a consistent way?
III. How internal dependencies impact a package architecture?
IV. How we can enforce the selected importing strategy in CI?

Consistent importing

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

✗ Cons:

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

Consistency reduces decision fatigue

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

Python importing without consistency

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 world!")
...
>>> hello_world()
Hello world!
>>> exit()
(base) jan@jan-Inspiron-3543:~/consistent_importing$ python
Python 3.12.8 [GCC 11.2.0] on linux
>>> hello_world()
Traceback (most recent call last):
  File "", line 1, in
NameError: name 'hello_world' is not defined
>>>
```

Python module

```python
# my_module.py
def hello_world() -> None:
  print("Hello world!")

print("Hello from my_module!")
```

```
(base) jan@jan-Inspiron-3543:~/consistent_importing$ python
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 world!
>>>
```

Python package

```
(base) :~/consistent_importing$ tree /f

│   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
>>> from pprint import pprint
>>> pprint(sys.path)
[
 '',
 'C:\\Users\\JBIEL\\Desktop\\projects\\report-filler',
 'C:\\Users\\JBIEL\\Desktop\\projects\\consistent_importing',
 'C:\\Users\\JBIEL\\AppData\\Local\\Programs\\Python\\Python313\\python313.zip',
 'C:\\Users\\JBIEL\\AppData\\Local\\Programs\\Python\\Python313\\DLLs',
 'C:\\Users\\JBIEL\\AppData\\Local\\Programs\\Python\\Python313\\Lib',
 'C:\\Users\\JBIEL\\AppData\\Local\\Programs\\Python\\Python313',
 'C:\\Users\\JBIEL\\Desktop\\projects\\consistent_importing\\.venv',
 'C:\\Users\\JBIEL\\Desktop\\projects\\consistent_importing\\.venv\\Lib\\site-packages'
]
```

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

```
(.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!")
```

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

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

Package vs Namespace Package

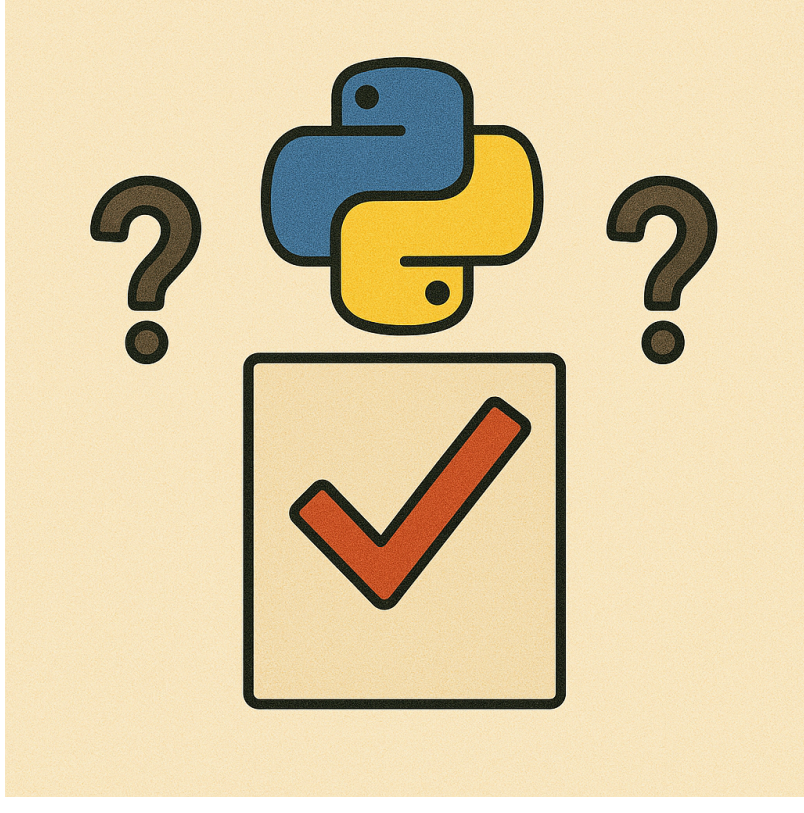
```
---my_package (/some/path)
    |   __init__.py
    |---plot
    |   __init__.py
    |---model
    |       __init__.py
...
---my_package (/some/another_path)
    |   __init__.py
    |---plot
    |   __init__.py
    |---computation
    |       __init__.py
  ...
```

```
(.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'
```

```
# src\on_import\module_b.py
print("greetings from module_b.py")
a = 123
# src\on_import\module_a.py
print("hello from module_a.py")

def function_a() -> None:
    import src.on_import.module_b
    print(dir(src.on_import.module_b))

print("goodbye from module_a.py")
# src\on_import\main.py
from src.on_import.module_a import function_a
import inspect

print("hello from main.py\n")
print(inspect.getsource(function_a))
function_a()
print("goodbye from main.py")
```

```
(.venv) >python -m src.on_import.main
hello from module_a.py
goodbye from module_a.py
hello from main.py

def module_function() -> None:
    import src.on_import.module_b
    print(dir(src.on_import.module_b))

greetings from module_b.py
[..., '__name__', '__package__', 'a']
goodbye from main.py
```

II. What is the best importing strategy?



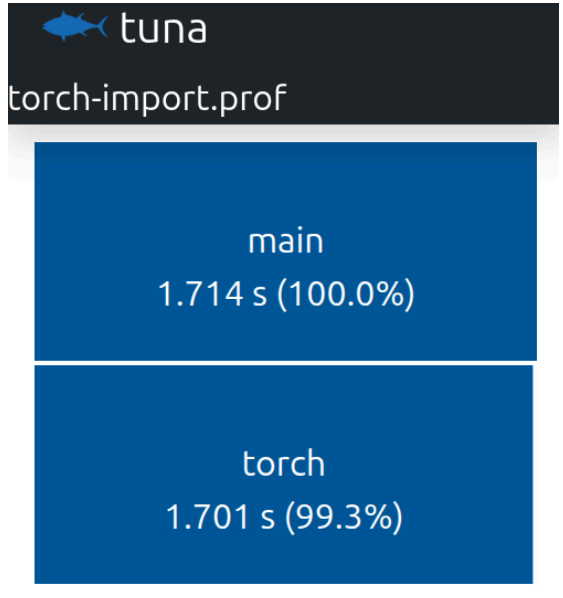
1. (PEP) Place imports at the top of a file[3]

Benefit: Transparency about dependencies

2. 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 circumstances

3. Do not overuse "if TYPE_CHECKING:"

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

if TYPE_CHECKING:
    import torch


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

Benefit: Avoiding circular dependencies

4. (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

5. 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 TimeSeriesAdapter
```

Benefit: Reduction of version control conflicts

6. (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

7. Use only well-known abbreviations

```
import os
import sys

import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
import sklearn as sk
import tensorflow as tf

import windows_temporary_file as wtf
```

Benefit: Avoid confusion on what the abbreviation stands for

8. 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

9. (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

10. Import directly from module where a definition is defined

```
(base):~/$ tree /f
│   main.py
├── os_ops
│   ├── _windows
│   │   ├   __init__.py
│   │   │   path.py
│   │   │   ...
│   │
│   ├── _linux
│   │   ├   __init__.py
│   │   │   path.py
│   │   │   ...
│   └── __init__.py
└─ __init__.py
```

```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}")
```

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

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

Benefit: Avoid ambiguity

III. How internal dependencies impact a package architecture?

Why to care about clean modular structure?

- ✓ **Concerns separation**
- ✓ Collaboration
- ✓ Maintainability

```
(base) jan@jan-Inspiron-3543:~/$ tree /f
│   main.py
├───gui
│   │   __init__.py
│   └───plots
│       │   __init__.py
│       └───graph
│               __init__.py
└───model
    │   __init__.py
    └───geometry
            node.py
            edge.py
            __init__.py
```

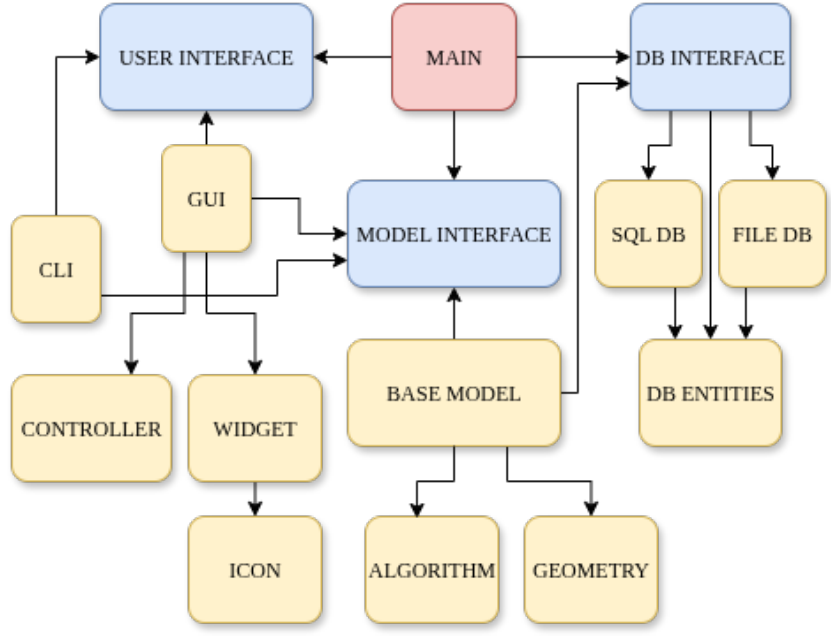
```
# running tests inside a specific package
python -m pytest model/geometry
# linting a specific package
ruff check gui/plots
```

Why to care about clean modular structure?

- ✓ Concerns separation
- ✓ **Collaboration**
- ✓ Maintainability

Why to care about clean modular structure?

- ✓ Concerns separation
- ✓ Collaboration
- ✓ **Maintainability**

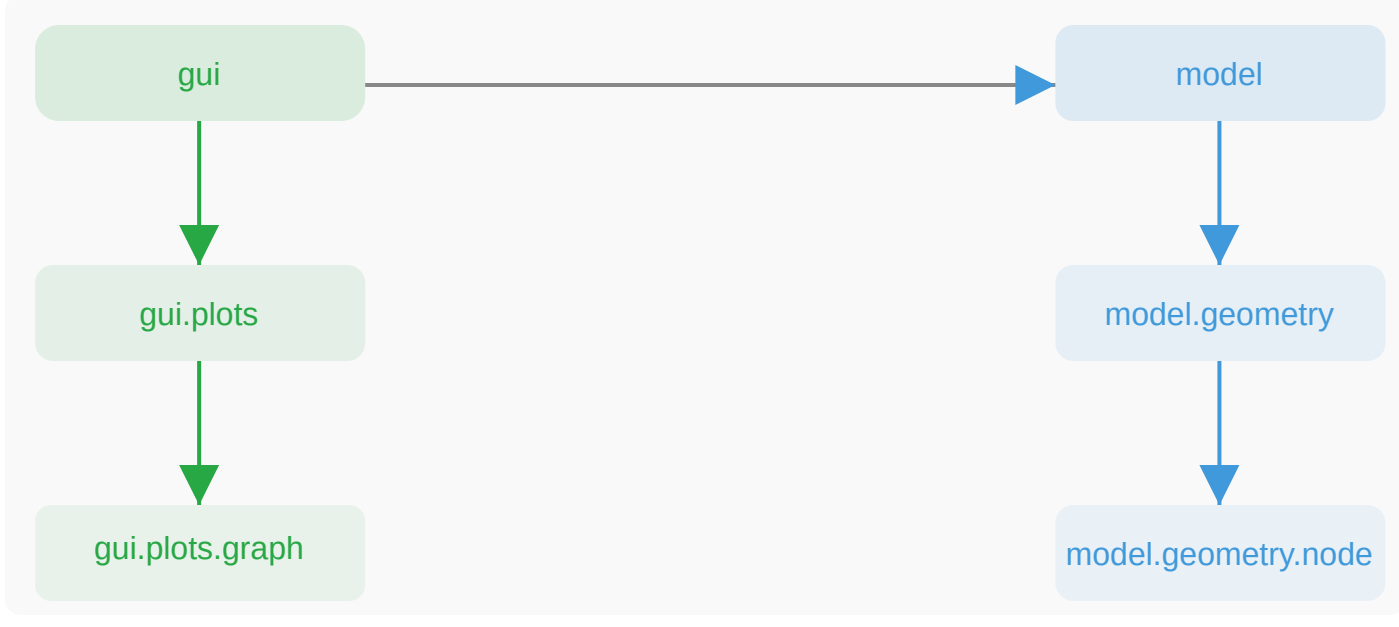


Python circular imports. A bug or a feature?

```
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)
```

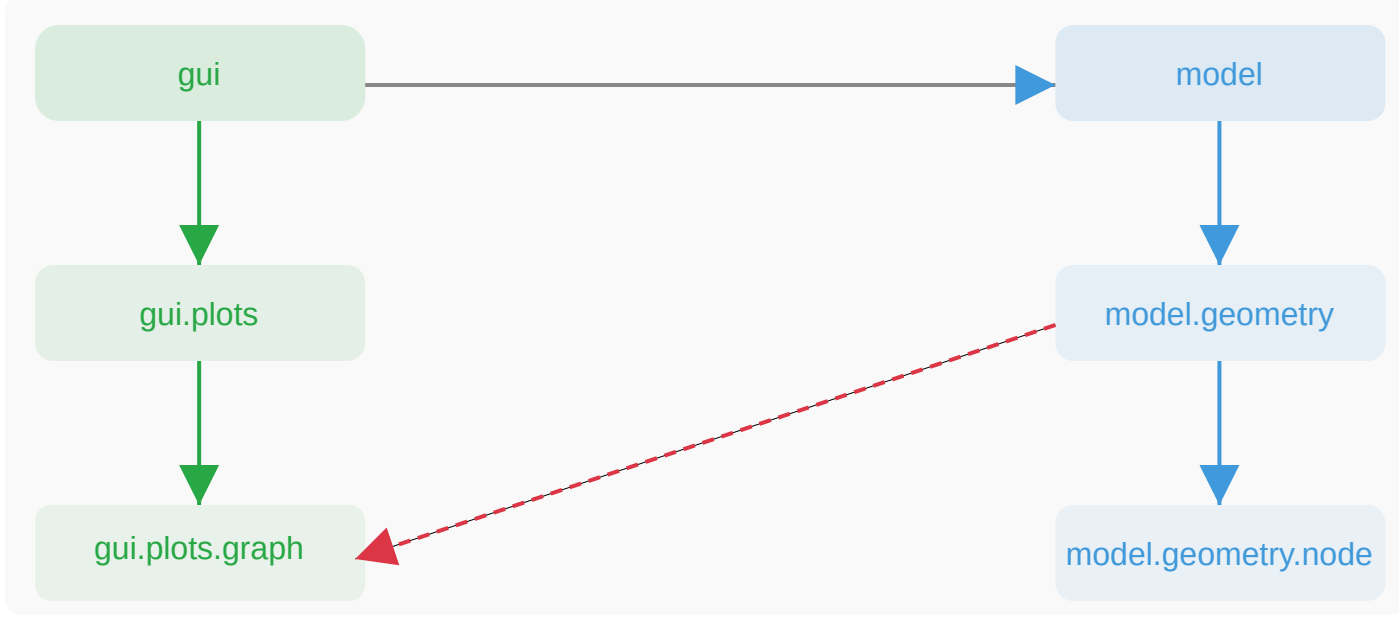
Circular imports often signal a design issue, but sometimes are used intentionally for plugin systems or late binding.

Circular dependencies between packages



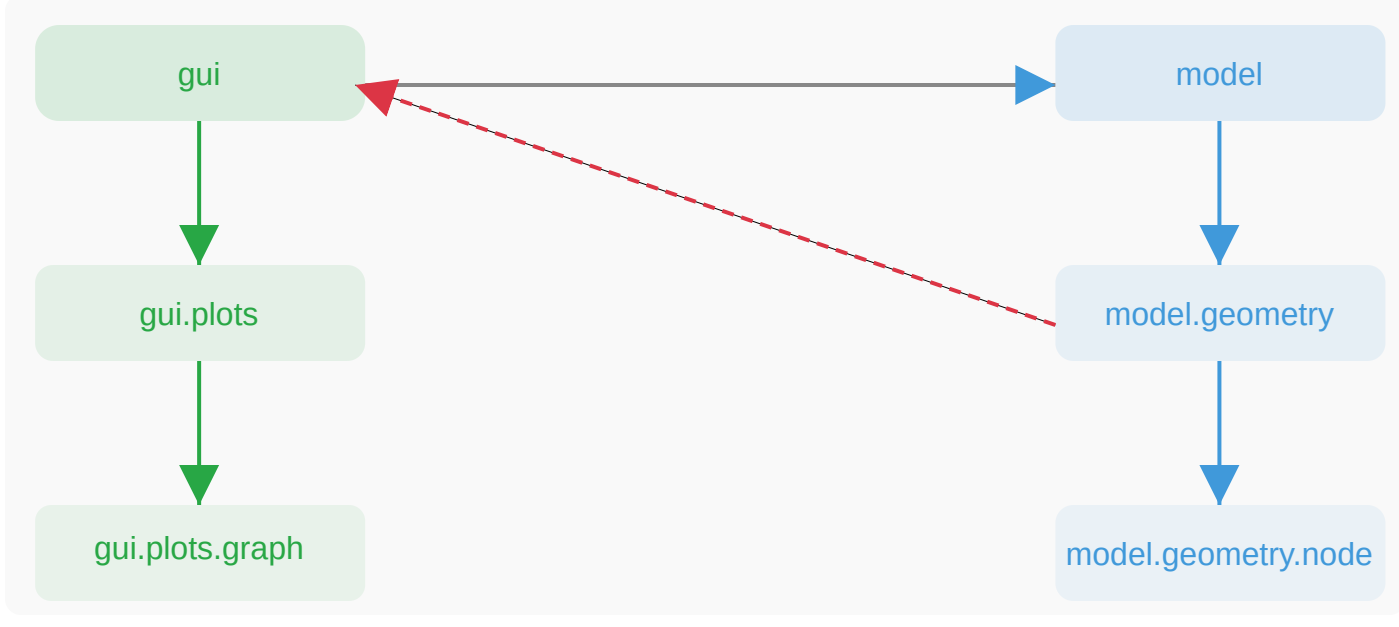
Packages "model" and "gui" re-exporting everything through __init__.py.
Package "gui" imports from "model".

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)
```

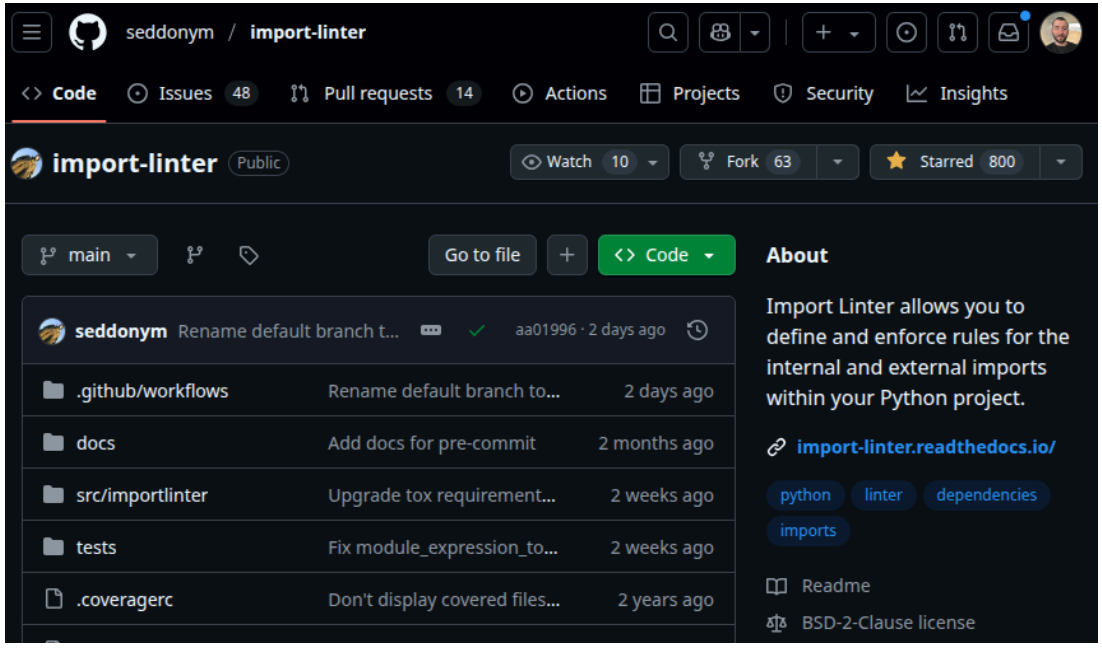
IV. How can we enforce the selected strategy in CI?

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
    "PLC0415",  # import-outside-top-level
    "TID252",  # relative-imports
    "F403",  # undefined-local-with-import-star-usage
]

[lint.isort]
force-single-line = true
known-first-party = ["my_another_package"]
```

Import Linter[4]



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

```
# .importlinter

[importlinter]
root_package = my_package

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

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

---------
Contracts
---------

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

GUI cannot be imported from other packages KEPT

Contracts: 1 kept, 0 broken.
```

AcyclicContract

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

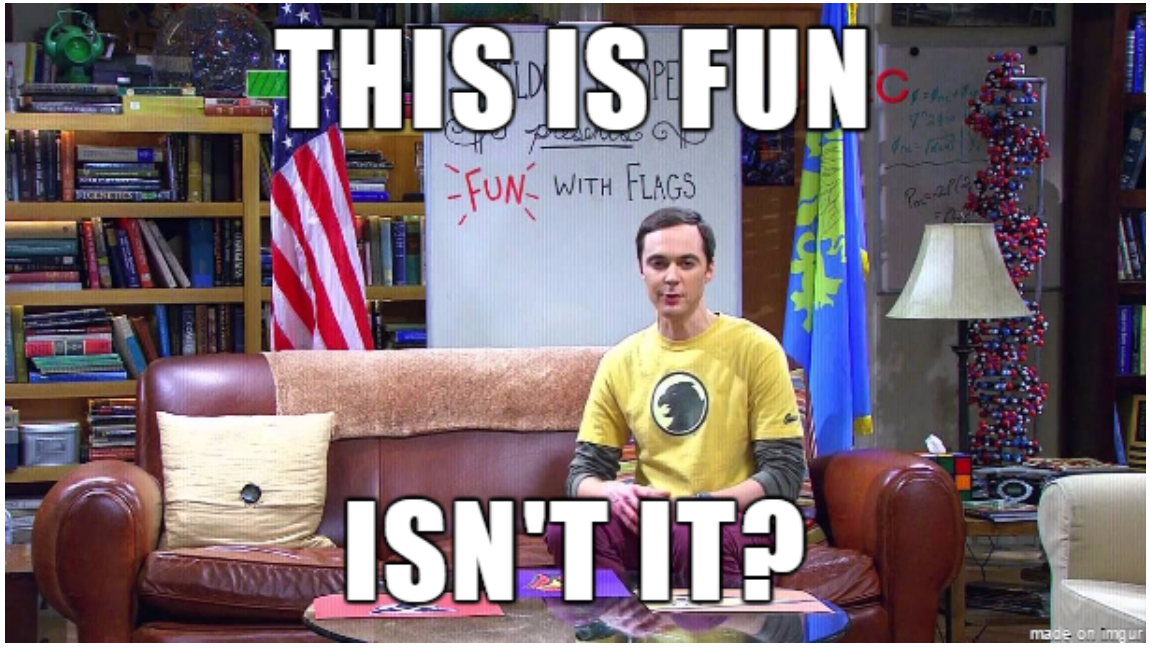
```
# .importlinter

[importlinter]
root_packages =
  django

[importlinter:contract:1]
name=Acyclic
type=acyclic
consider_package_dependencies=true
max_cycle_families=-1
exclude_parents=
  django.test
```

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

Check upholding of AcyclicContract in django

```
...

>>>> Cycles family for parent module 'django'

Sibilings:
(
  django.apps
  django.core
)

Number of cycles: 1

Cycle 1 (package dependency):

(
 -> django.apps (full path: 'django.apps.config')
 -> django.core (full path: 'django.core.exceptions')
 -> django.core (full path: 'django.core.checks.model_checks')
 -> django.apps
)

<<<< Cycles family for parent module 'django'

Number of cycle families found for a contract 'AcyclicDependencies': 167
Number of cycle families with package dependencies: 88
```

ADP (Acyclic Dependencies Principle)

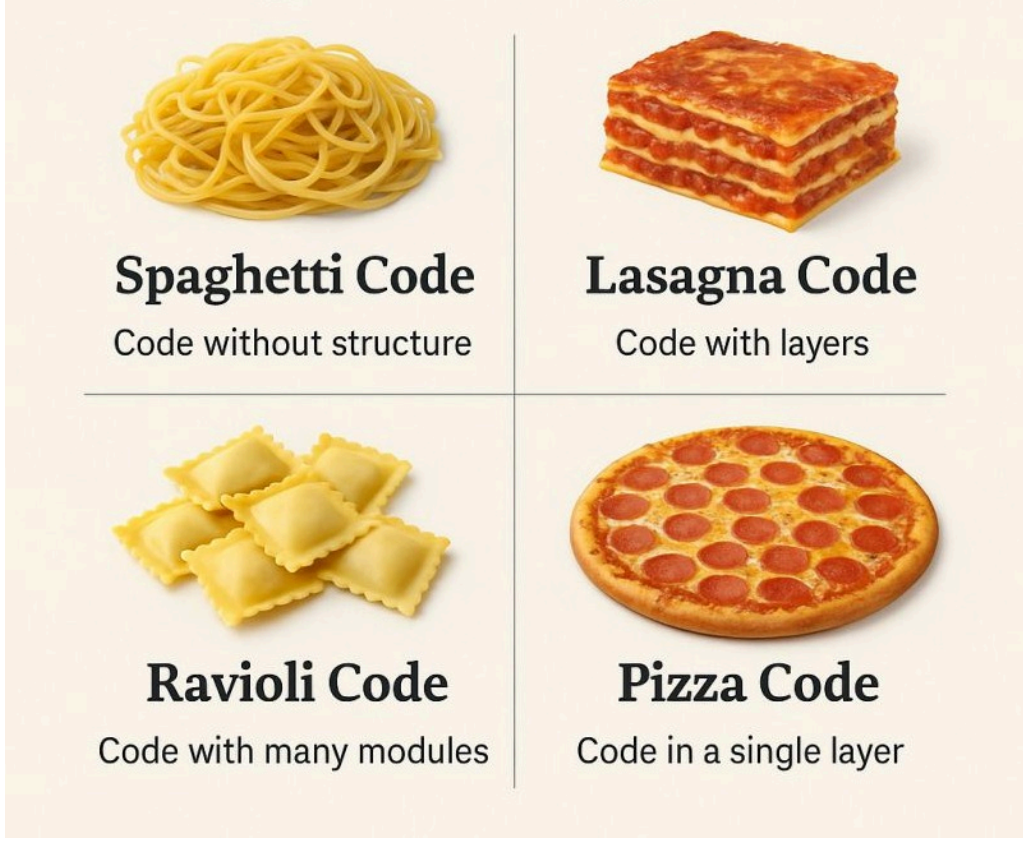


Could a development have been more fun for django developers if they had used AcyclicContract from the start of the development?

Bibliography

1. Photo by Lester Hsu, https://orsted.com/en/media/news/2022/04/20220421515811
2. Why do successful people wear the same outfits every day?, https://www.todaywellspent.com/blogs/articles/why-do-successful-people-wear-the-same-outfits-every-day
3. PEP-0008, Imports, https://peps.python.org/pep-0008/#imports
4. Import Linter, https://github.com/seddonym/import-linter
5. Italian pasta code, Lynn (Yu Ling) Wang, https://www.linkedin.com/in/yuling-wang-jobmenta/

(EXTRA) Python code that can adapt to changing requirements



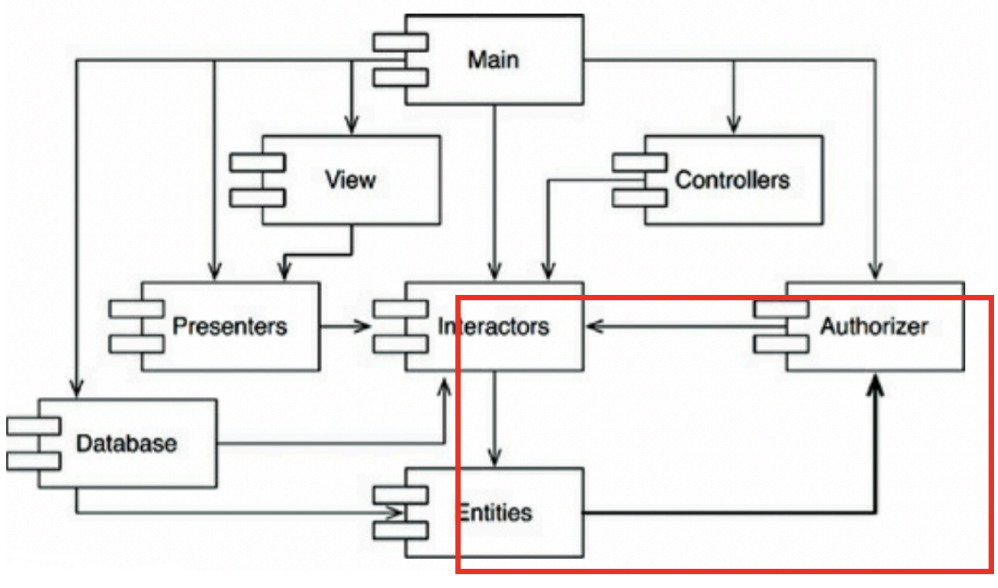
Using Python, it is easy to cook some italian pasta code [5]

Clean code principles

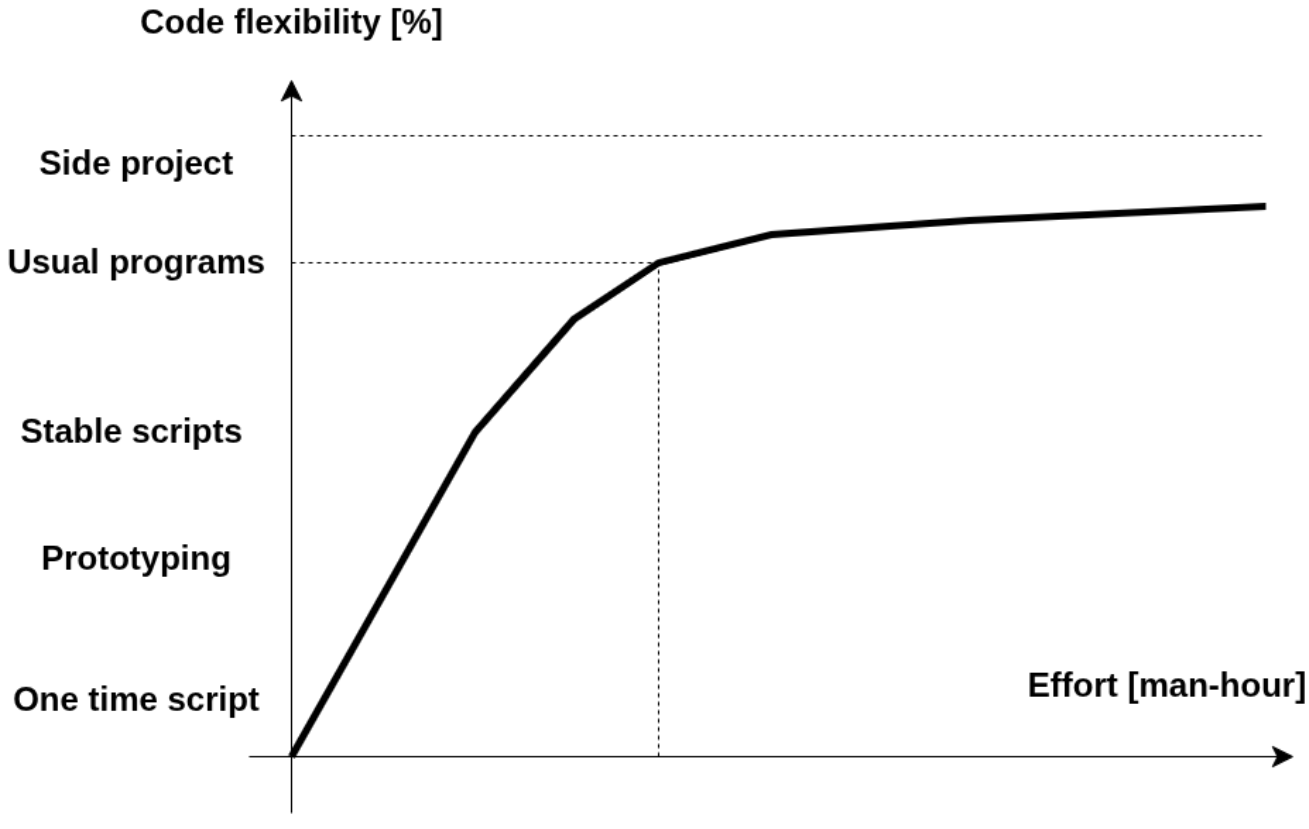
Uncle Bob
Clean Code: A Handbook of Agile Software Craftsmanship
2008

- **SRP** - Single Responsibility Principle
- **OCP** - Open/Closed Principle
- **LSP** - Liskov Substitution Principle
- **ISP** - Interface Segregation Principle
- **DIP** - Dependency Inversion Principle
- **DRY** - Don't Repeat Yourself
- **KISS** - Keep It Simple, Stupid
- **YAGNI** - You Aren't Gonna Need It
- **POLA** - Principle of Least Astonishment
- **ADP** - Acyclic Dependencies Principle

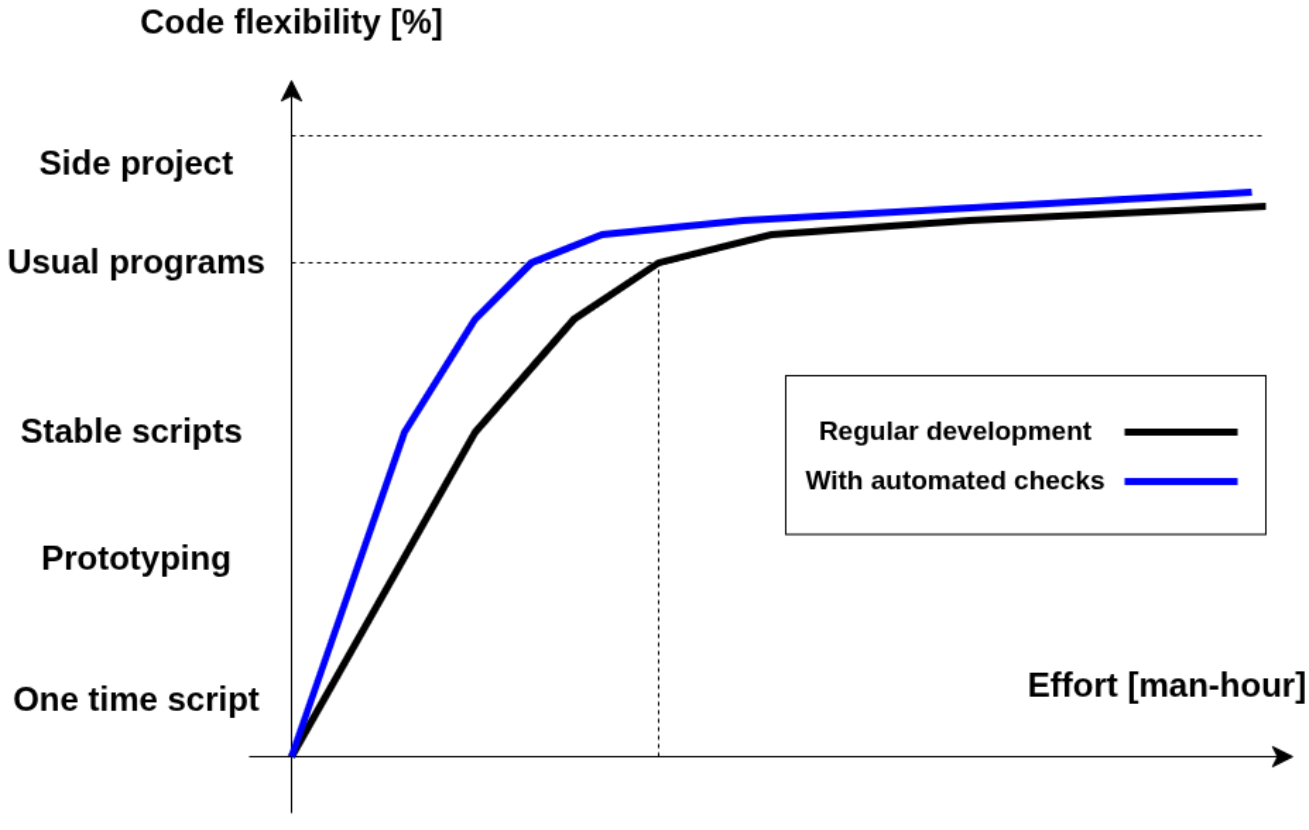
Acyclic dependencies principle (ADP)



- make the code hard to understand, thus reducing maintainability
- harder to change one component without affecting another because of strong coupling
- impossible to test each individual component because they can't be separated since they act as a single component



Effort vs benefit of applying clean code principles



Automated checks of clean code principles violations