Plug Life Into Your Codebase

Making an established Python codebase pluggable

Bianca Henderson

April 22, 2023

Hello! 🔌

Who am I?

- Software engineer at Anaconda
- Taught myself Python via books + creating text-based adventure games
- My favorite thing to work on is CLIs
- Also interested in video games, board games, science/math, 3D printing, AI research, art, writing, music, etc.

Who is this talk for?

- Developers who are curious about plugin infrastructure
- Anyone interested in learning more about conda or pluggy
- Codebase maintainers who are interested in expanding the functionality of their Python project!

Agenda

What we'll cover in this talk

1 | What are plugins?

2 | Introducing `pluggy`

3 | A real-world example

4 | Other use cases

5 | Reference materials

What are plugins?

With a sufficient number of users of an API,

it does not matter what you promise in the contract:

all observable behaviors of your system will be

depended on by somebody.

– *Hyrum's Law*

Plugins are guardrails to alleviate the effects of Hyrum's Law

Analogy Time! 🔌

What are plugins?

What are plugins?

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What are plugins?

What are plugins?

What are plugins? (recap)

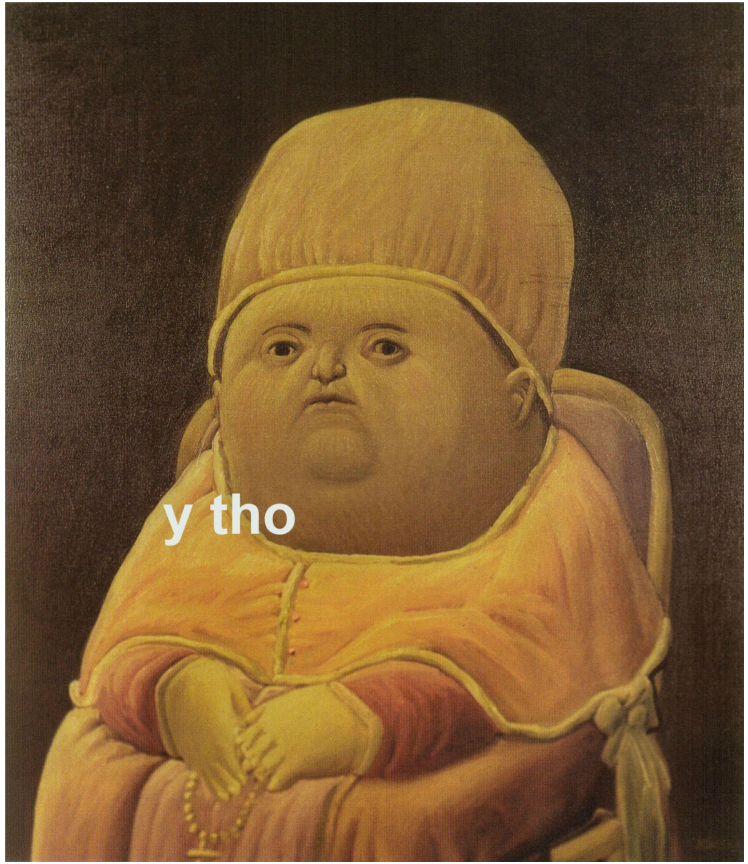
- Customization or extra feature
- Not part of the default codebase
- Discoverable
- Can be distributed separately
- Can be maintained by others

Plugin examples

- Browser extensions
- Language support in IDEs
- Media players
- … and more

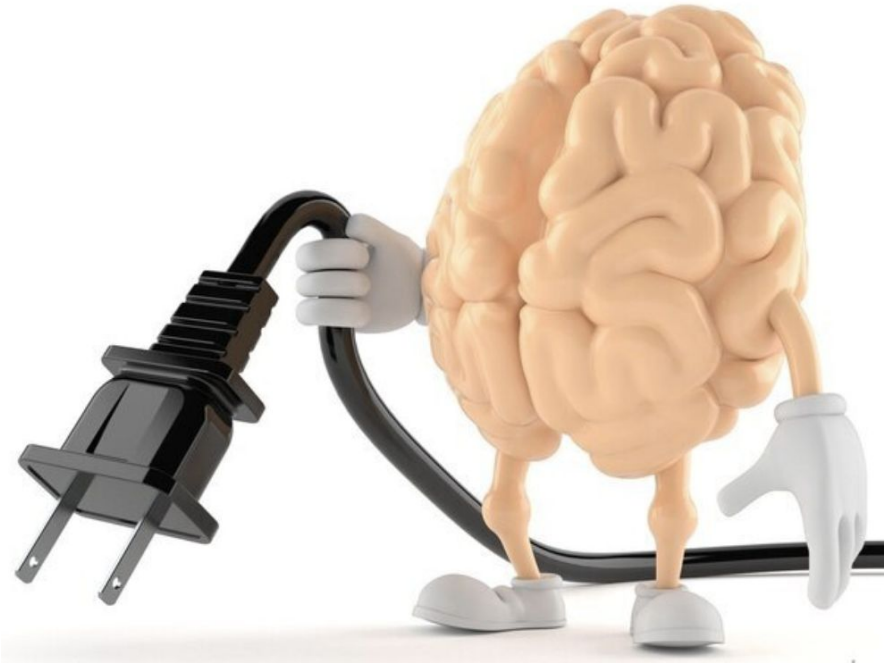
Why plugins?

- Encourages innovation
- Enforces separation of concern
- Enables community contributions
- Can address security issues
- Improves UX for end users



Plugin fundamentals

- Discovery
- Registration
- Application hooks
- API exposure



Introducing: `pluggy`!

- Open source and written in Python

  `github.com/pytest-dev/pluggy`
- Host, hooks, plugin
- At the core of `pytest`, `tox`, `devpi`

Documentation!

`https://pluggy.readthedocs.io/en/stable/index.html#`

How to use `pluggy`

- Have host
- Write plugin
- Define hook specifications
- Mark hook implementation

Why `pluggy`?

- Enables more loosely coupled systems
- Responsibility is on host program designer, not plugin designer
- Clear framework
- Straightforward yet customizable

pluggy Example

```
# example.py

import pluggy

hookspec = pluggy.HookspecMarker("example_for_pycon")
hookimpl = pluggy.HookimplMarker("example_for_pycon")



class ExampleSpec:
    """A hook specification namespace."""

    @hookspec
    def myhook(self, arg1, arg2):
        """My special little hook that you can customize."""

~file shortened~
```

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Every `pluggy` application needs a hook specification to register any plugin hooks

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The `hookimpl` object marks the implementations of the plugin hooks we have defined

pluggy Example

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~file shortened~
```

pluggy Example

```
# example.py (continued)

class MyPlugin:
    """A hook implementation namespace."""

    @hookimpl
    def myhook(self, arg1, arg2):
        print("inside Plugin_1.myhook()")
        return arg1 + arg2

pm = pluggy.PluginManager("example_for_pycon")
pm.add_hookspecs(ExampleSpec)

pm.register(MyPlugin())

results = pm.hook.myhook(arg1=1, arg2=2)
print(results)
```

pluggy Example

```
# example.py (continued)

class MyPlugin:
    """A hook implementation namespace."""

    @hookimpl
    def myhook(self, arg1, arg2):
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pm.register(MyPlugin())

results = pm.hook.myhook(arg1=1, arg2=2)
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```

This function with the hook implementation decorator <u>must</u> have the same name as the function decorated by the corresponding hook specification!

pluggy Example

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pluggy Example

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Here we create a plugin manager and add the specification

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```

We register the plugin here

pluggy Example

```
# example.py (continued)

class MyPlugin:
    """A hook implementation namespace."""

    @hookimpl
    def myhook(self, arg1, arg2):
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pm.add_hookspecs(ExampleSpec)

pm.register(MyPlugin())

results = pm.hook.myhook(arg1=1, arg2=2)
print(results)
```

We call the “myhook” hook here

Running the `pluggy` Example

```
$ python3 example.py
```

Running the `pluggy` Example

```
$ python3 example.py

inside MyPlugin.myhook()
[3]
```

pluggy Example

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# example.py (continued)

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```

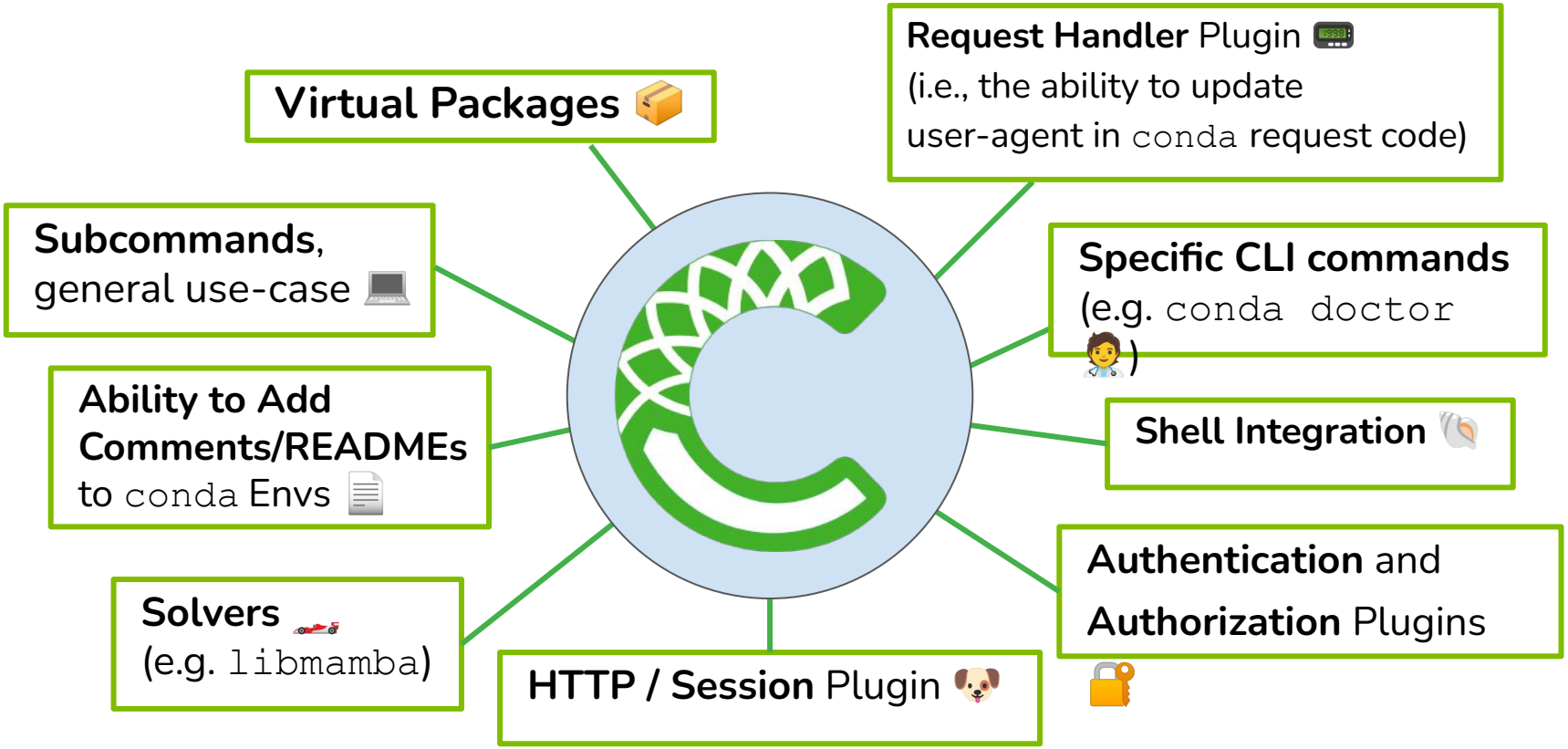
What the plugin is doing

A real-world example: Conda

What is conda?

- Package and environment manager
- Written in Python
- macOS, Windows, Linux
- Open source
- Language-agnostic
- More than 35 million active users
- Over 10 years old

Conda plugins use cases (not a complete list!)



Conda plugins use cases (not a complete list!)

Subcommands, general use-case 💻

Virtual Packages

Request Handler Plugin (i.e., the ability to update user-agent in `conda` request code)

Specific CLI commands (e.g. `conda doctor`)

Ability to Add Comments/READMEs to `conda` Envs

Shell Integration

Solvers (e.g. `libmamba`)

Authentication and **Authorization** Plugins

HTTP / Session Plugin

Let’s get into it some details!

How to use `pluggy`

- Have host —> Conda
- Write plugin —> Subcommands
- Define hook specifications
- Mark hook implementation

Conda’s plugin project structure

```
$ tree conda/plugins/

├── __init__.py
├── hookspec.py
├── manager.py
├── solvers.py
├── types.py
├── verbose_solver.py
└── virtual_packages
    ├── __init__.py
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Specific plugin types can be shipped by default with the codebase and exist in their own directories

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Customization of plugin management is possible with custom classes that subclass from `pluggy.PluginManager`

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conda/plugins/**hookspec.py**

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import pluggy

from .types import CondaSolver, CondaSubcommand, CondaVirtualPackage

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conda/plugins/**types.py**

```python
from __future__ import annotations
from typing import Callable, NamedTuple
from ..core.solve import Solver

class CondaSubcommand(NamedTuple):
    """
    A conda subcommand.
    :param name: Subcommand name (e.g., ``conda my-subcommand-name``).
    :param summary: Subcommand summary, will be shown in ``conda --help``.
    :param action: Callable that will be run when the subcommand is invoked.
    """

    name: str
    summary: str
    action: Callable[
        [list[str]],  # arguments
        int | None,  # return code
    ]
```

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```

ascii_graph/**ascii_graph.py**

```
import argparse
from sympy import symbols
from sympy.plotting import textplot

import conda.plugins

def ascii_graph(argv: list):
    parser = argparse.ArgumentParser("conda ascii-graph")
    parser.add_argument("x", type=float, help="First coordinate to graph")
    parser.add_argument("y", type=float, help="Second coordinate to graph")
    parser.add_argument("z", type=float, help="Third coordinate to graph")
    args = parser.parse_args(argv)

    s = symbols('s')
    textplot(s**args.x,args.y,args.z)

[continued on next slide...]
```

ascii_graph/**ascii_graph.py**

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[continued on next slide...]
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```

The part that gets executed as a plugin

[continued on next slide...]

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[continued from previous slide...]
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@conda.plugins.hookimpl
def conda_subcommands():
    yield conda.plugins.CondaSubcommand(
        name="ascii-graph",
        summary="A subcommand that takes three coordinates and prints out an ascii graph",
        action=ascii_graph,
        )
```

The `@hookimpl` decorator for marking the <u>implementation</u> of this subcommand plugin

ascii_graph/**ascii_graph.py**

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[continued from previous slide...]
def ascii_graph(argv: list):
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This function with the hook implementation decorator <u>must</u> have the same name as the function decorated by the corresponding hook specification!

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[continued from previous slide...]
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The ASCII Graph plugin project structure

```
$ tree ascii_graph/

└── ascii_graph
    ├── ascii_graph.py
    └── pyproject.toml
```

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```

ascii_graph/**pyproject.toml**

```toml
[build-system]
requires = ["setuptools>=61.0", "setuptools-scm"]
build-backend = "setuptools.build_meta"

[project]
name = "ascii-graph"
version = "1.0"
description = "My ascii graph subcommand plugin"
requires-python = ">=3.7"
dependencies = ["conda", "sympy"]

[tools.setuptools]
py_modules=["ascii_graph"]

[project.entry-points.conda]
ascii-graph = "ascii_graph"
```

ascii_graph/**pyproject.toml**

```
[build-system]
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ascii-graph = "ascii_graph"
```

The plugin's requirements and dependencies

ascii_graph/**pyproject.toml**

```
[build-system]
requires = ["setuptools>=61.0", "setuptools-scm"]
build-backend = "setuptools.build_meta"

[project]
name = "ascii-graph"
version = "1.0"
description = "My ascii graph subcommand plugin"
requires-python = ">=3.7"
dependencies = ["conda", "sympy"]

[tools.setuptools]
py_modules=["ascii_graph"]

[project.entry-points.conda]
ascii-graph = "ascii_graph"
```

Plugin Installation (in development mode)

```
$ pip install -e .

[lots o' output]

Successfully built ascii-graph
Installing collected packages: mpmath, sympy, ascii-graph
Successfully installed ascii-graph-1.0 mpmath-1.2.1 sympy-1.11.1
```

Plugin Installation (in development mode)

```
$ pip install -e .

[lots o' output]

Successfully built ascii-graph
Installing collected packages: mpmath, sympy, ascii-graph
Successfully installed ascii-graph-1.0 mpmath-1.2.1 sympy-1.11.1
```

Yay, everything the plugin needs is installed!

Invoking the subcommand plugin!

```
$ conda --help
usage: conda [-h] [-V] command ...

conda is a tool for managing and deploying applications, environments and packages.

Options:

~snip~

conda commands available from other packages:
 ascii-graph - A subcommand that takes three coordinates and prints out an ascii graph

conda commands available from other packages (legacy):
  content-trust
  env
  suggest
```

Invoking the subcommand plugin!

```
$ conda --help
usage: conda [-h] [-V] command ...

conda is a tool for managing and deploying applications, environments and packages.

Options:

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conda commands available from other packages:
 ascii-graph - A subcommand that takes three coordinates and prints out an ascii graph

conda commands available from other packages (legacy):
  content-trust
  env
  suggest
```

Our new custom conda subcommand is available for use!

Invoking the subcommand plugin!

```
$ conda ascii-graph -5 5 3
```

We type: `conda ascii-graph -5 5 3`
and hit “enter” to get...

Invoking the subcommand plugin!

```
$ conda ascii-graph -5 5 3
0.0041 |                                                 /
       |                                                /
       |                                               .
       |
       |                                              .
       |                                             /
       |                                           ..
       |                                          /
       |                                         /
       |                                       ..
0.0022 |----------------------------------------/-----------
       |                                     ..
       |                                   ..
       |                                 ..
       |                               ...
       |                             ...
       |                          ....
       |                      .....
       |                 ......
       |      ...........
0.0003 |-----------------------------------------------------
        5                         4                         3
```

Different plugins, same plugin API

What else?

Subcommands 💻

Request Handler 📟

Solvers 🏎️

Virtual Packages 📦

Authentication 🔐

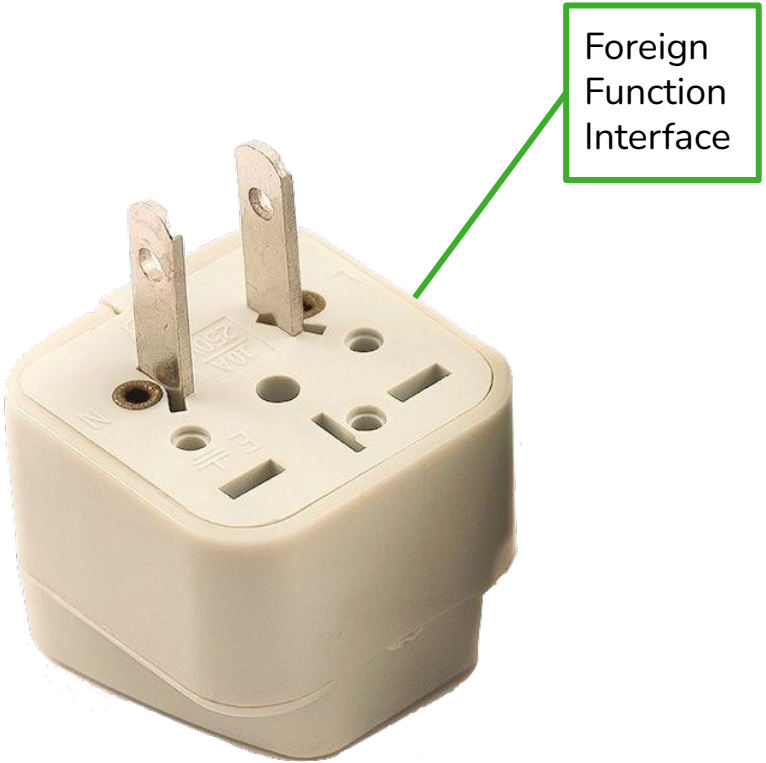
Shell Integration 🐚

Plugin use cases

- Vendor or client-specific extensions
- Code editor integrations
- Experimental features
- Refactoring
- … and much more!

Non-Python languages welcome!

- Write the plugin in Python
- Write a program in C/C++, Rust, Perl, Java, etc.
- Use a Foreign Function Interface (e.g., CFFI, Maturin)



Subcommand Tutorial

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README.md

Conda Plugin Tutorials: Subcommands: Python

In this tutorial, we will create a new conda subcommand written in Python that takes an input of three coordinates and prints out an ASCII graph.

To follow along with this guide, make sure you have the latest conda, conda-build, and pip installed:

```
(base) $ conda update conda conda-build pip
```

Project directory structure

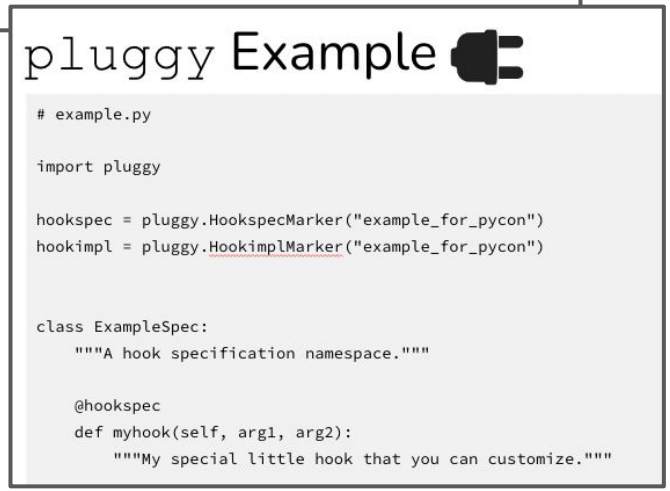
Set up your working directory and files as shown below (or create a new repository using this template):

```
python/
├── recipe/
│   └── meta.yaml
├── ascii_graph.py
└── pyproject.toml (or setup.py)
```

The custom subcommand module

The following module implements a function, `ascii_graph` (where a set of three numbers gets converted into an ascii graph), and registers it with the plugin manager hook called `conda_subcommands` using the `@conda.plugins.hookimpl` decorator:

Presentation Materials



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Conclusion 🔌

Thank you!