International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

IAMC
Physical Earth Systems
Human Earth Systems
Integrated Assessment Modeling Consortium
iamconsortium.org
Founded 2007

pyam

an open-source Python package for IAM (and energy system) scenario analysis and visualization

openmod meeting
ETH Zürich

Daniel Huppmann & Matthew Gidden
June 8, 2018

The IAMC template for timeseries data

A community effort for compiling and sharing scenario results

Over the past decade, the integrated-assessment community (IAMC) developed a tabular data format used for model intercomparison

- ⇒ High-profile use case: IPCC Fifth Assessment Report (AR5) see https://tntcat.iiasa.ac.at/AR5DB/
- ⇒ Used by ~20 research teams around the world

	A	B	C	D	E	F	G	H	I
1	**Model**	**Scenario**	**Region**	**Variable**	**Unit**	**2005**	**2010**	**2015**	**2020**
2	MESSAGE	CD-LINKS 400	World	Primary Energy	EJ/y	454.5	479.6	...	...

It's not a great standard...

- ⇒ No metadata, no sub-annual time resolution, bad scalability, ...
- ⇒ But it's easy to work with for non-experts, across platforms, ...
- ⇒ And it's the format we are stuck with in the IAM community...

The origin of the *pyam* package

Combining two use cases into a common Python package

- Harmonization and visualization of emissions pathways in IAMs
  - ⇒ *aneris* for IAM harmonization
    see software.ene.iiasa.ac.at/aneris

  - ⇒ *pyam* for plotting & visualization
    Matthew J. Gidden et al. "A methodology and implementation of automated emissions harmonization for use in Integrated Assessment Models" Environmental Modelling & Software 105:187-200, 2018
    DOI: 10.1016/j.envsoft.2018.04.002

- Scenario database for the IPCC "Special Report on 1.5°C" (SR1.5)
  - ⇒ All scenario data and Jupyter notebooks for analysis and figures to be published together with the full report (October 2018)

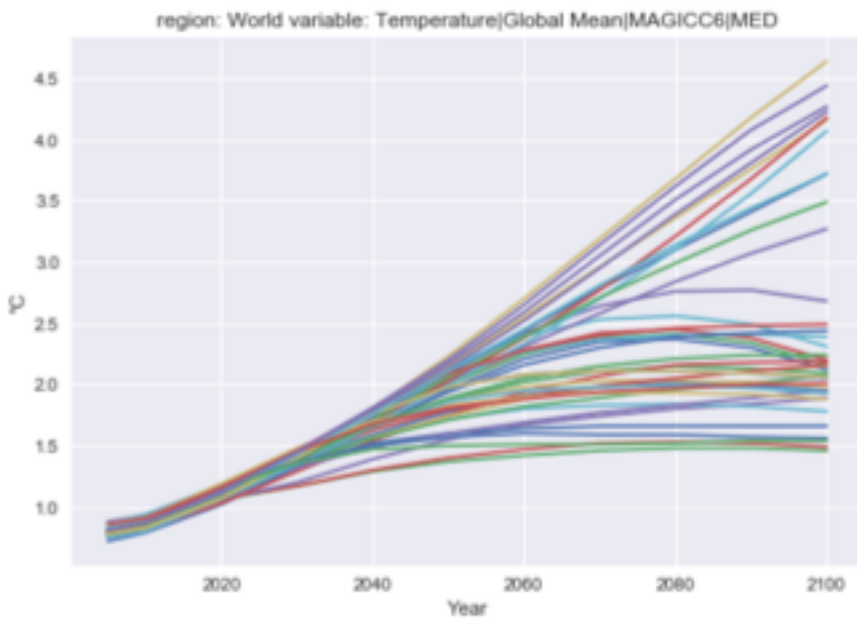
  Requirements:
  - ⇒ Completeness checks, data consistency validation, categorization
  - ⇒ Statistical analysis on filtered data, plotting & visualization

An example workflow for looking at data (I)

After loading a scenario snapshot as an `IamDataFrame`, you can easily filter and use standard plotting tools

```
In [7]: v = 'Temperature|Global Mean|MAGICC6|MED'
        df.filter({'region': 'World', 'variable': v}).line_plot(legend=False)

Out[7]: <matplotlib.axes._subplots.AxesSubplot at 0x11c94d2e8>
```



Selected cells from tutorial presentation available at
https://iiasa.github.io/ene-present.github.io/openmod-zurich2018/

An example workflow for looking at data (II)

You can assign scenarios to categories depending on their data and apply standard plotting arguments like color

In [9]:
```
df.categorize(
    'temperature', 'Below 1.6C',
    criteria={v: {'up': 1.6, 'year': 2100}},
    color='cornflowerblue'
)
```

```
INFO:root:4 scenarios categorized as `temperature: Below 1.6C`
```

In [10]:
```
df.categorize(
    'temperature', 'Below 2.0C',
    criteria={v: {'up': 2.0, 'lo': 1.6, 'year': 2100}},
    color='forestgreen'
)
```

```
INFO:root:8 scenarios categorized as `temperature: Below 2.0C`
```

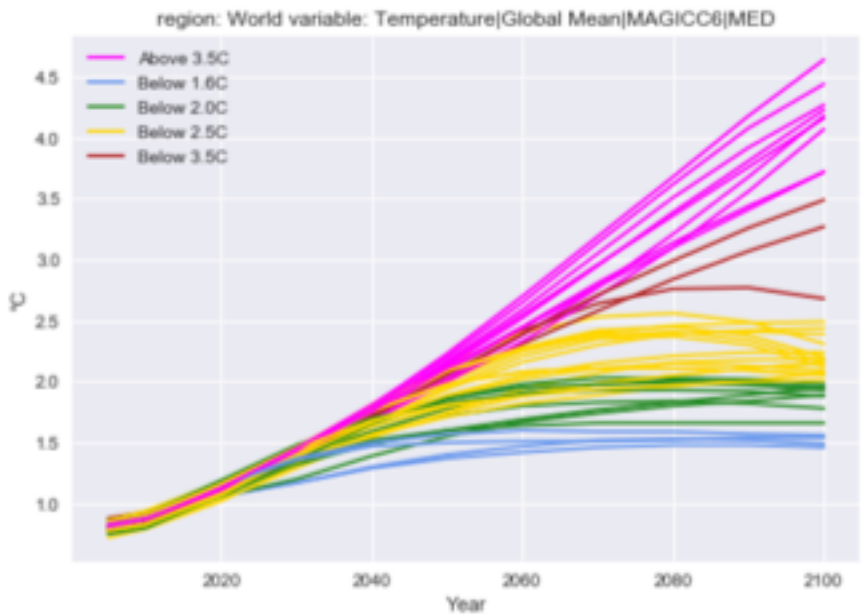
Selected cells from tutorial presentation available at
https://iiasa.github.io/ene-present.github.io/openmod-zurich2018/

An example workflow for looking at data (III)

You can then plot using the categorization and default settings

```
In [16]: df.filter({'variable': v, 'exclude': False})\
             .line_plot(color='temperature')

Out[16]: <matplotlib.axes._subplots.AxesSubplot at 0x11ca3eba8>
```



Selected cells from tutorial presentation available at
https://iiasa.github.io/ene-present.github.io/openmod-zurich2018/

An example for data validation

We often want to check that reported scenario results are within a certain range, e.g. comparison to reference data

In [18]:
```
df.filter(region='World').validate(criteria={'Primary Energy': {'lo': 500, 'year':
2010}}).head()
```

```
INFO:root:20 of 3565 data points to not satisfy the criteria
```

Out[18]:

	model	scenario	region	variable	unit	year	value
913	IMAGE 2.4	AMPERE3-450	World	Primary Energy	EJ/yr	2010	473.91
919	IMAGE 2.4	AMPERE3-450P-CE	World	Primary Energy	EJ/yr	2010	473.91
925	IMAGE 2.4	AMPERE3-450P-EU	World	Primary Energy	EJ/yr	2010	473.91
931	IMAGE 2.4	AMPERE3-550	World	Primary Energy	EJ/yr	2010	473.79

Selected cells from tutorial presentation available at
https://iiasa.github.io/ene-present.github.io/openmod-zurich2018/

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

Thank you very much for your attention!

Check out the link below for a full presentation on current *pyam* features
https://iiasa.github.io/ene-present.github.io/openmod-zurich2018/

The *pyam* package is available at github.com/IAMconsortium/pyam
under an APACHE 2.0 license

Dr. Daniel Huppmann
Research Scholar – Energy Program
International Institute for Applied Systems Analysis (IIASA)
Schlossplatz 1, A-2361 Laxenburg, Austria

huppmann@iiasa.ac.at
http://www.iiasa.ac.at/staff/huppmann