PAUL SCHERRER INSTITUT

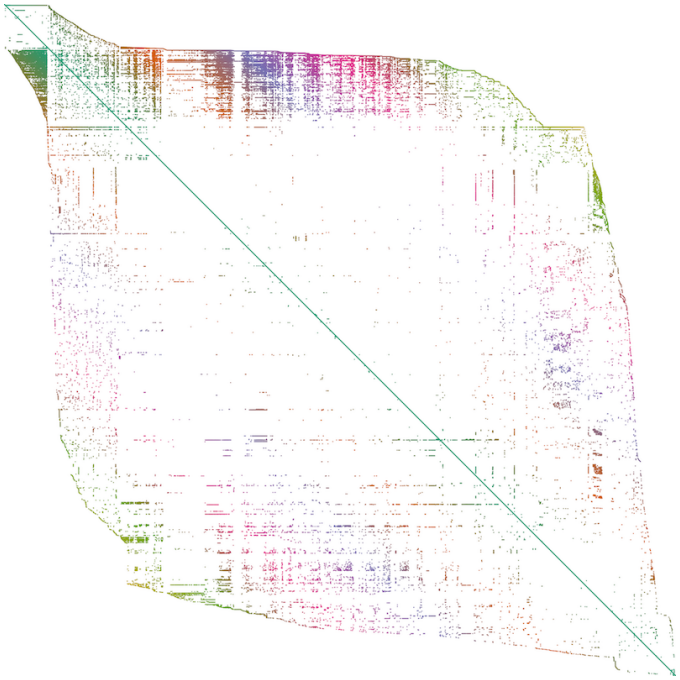
PSI

Chris Mutel, Pascal Lesage

Direct sampling to improve accuracy of Monte Carlo uncertainty analysis

SETAC Europe Annual Conference: May 30, 2019

Standard practice in uncertainty assessment



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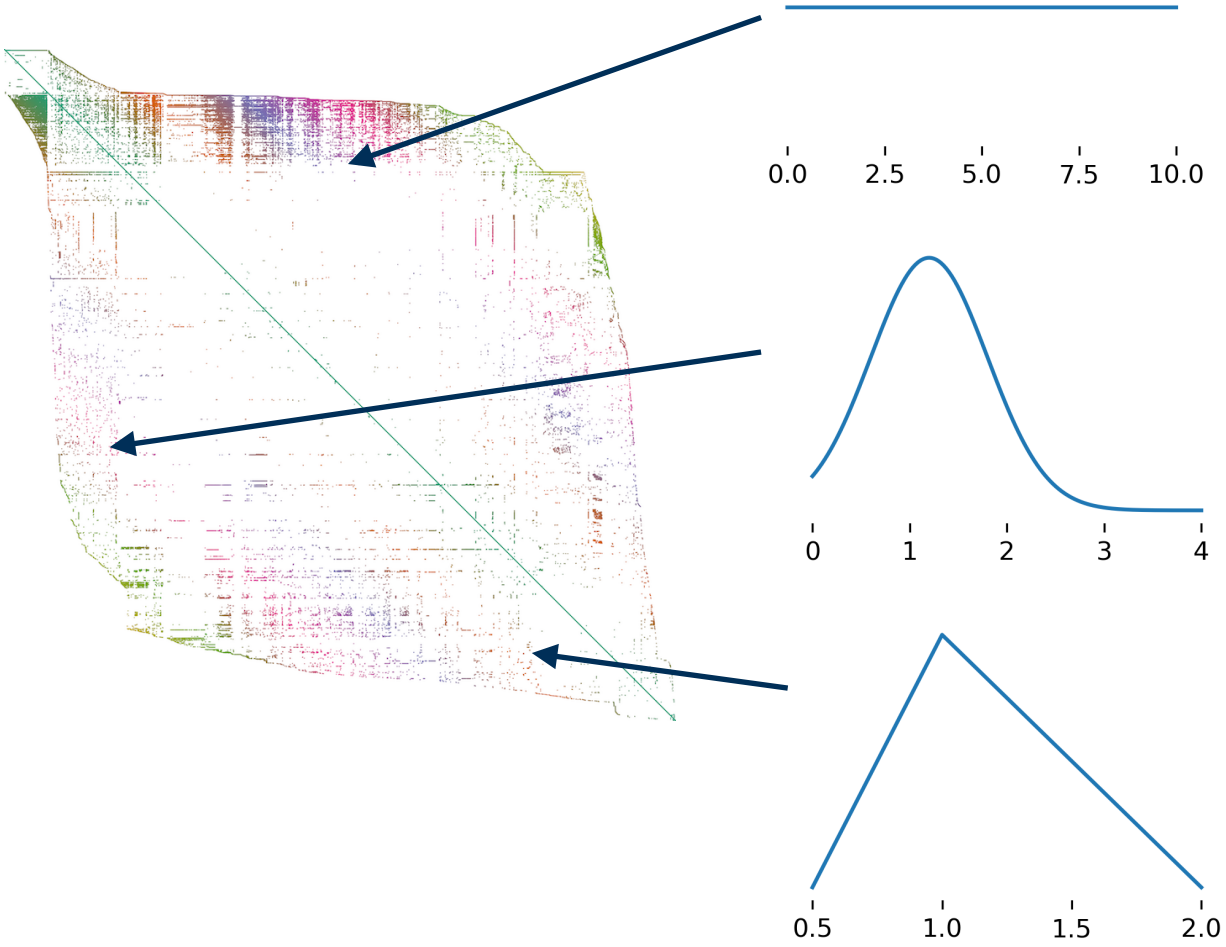

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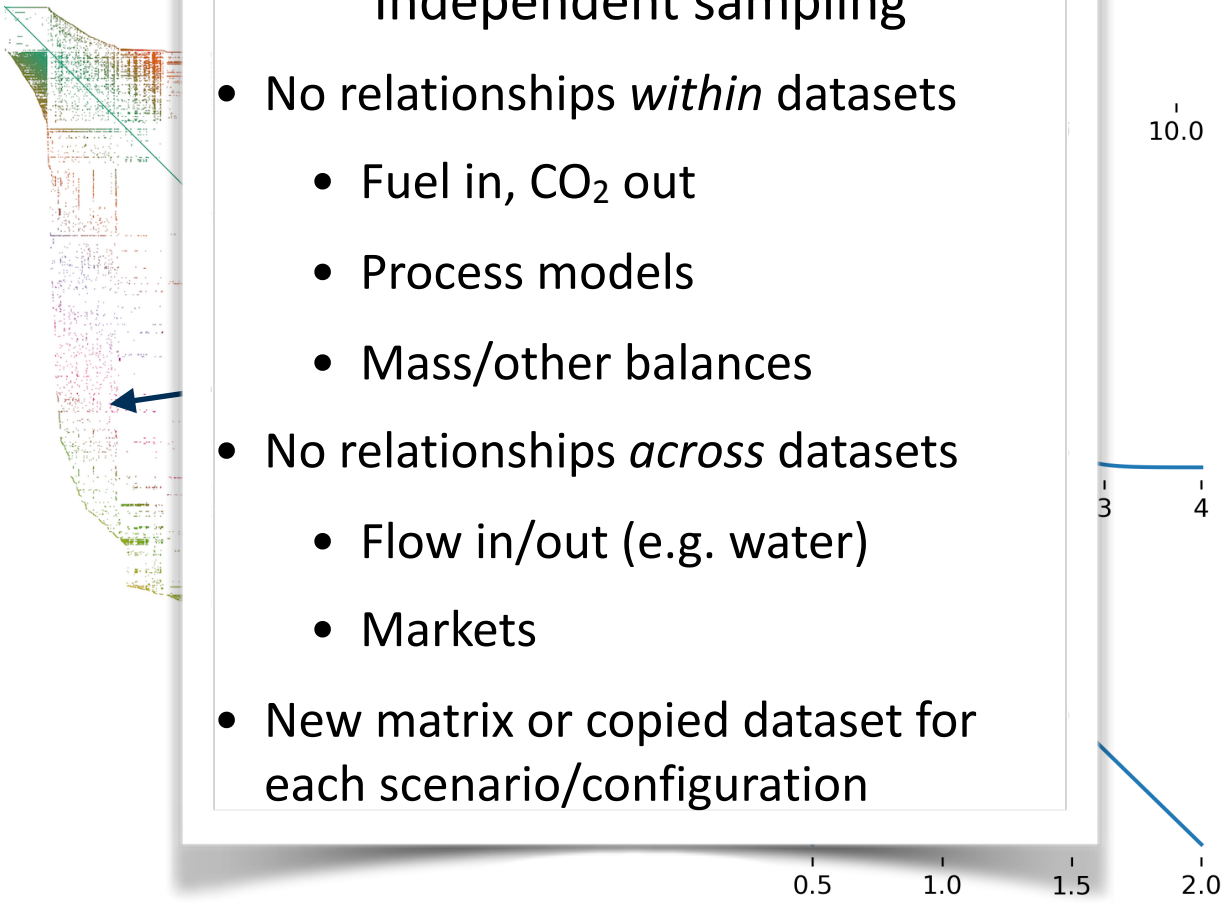
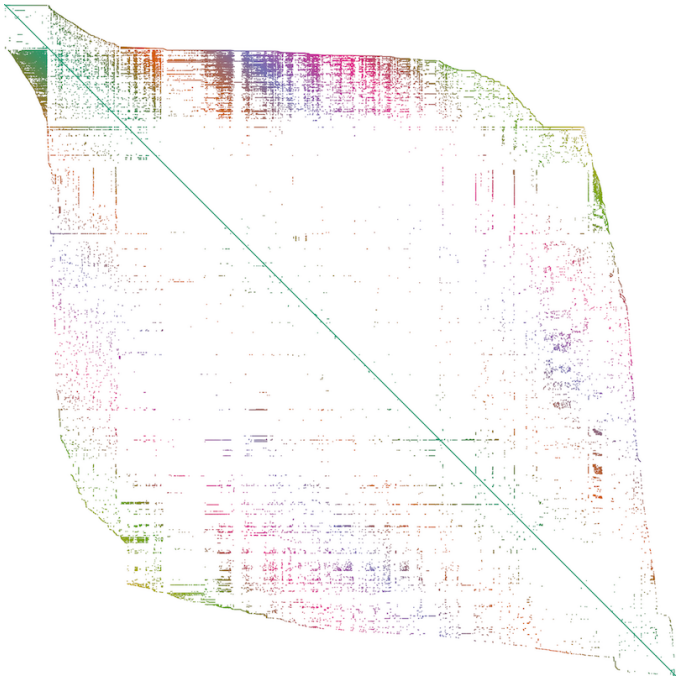


Independent sampling

- No relationships *within* datasets
  - Fuel in, CO_2 out
  - Process models
  - Mass/other balances
- No relationships *across* datasets
  - Flow in/out (e.g. water)
  - Markets
- New matrix or copied dataset for each scenario/configuration

An alternative: Pre-sampled values



Sparse matrices

Row	Col	Value
7	42	0.8784
14376	999	0.16272
3956	16017	0.57
576	14001	0.900393

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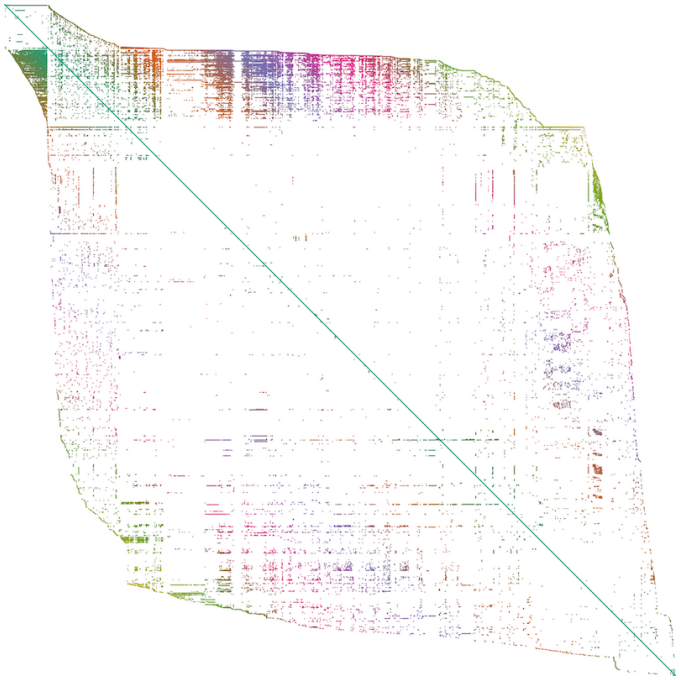

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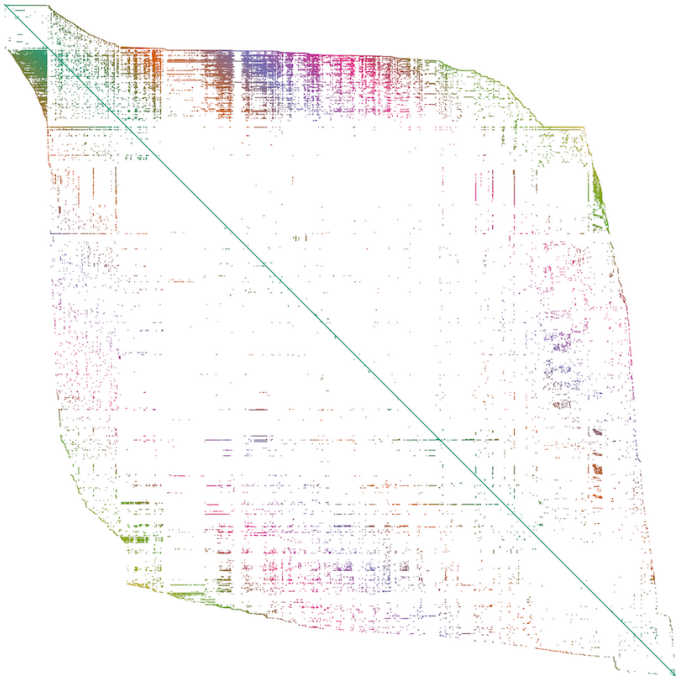

Generate new values

outside LCA calculation loop

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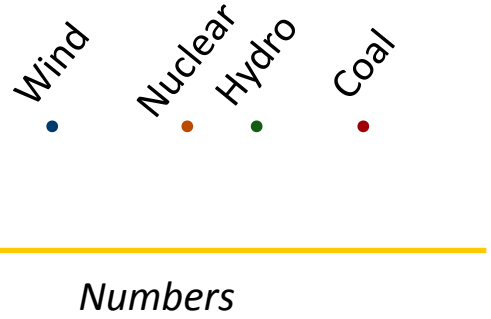

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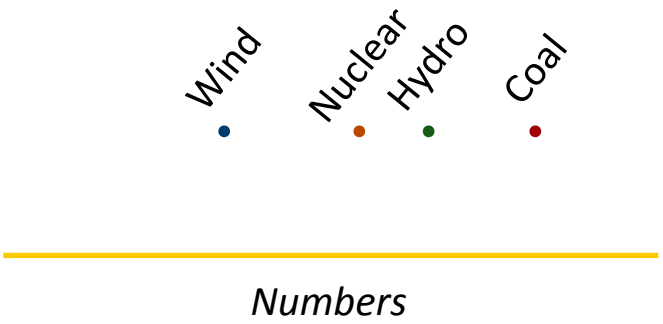

No uncertainty in markets. Why?

- Sum to one
- Lack of data on distributions

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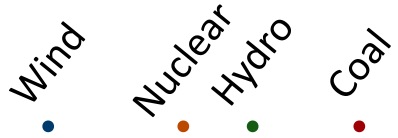

Numbers

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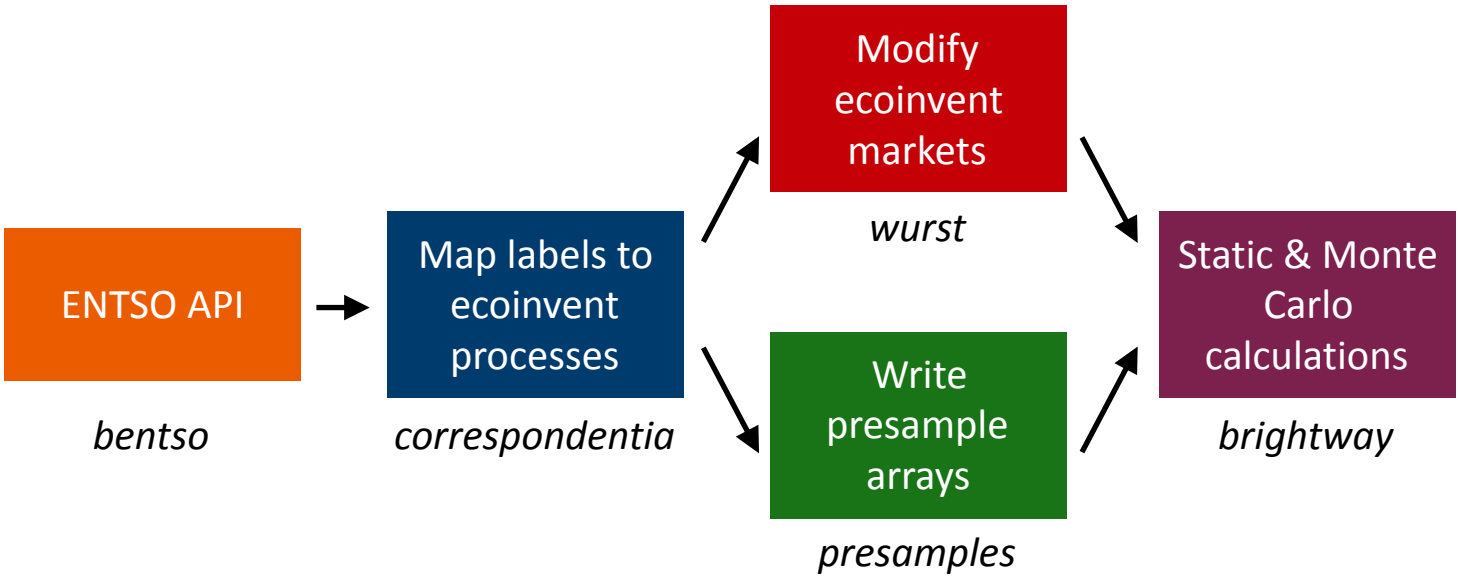

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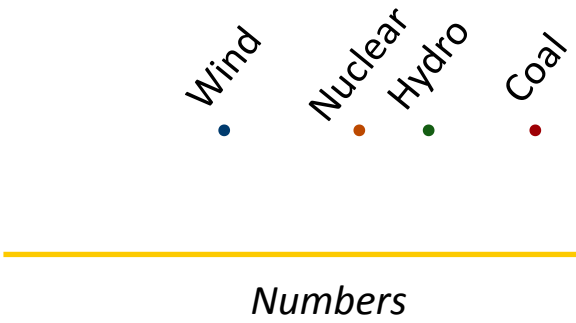

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ENTSO presamples

- Right sums
- Correlation amont technologies
- Easy to update/change year
- Production & trade

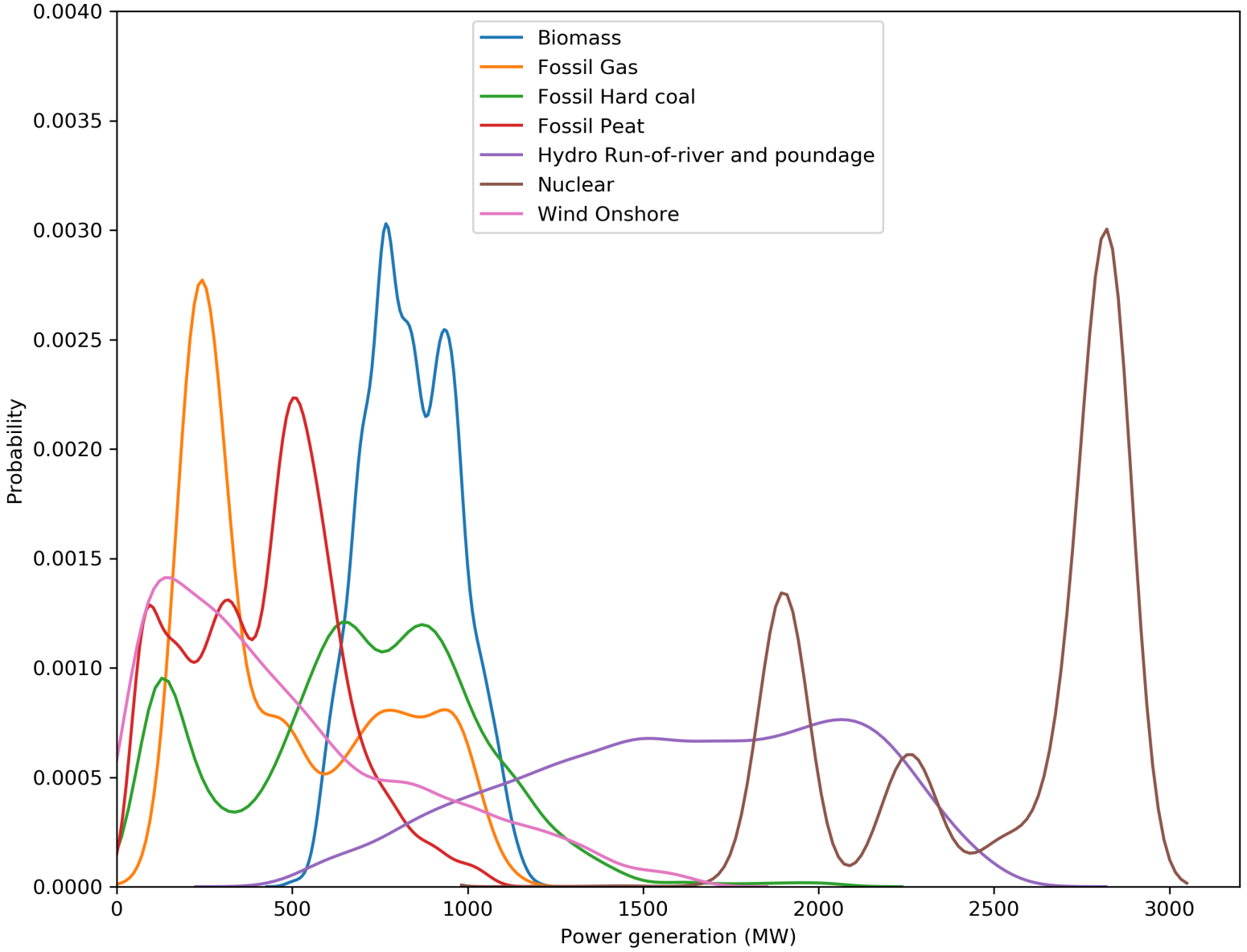
ENTSO API → *bentso*

correspondentia

presample arrays → *presamples*

Static & Monte Carlo calculations → *brightway*

Example: Electricity markets in Finland



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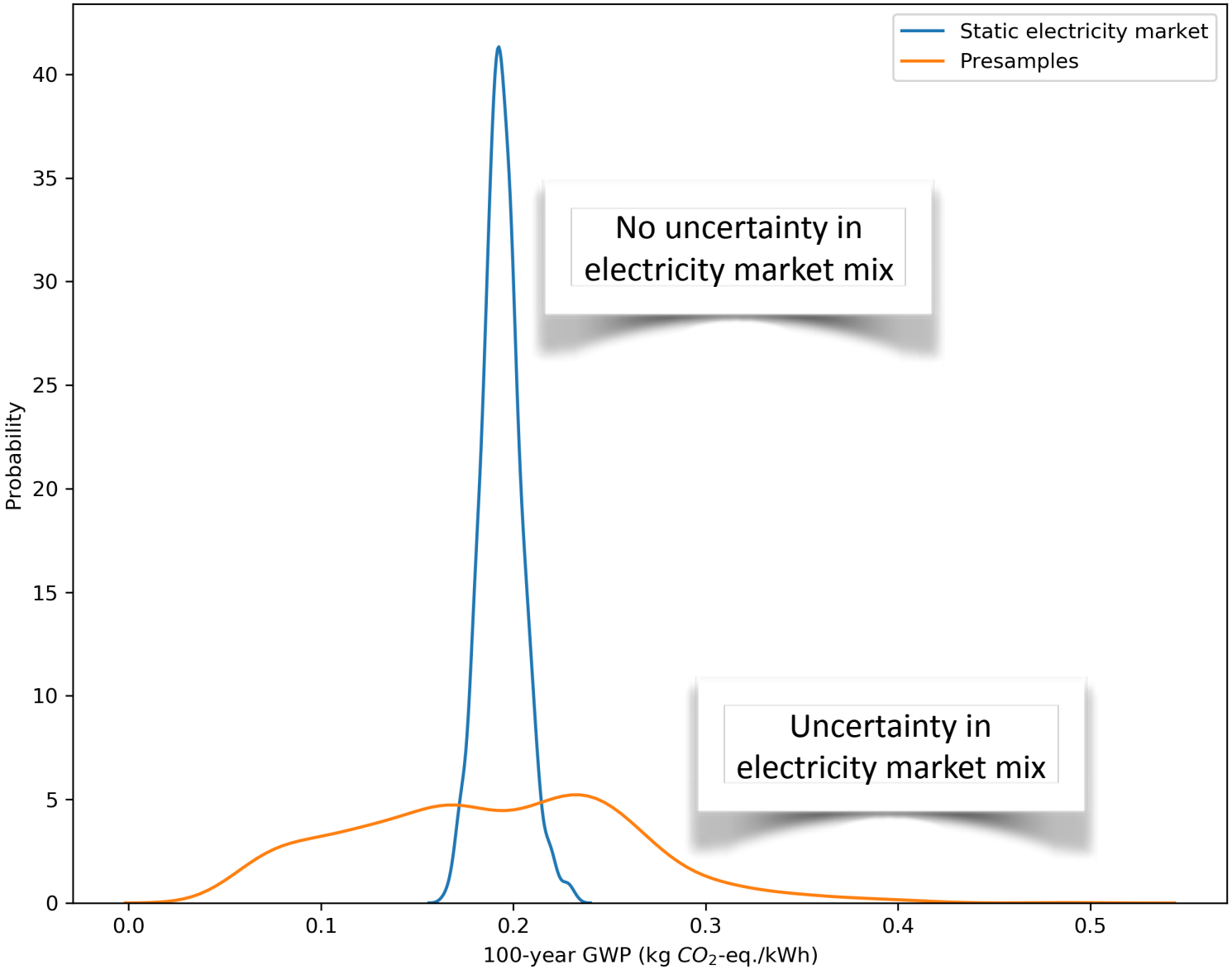

presamples software

- Write, load, manage, & verify presample arrays
- Open source; documented & tested (95% coverage)
- LCA-software generic
  - Built on datapackage standard by Open Knowledge Foundation

Metadata:

datapackage.json

Arrays:

binary (floating-point)

Icons from Shastry, Harper, Mitchell Eva

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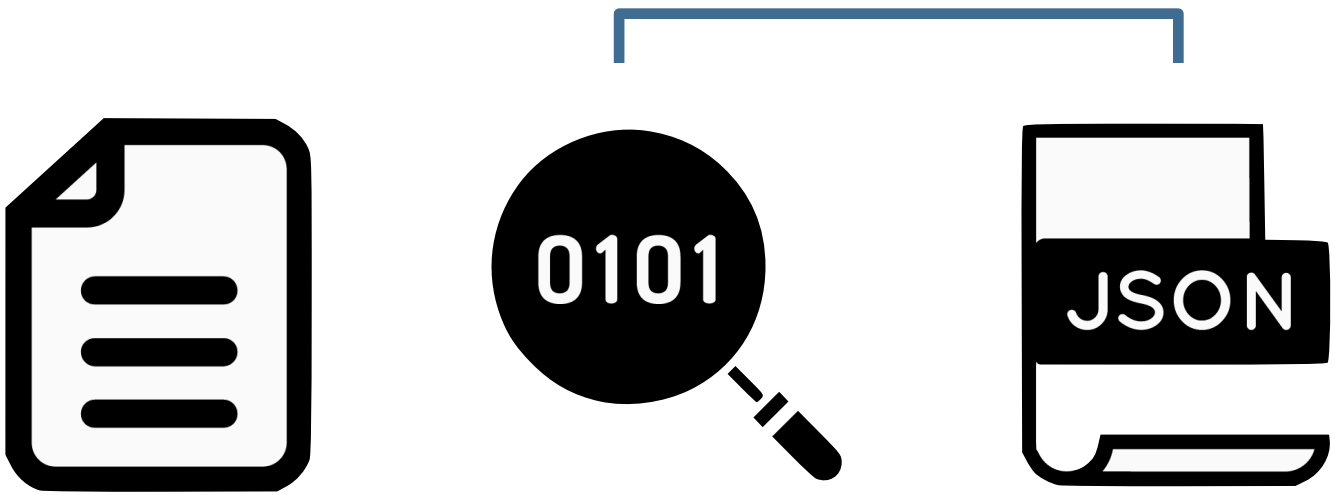

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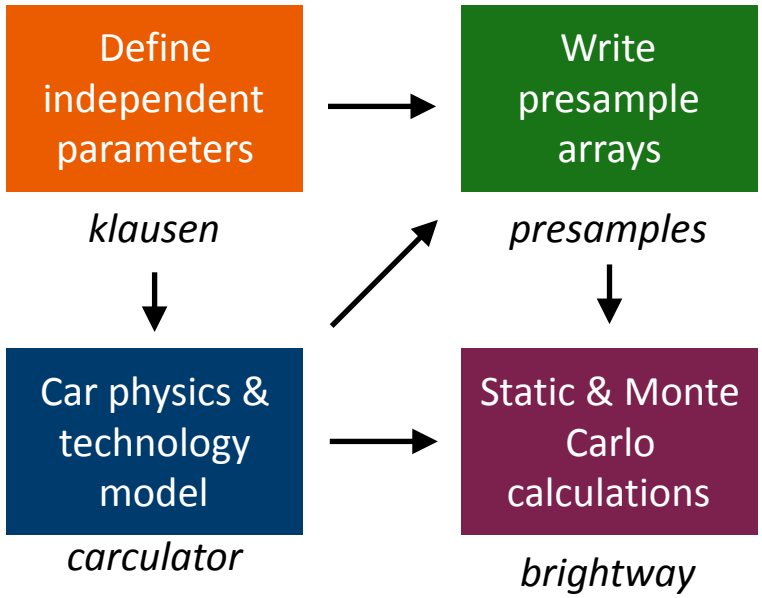
Parameter metadata:

JSON

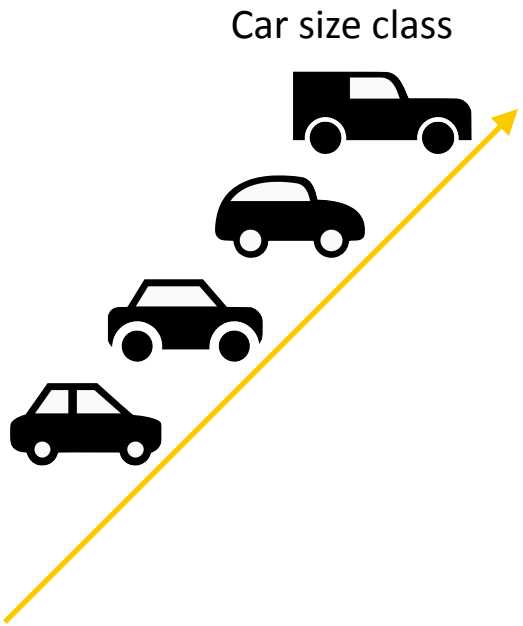
Icons from Shastry, Harper, Mitchell Eva

Example: Prospective mobility assessment

- LCI dataset as a document is a *leaky abstraction*
- Want a model where correlated outputs are a function of:
  - Car power
  - Car mass
  - Driving cycle
  - Lightweighting
  - Autonomous vehicle/technology penetration
  - etc.



In/dependent variables



Cox, et al. 2018. Uncertain environmental footprint of current and future battery electric vehicles. ES&T 52 (8): 4989-4995.

Icons: Alone forever, joeartcon, rajesh, yanti

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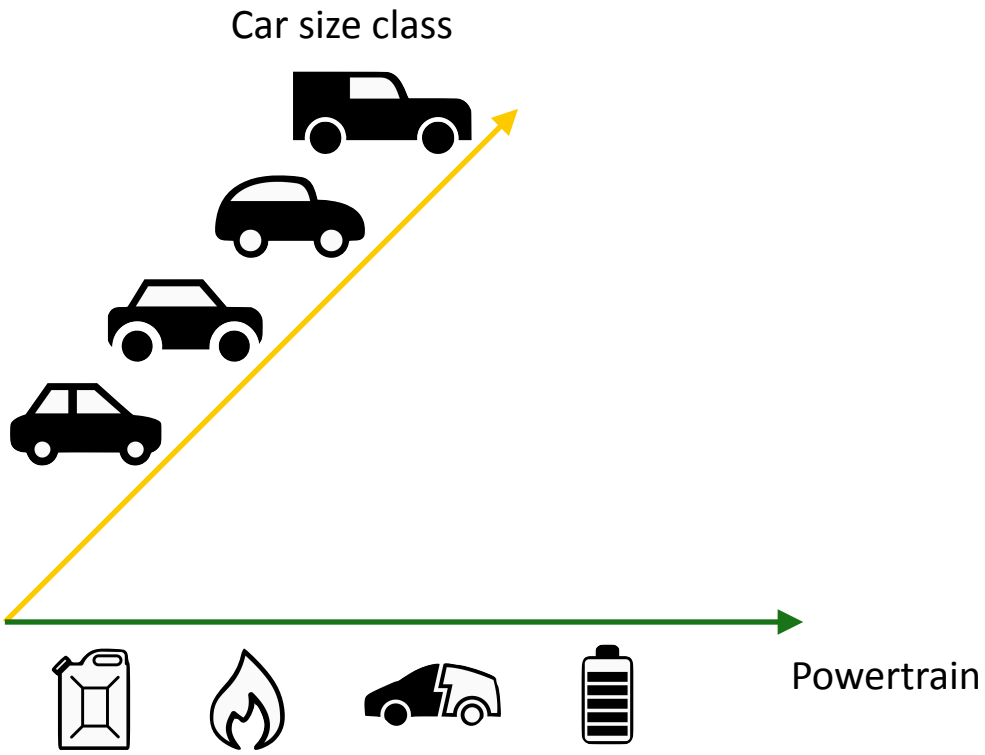

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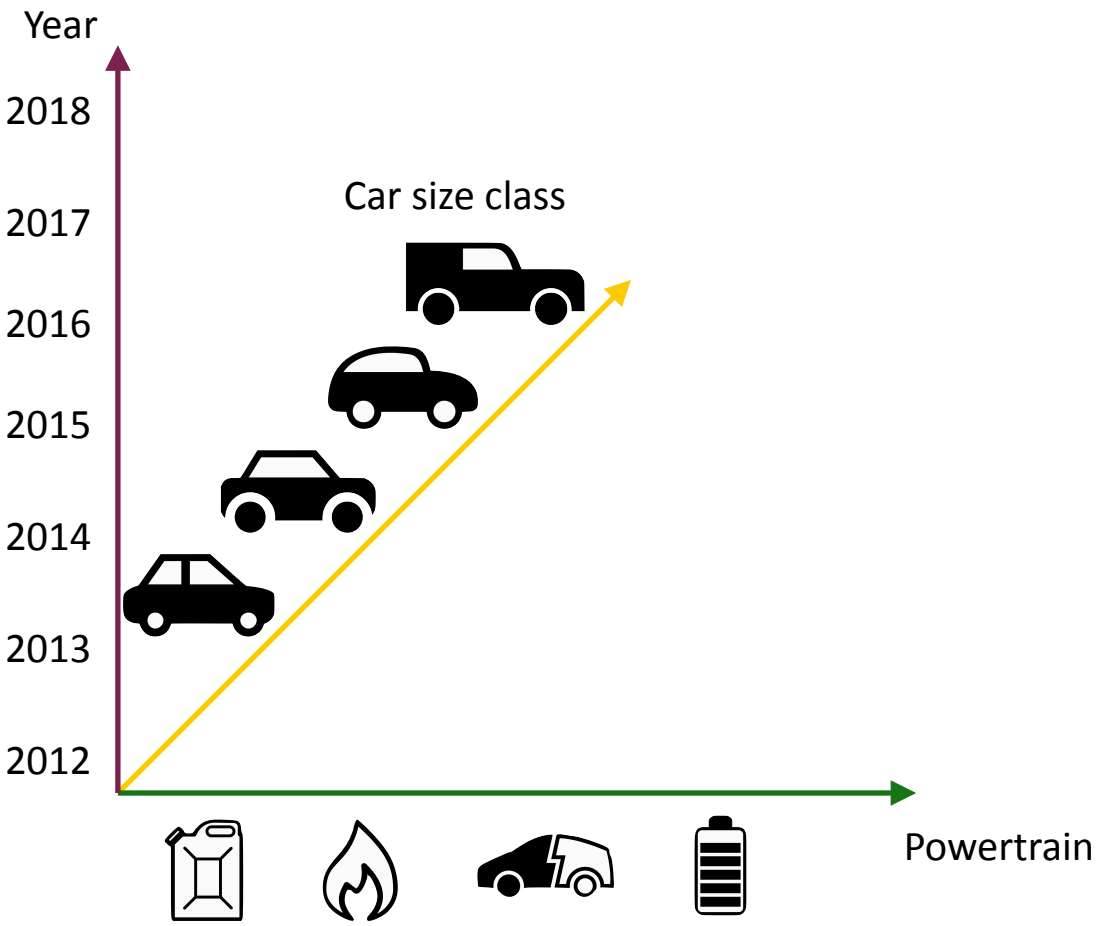

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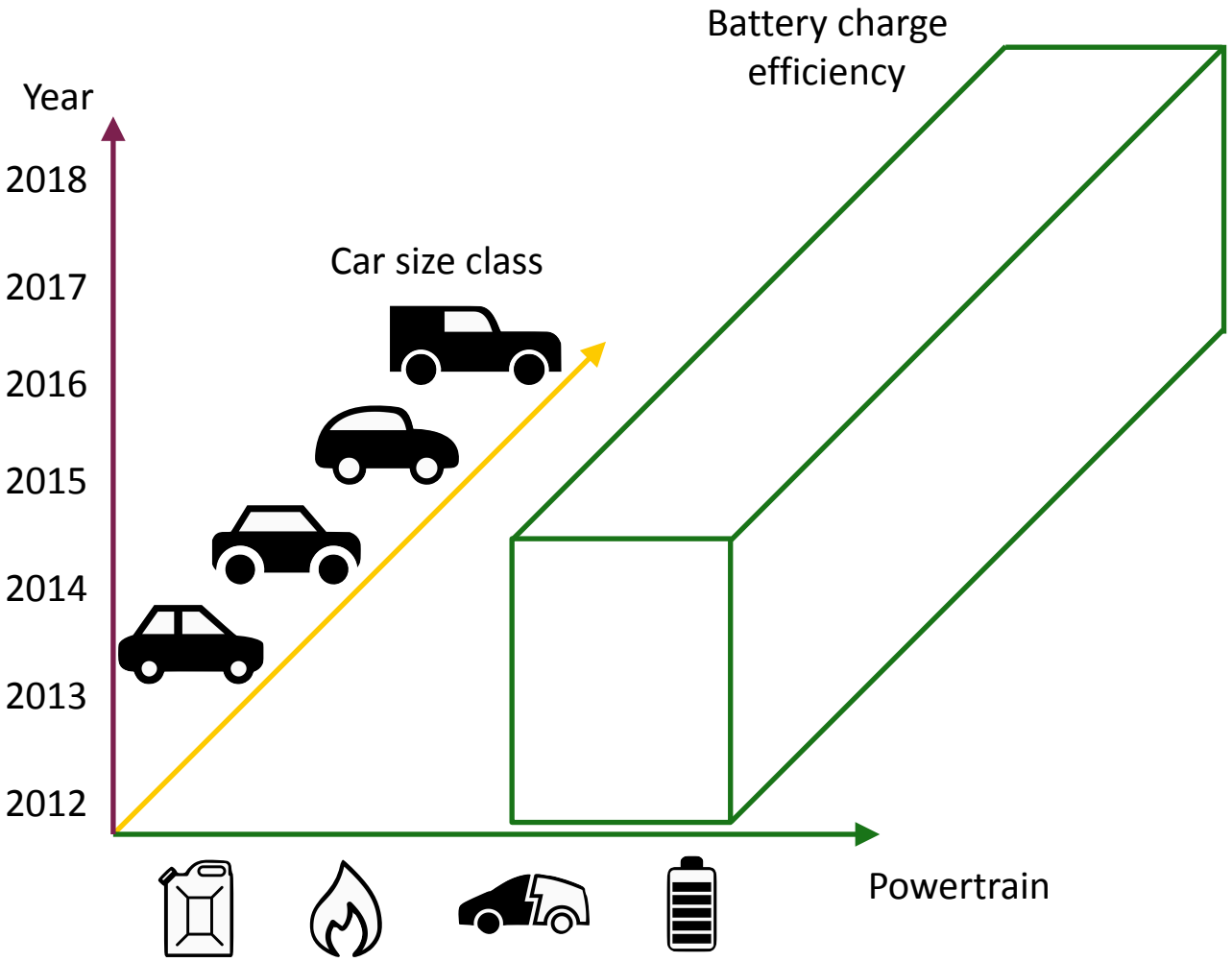

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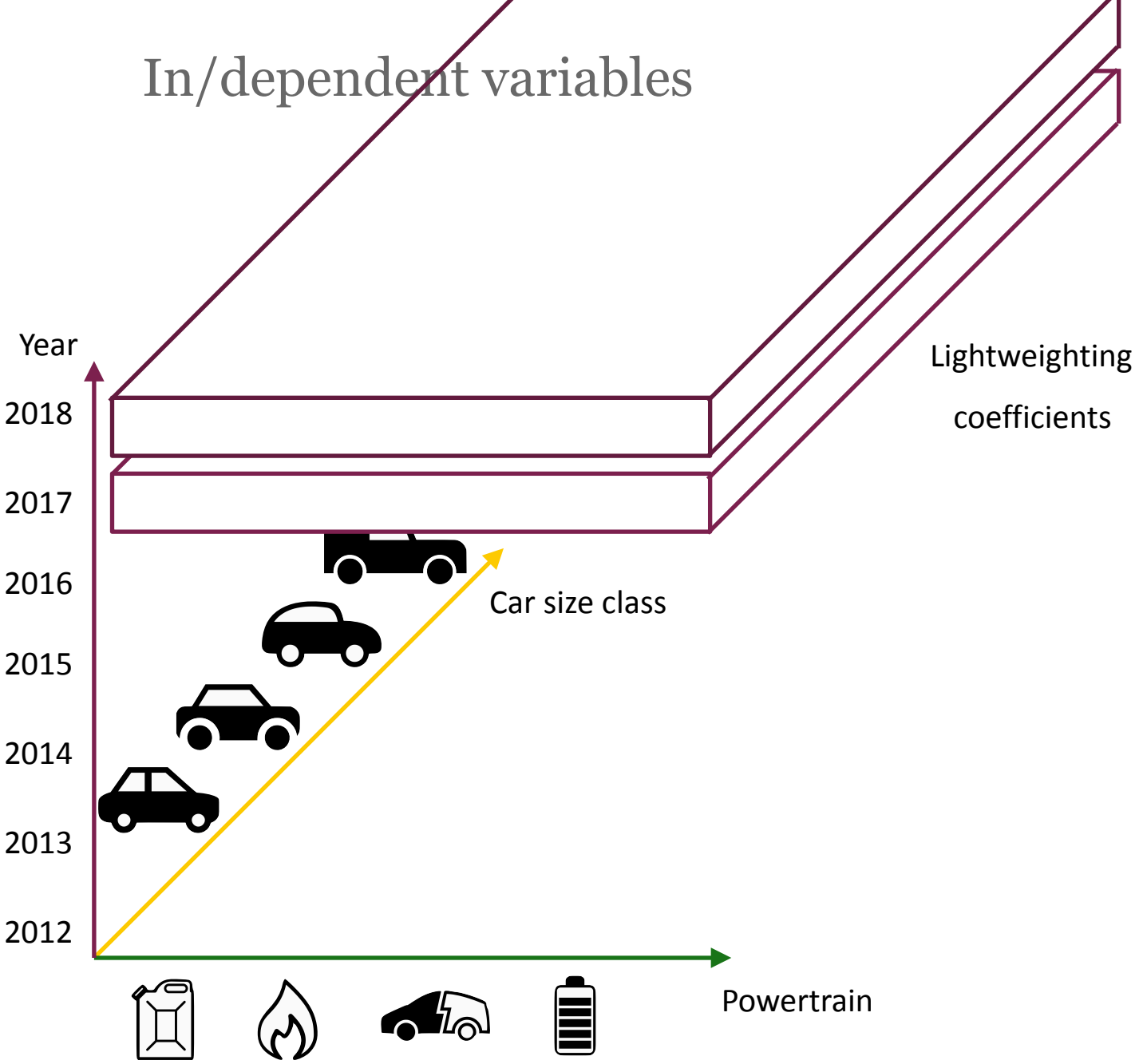

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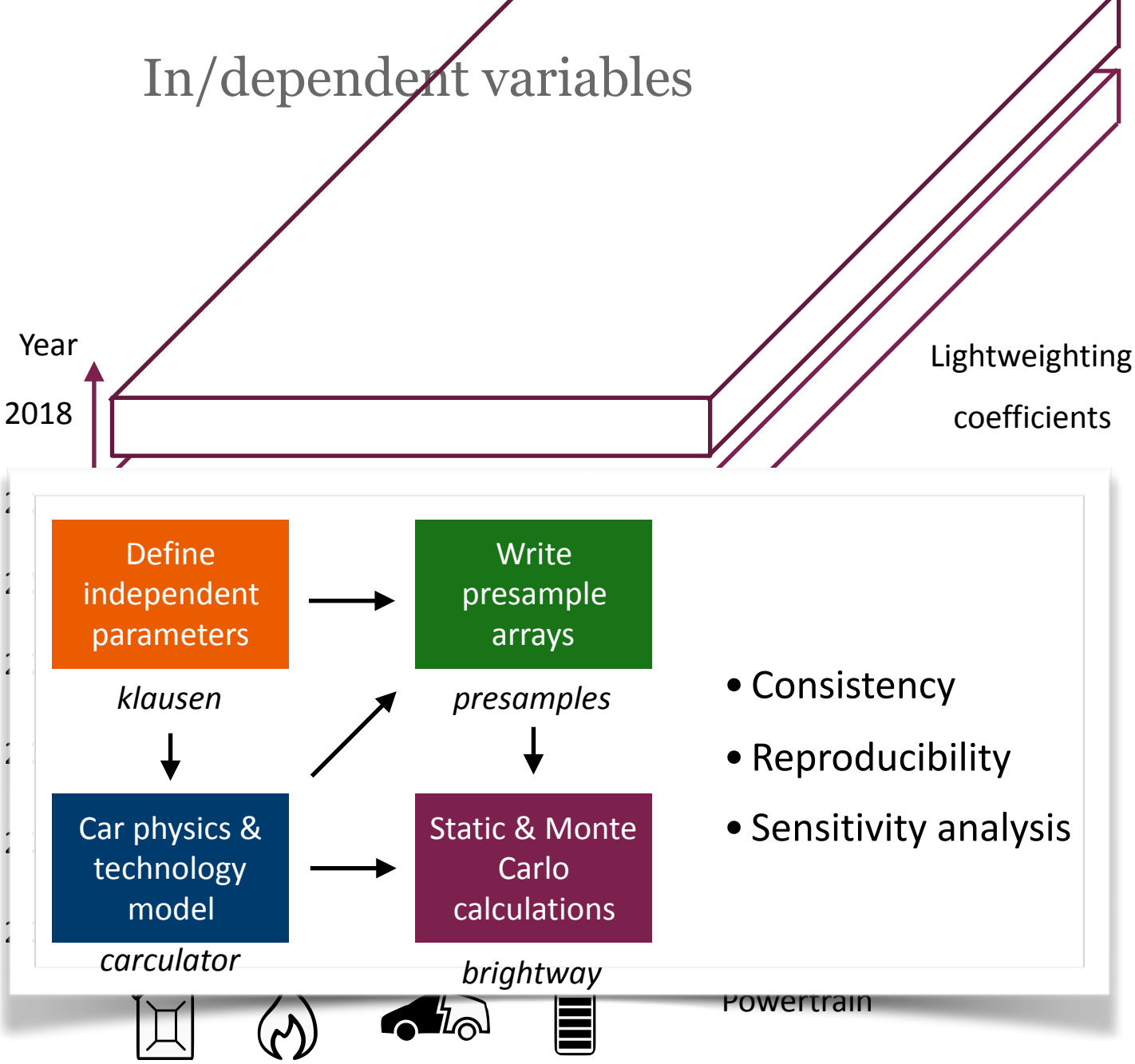

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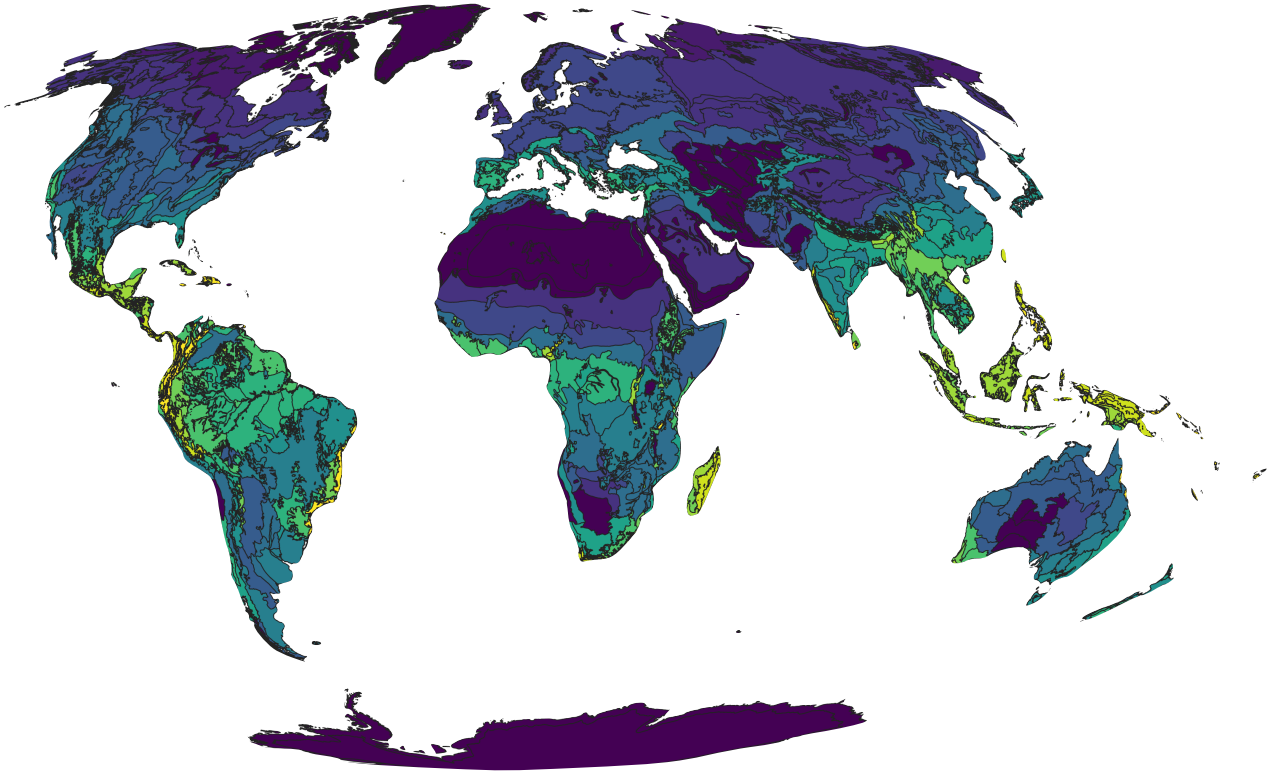

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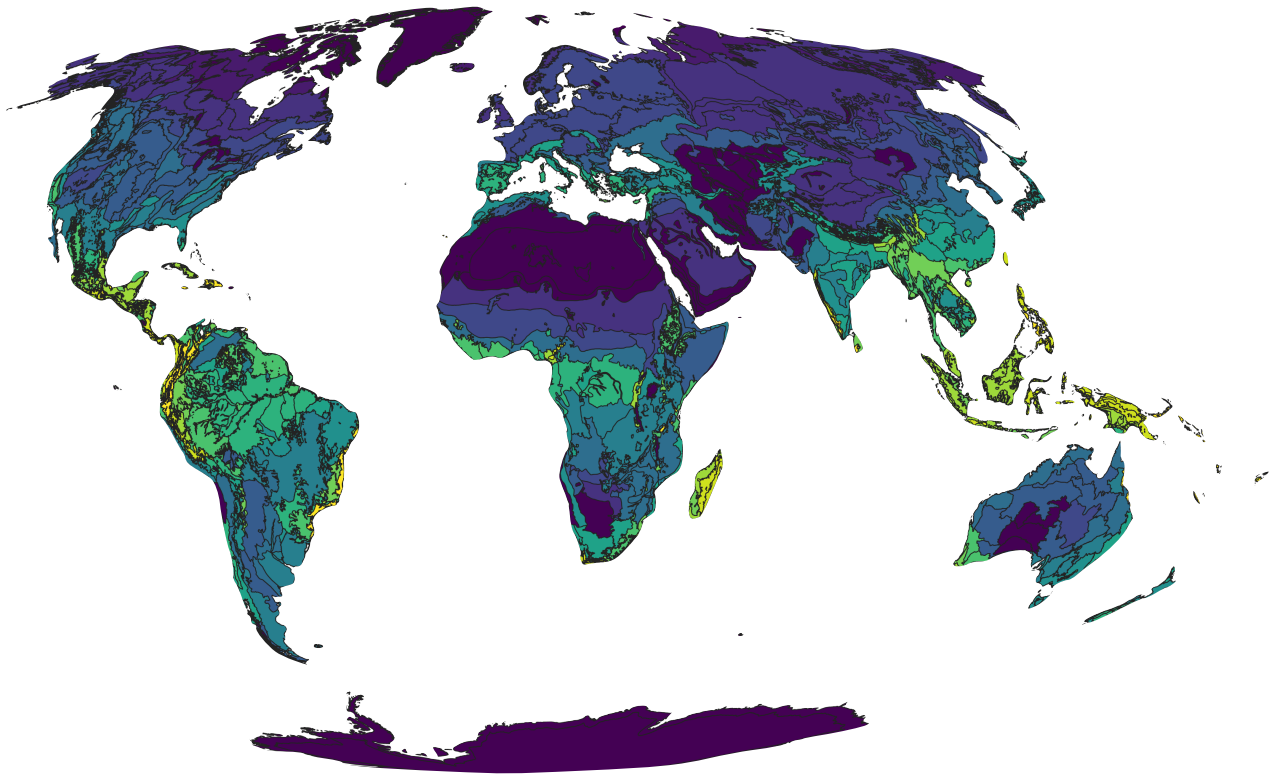

$$CF_{occ,g,i,j} = \frac{a_{i,j} S_{org,g,j} \left[1 - \left(\frac{A_{new,j} + \sum_{i=1}^{n} h_{g,i,j} \cdot A_{i,j}}{A_{org,j}} \right)^{Z_j} \right]}{A_{i,j}}$$

Conclusions: Implementation

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- All calculations (Jupyter notebooks) and this presentation:
  - https://github.com/cmutel/SETAC-2019-presamples

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- Databases **and** LCIA methods should released “blessed” presamples

Wir schaffen Wissen – heute für morgen

My thanks go to

- Pascal Lesage for everything :)
- PSI team for inspiration
- Brian Cox for car model and data
- Openmod community for being awesome

This presentation:

Long: https://github.com/cmutel/SETAC-2019-presamples

Short: https://tiny.cc/setac19