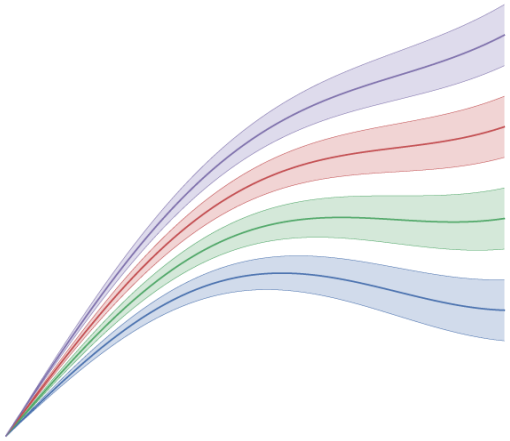
The Python package *pyam* for analysis, validation & visualization of integrated-assessment and energy-systems scenarios



pyam: analysis and visualization of integrated assessment scenarios

License Apache 2.0 | python 3.7 | 3.8 | 3.9 | 3.10 | chat Slack | mail groups.io

code style black | pytest passing | docs passing | codecov 95%

DOI 10.5281/zenodo.1470400 | ORE 10.12688/openreseurope.13633.2

Repository hosted on GitHub

Community supported by Groups.io slack

Documentation hosted by Read the Docs

pyam-iamc.readthedocs.io

This presentation is available under: https://doi.org/10.5281/zenodo.7757907

Philip Hackstock

openmod Workshop

March 22, 2023

This workshop is partly funded from the European Union's Horizon 2020 research and innovation programme under grant agreements No 821471 (ENGAGE), No 821124 (NAVIGATE), and No 101022622 (ECEMF).

Session Goals

What to take home today

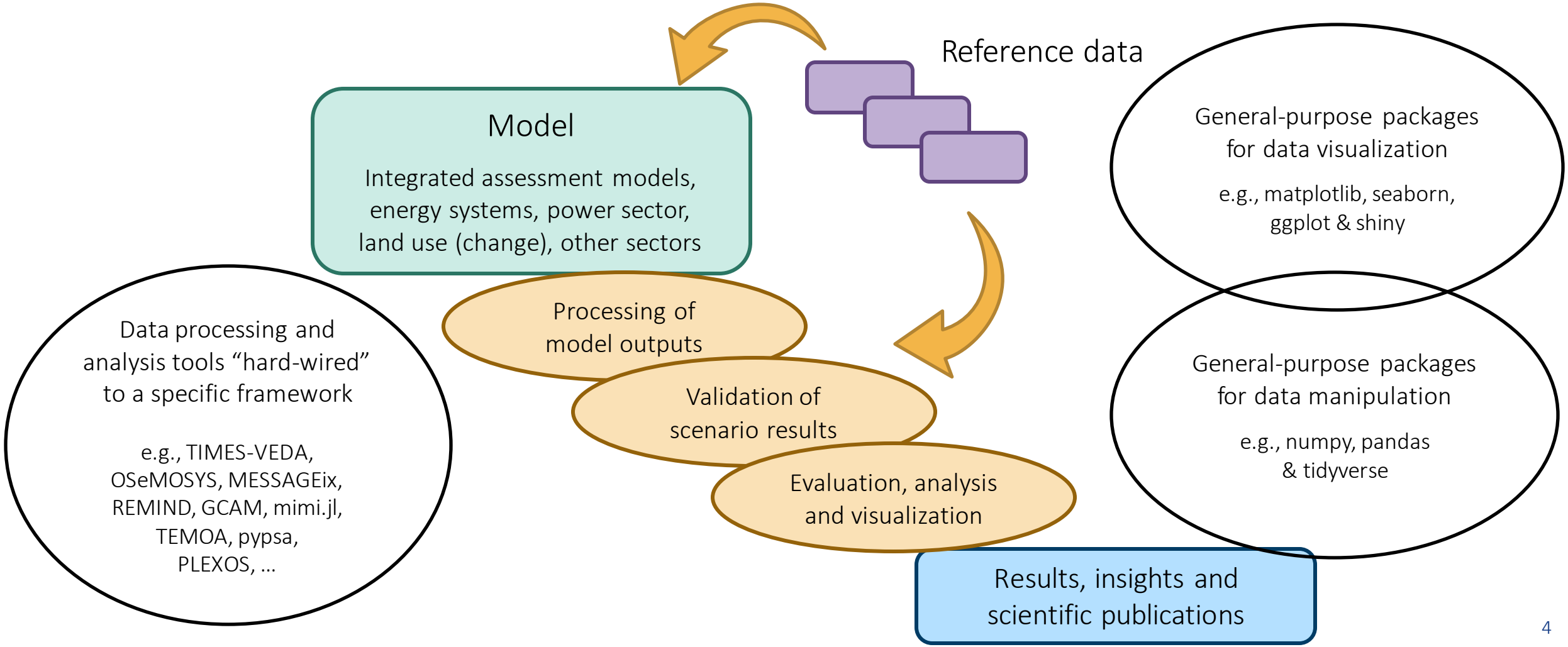
- Why would you want to use pyam for your data analysis workflow?
- What kind of data formats are supported and how are they read?
- How to create plots using pyam?
- How to do timeseries arithmetic?

Part 1

Introduction & motivation

Introduction: From model results to scenario analysis

There are many solutions and tools for scenario analysis & data visualization, but most are tools either "hard-wired" to a modelling framework or general purpose



Better-practices for scripts for scenario analysis and data visualization

Many modelling frameworks adopt "best-practice of collaborative development", but scripts for scenario analysis are often written in an ad-hoc fashion

- A common approach to scenario analysis & data visualization
  ⇒ Write a few lines of code for a simple feature – a few features – and a little bit more …
- Caveats of this incremental approach (not always, but way too often)
  ⇒ *copy-paste* of large snippets of code from one project to the next
  ⇒ No version management for the analysis scripts
  ⇒ Insufficient documentation of code
  ⇒ No testing, no *continuous-integration*-strategy
- Why is this a problem for open & reproducible science?
  ⇒ Limited reproducibility or transparency of the results
  ⇒ Risk of errors or bugs in existing features during further development
  ⇒ Risk of errors or bugs due to dependency updates

Our vision: a community Python toolbox for energy & climate research

The pyam package offers a suite of model-independent methods to streamline the processing, analysis & visualization of scenario results

- Design principles:
  - ⇒ Harmonized data structure and formats
  - ⇒ Model-independent standardized methods for scenario analysis & visualization
  - ⇒ Modular package architecture and simple integration in other packages & workflows

- Advantages for modellers and analysts
  - ⇒ Standardized interface following the *pandas* & *matplotlib* packages
  - ⇒ Comprehensive documentation, tutorials, email list, Slack workspace, …
  - ⇒ High-performance implementation, `pandas.Series` instead of `pandas.DataFrame`
  - ⇒ Increased transparency & better intelligibility through shorter analysis scripts
  - ⇒ Higher reliability thanks to a well-testing package with a *continuous-integration*-strategy

Part 2

The pyam package

Supported data models and file formats

The package supports various formats & types of timeseries data and is currently used by more than a dozen modelling teams

Supported timeseries data formats:

The *pyam* package was initially developed to work with the ***IAMC template***, a tabular format for yearly timeseries data

	A	B	C	D	E	F	G	H
1	**Model**	**Scenario**	**Region**	**Variable**	**Unit**	**2005**	**2010**	**2015**
2	MESSAGE	CD-LINKS 400	World	Primary Energy	EJ/y	462.5	500.7	...

But the package also supports sub-annual time resolution

⇒ Continuous-time formats (e.g., hourly timeseries data)

⇒ Representative sub-annual timeslices (e.g., "winter-night")

Compatible i/o and file formats:

⇒ Full integration with the *pandas* data analysis package

⇒ Tabular data (`xlsx`, `csv`) & "frictionless" datapackage format

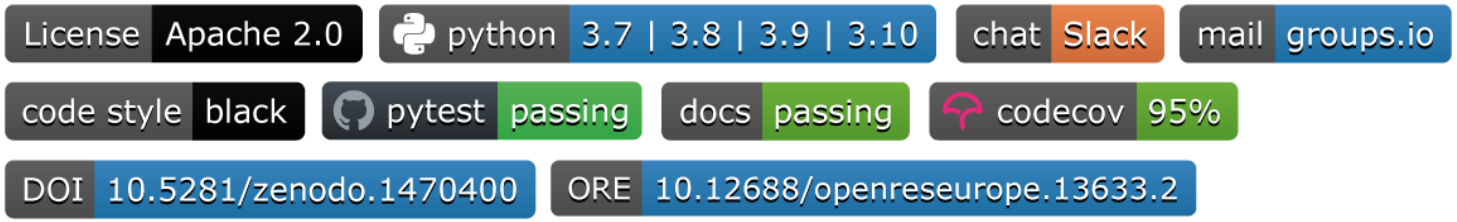
The *pyam* package for integrated assessment & macro-energy modelling

A community package for scenario processing, analysis & visualization following best practice of collaborative scientific software development

Use cases and features

- ⇒ Data processing — Data i/o & file format conversion, aggregation, downscaling, unit conversion, …
- ⇒ Validation — Checks for completeness of data, internal/external consistency, numerical plausibility …
- ⇒ Analysis & visualization — Categorization and statistics of scenario ensembles, plotting library, …

D. Huppmann, M. Gidden, et al. (2021). *Open Research Europe* 1:74. doi: 10.12688/openreseurope.13633.2



Repository hosted on GitHub

Community supported by Groups.io slack

Documentation hosted by Read the Docs

#pyam_iamc

pyam-iamc.readthedocs.io

Developing a community for a community package

We made an effort to make the pyam package usable for modellers & analysts with a wide range of experience levels and scientific backgrounds

- Simple installation
  ⇒ Available via the common Python managers *pypi* and *conda*
- Open-access manuscript & comprehensive documentation
  ⇒ Several tutorials and full-fledged API documentation
- For novice users or moderate-interest users:
  ⇒ An email list for announcements of new releases and questions
- For users interested in frequent updates, tips-and-tricks and more interaction
  ⇒ A Slack workspace with a **#helpdesk** channel
- For expert users and anyone interested in contributing
  ⇒ The GitHub repo for collaborative scientific software development like issues and pull requests, continuous-integration workflows, release management, etc.

Part 3

Live demo & interactive discussion

See the open-source notebook at

https://github.com/phackstock/openmod-pyam-workshop

Thank you very much for your attention!

Philip Hackstock
openmod Workshop
March 22, 2023

This presentation is available under: https://doi.org/10.5281/zenodo.7757907