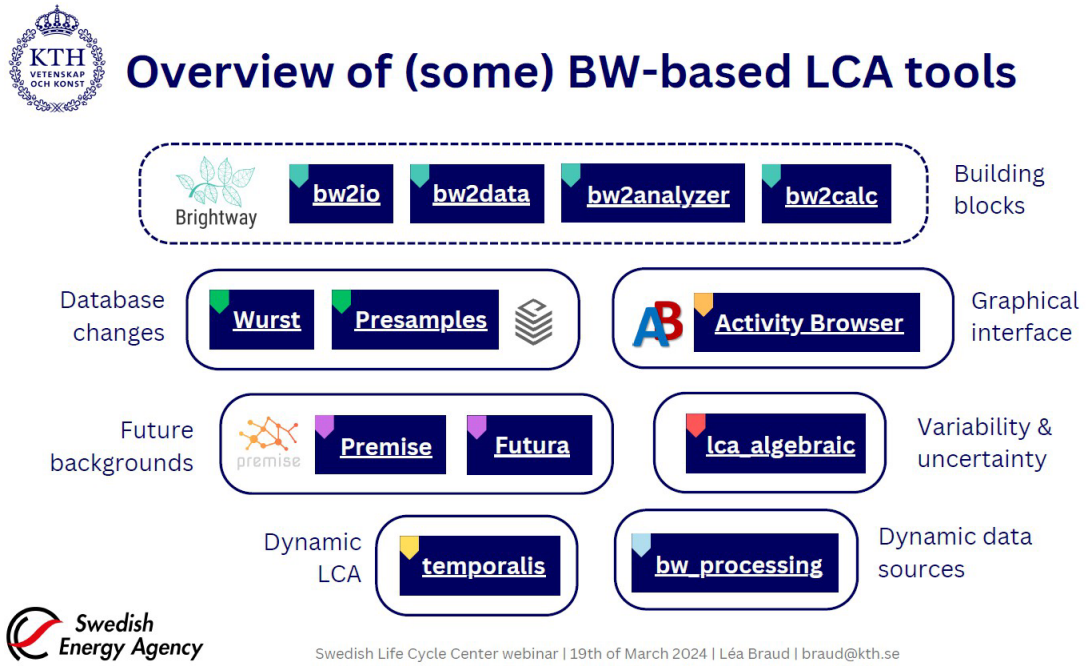
PSI Center for Energy and Environmental Sciences

Introduction to open source software for innovative, flexible LCA

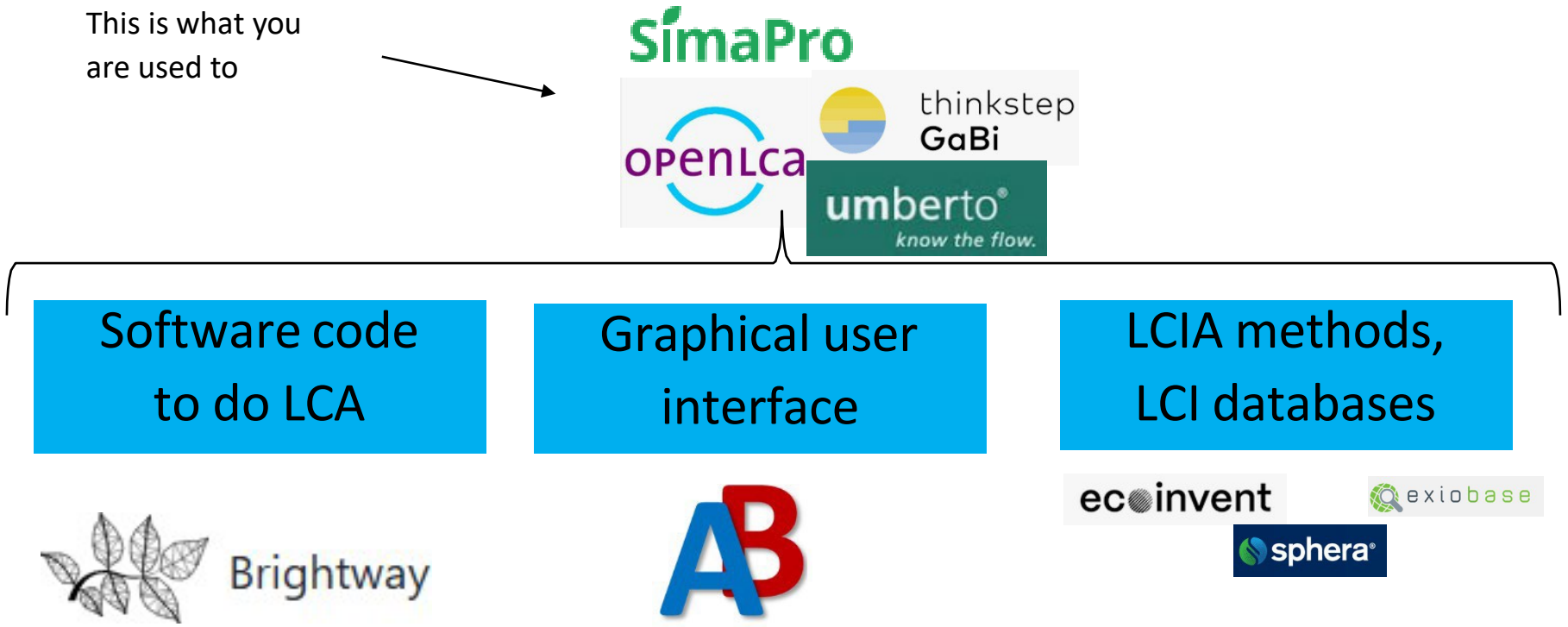


Léa Braud, Swedish Life Cycle Center Webinar

Karin Treyer
Autumn School November 2024

What is Brightway exactly?

This is what you are used to



- BW is an open-source software python package for LCA and environmental impact assessment *(=python made useful for LCA)*
- It allows for working with large datasets and performing fast LCA calculations.
- It offers possibilities to *break the limits of conventional LCA*.
- Many ways of how to use it, depending on your project and programming skills.

Some attributes of BW

- **Open source, python-based LCA software** = community driven
  - ***Fast*** calculation time
  - ***Advanced***: e.g. regionalised/dynamic/prospective LCA)
  - ***Flexible***: Coupling with other models/measurements/etc.
  - ***Transparent***: Easy sharing of notebooks and data;
    reproducing results is possible at any time
  - ***Consistent***, e.g. systematic modifications of background data

Some attributes of BW – should I then use it?

- **Open source, python-based LCA software** = community driven
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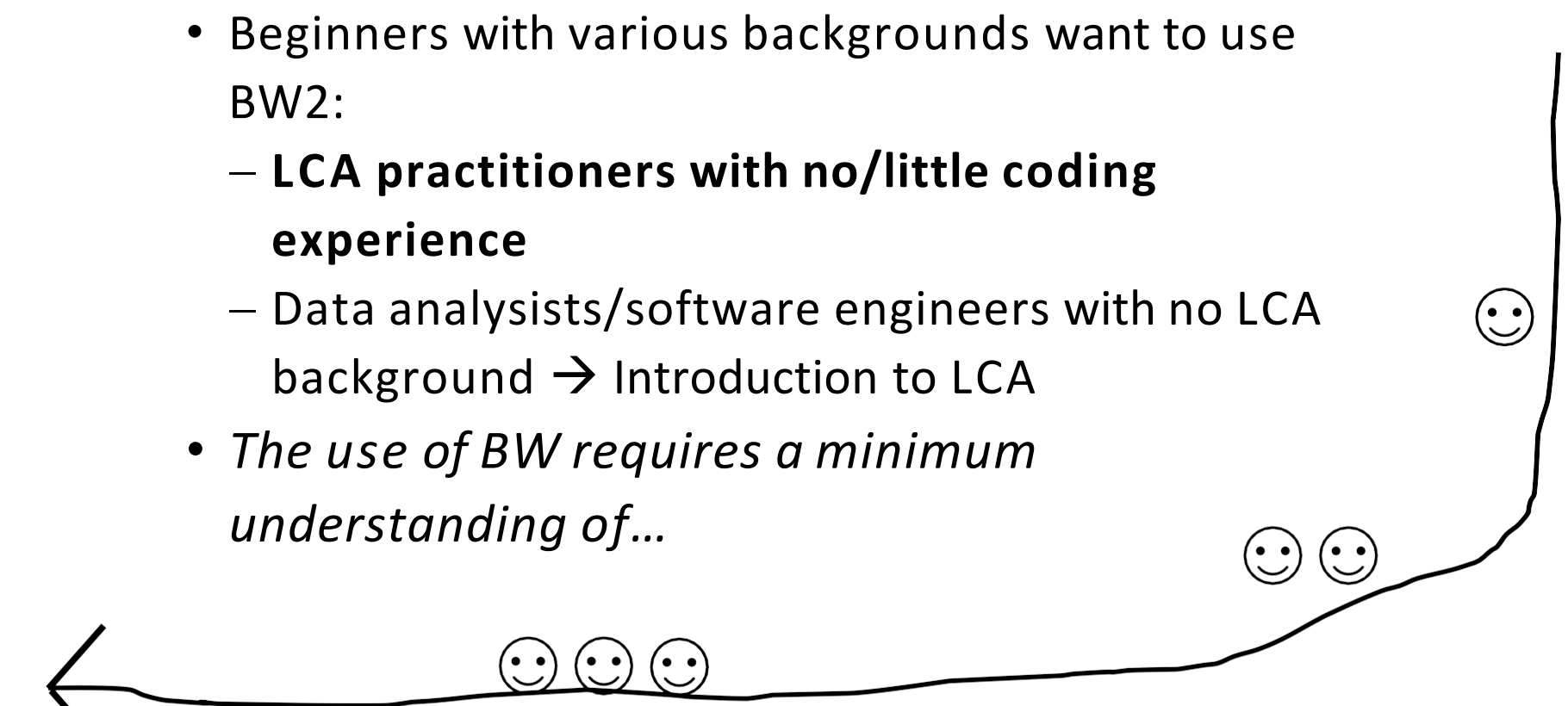
- LCA studies from easy to complex are possible with BW
- BW does not intend to replace software like SimaPro or OpenLCA – it depends on what you want to do, how much time you want to invest etc. which software you choose.
- **Open source code = we can build on the models of others, collaborate, move faster, make LCA better!**

Prerequisites and buzzwords you should know

- Beginners with various backgrounds want to use BW2:
  - **LCA practitioners with no/little coding experience**
  - Data analysists/software engineers with no LCA background → Introduction to LCA
- *The use of BW requires a minimum understanding of…*



Anaconda/Miniconda

The engine to install/open the software (package/environment management system)

Activity Browser

Graphical User Interface of BW2

Python

The language in which BW is written.
pandas, numpy, seaborn, matplotlib are very useful for LCA with BW.
*best search for python data analysis courses for getting started,

Brightway

The open python software code for doing LCA

Module, package, library

Libraries/packages contain modules. A module is a script with functions and classes.

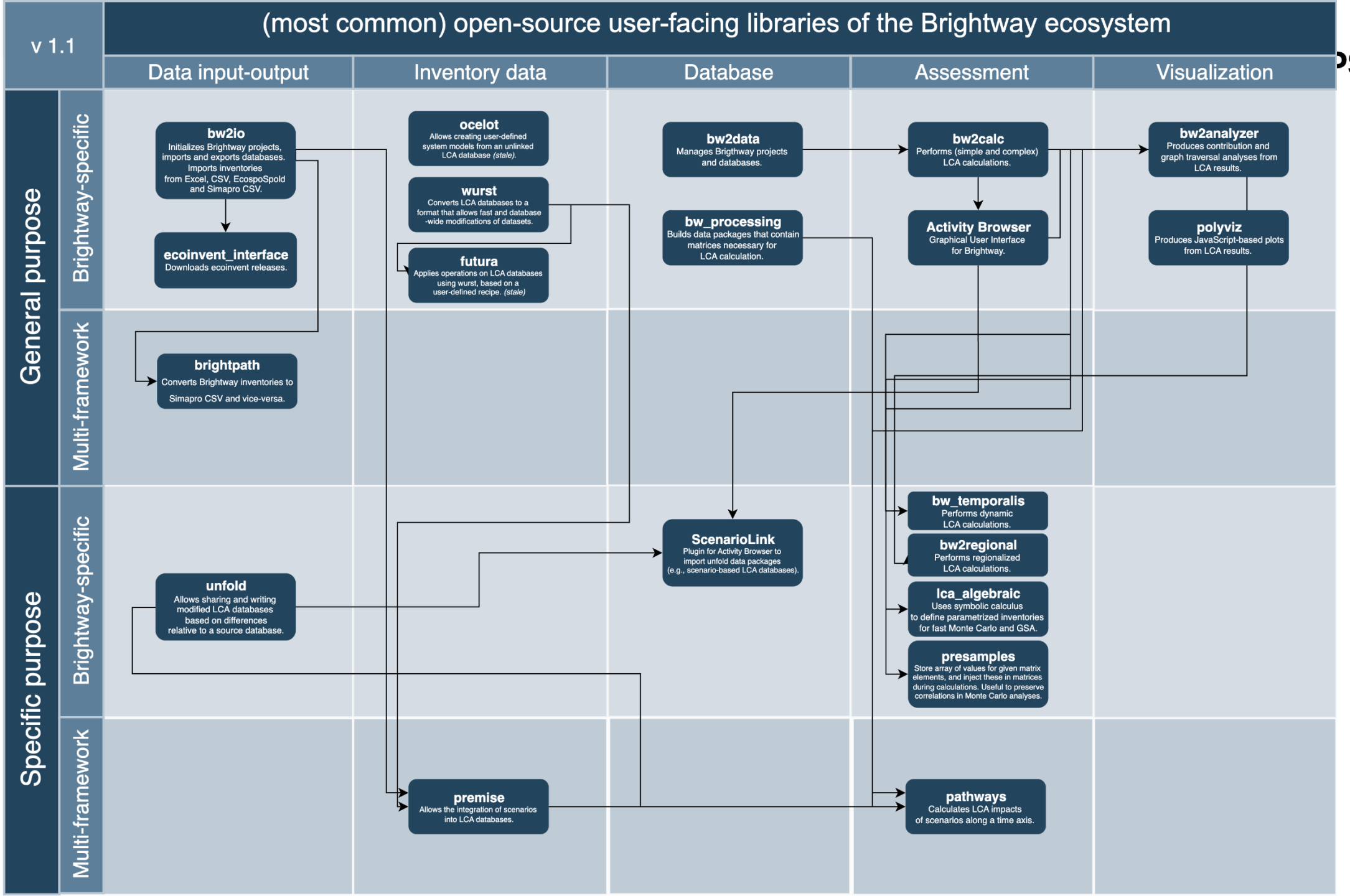
Lib/packages are not exactly the same, but the terms are often used interchangeably.

Jupyter

Used to create and share notebooks containing your LCA study code. You need an editor to open jupyter notebooks (e.g. spyder, VSC)

Github

Sharing, collaborating, managing projects, versioning, filing issues = reporting bugs/new ideas


v 1.1
(most common) open-source user-facing libraries of the Brightway ecosystem
Data input-output
Inventory data
Database
Assessment
Visualization
General purpose
Brightway-specific
Multi-framework
Specific purpose
Brightway-specific
Multi-framework
bw2io
Initializes Brightway projects, imports and exports databases. Imports inventories from Excel, CSV, EcospoSpold and Simapro CSV.
ecoinvent_interface
Downloads ecoinvent releases.
brightpath
Converts Brightway inventories to Simapro CSV and vice-versa.
ocelot
Allows creating user-defined system models from an unlinked LCA database (stale).
wurst
Converts LCA databases to a format that allows fast and database -wide modifications of datasets.
futura
Applies operations on LCA databases using wurst, based on a user-defined recipe. (stale)
bw2data
Manages Brigthway projects and databases.
bw_processing
Builds data packages that contain matrices necessary for LCA calculation.
bw2calc
Performs (simple and complex) LCA calculations.
Activity Browser
Graphical User Interface for Brightway.
bw2analyzer
Produces contribution and graph traversal analyses from LCA results.
polyviz
Produces JavaScript-based plots from LCA results.
unfold
Allows sharing and writing modified LCA databases based on differences relative to a source database.
ScenarioLink
Plugin for Activity Browser to import unfold data packages (e.g., scenario-based LCA databases).
bw_temporalis
Performs dynamic LCA calculations.
bw2regional
Performs regionalized LCA calculations.
lca_algebraic
Uses symbolic calculus to define parametrized inventories for fast Monte Carlo and GSA.
presamples
Store array of values for given matrix elements, and inject these in matrices during calculations. Useful to preserve correlations in Monte Carlo analyses.
premise
Allows the integration of scenarios into LCA databases.
pathways
Calculates LCA impacts of scenarios along a time axis.

Premise: Prospective LCA

premise
A python package using BW and own code to combine IAM scenarios with LCI databases.

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What is premise?

- Python package for *generating prospective LCI databases*
- Uses BW, wurst and own code to *combines scenarios from Integrated Assessment Models (IAMs) with e.g. ecoinvent*
- *Main changes are in energy related sectors* (decarbonisation focus of IAMs): Transport, fuels, electricity, heat, steel, cement

⇒ Careful interpretation of LCIA results required

How can I use it?

a) Use it via Activity Browser («ScenarioLink plugin»), or
b) Via jupyter notebook (install BW, run premise, generate databases and export to AB/SimaPro or openLCA CSV/sparse matrices

What it is, «installation», how to use: https://premise.readthedocs.io
Code, excel files with inventories https://github.com/polca/premise

So how can I use Brighway?

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Via AB only (and excel)

- I want to do LCA as I am used to from e.g. SimaPro, and don't have to deal with the code behind
- I want a smooth intro to Brightway

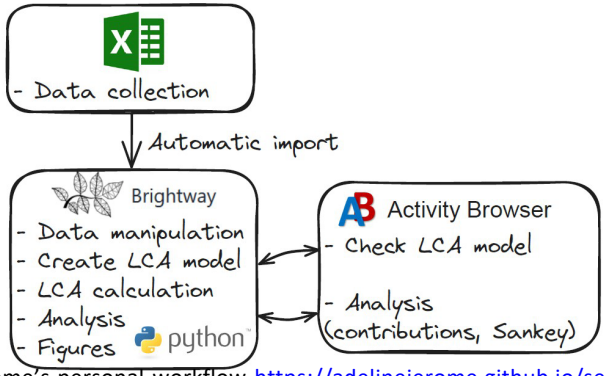
Excel spreadsheets are usually used to **build (at least the basis of) your own inventories**, linked to your source data for complete traceability&documentation. Further, I use it for **creating plots**. With advancing python skills, (much nicer and more flexible) visualisation can be done with e.g. seaborn, matplotlib.

Using jupyter notebooks, AB, (and excel)

- I want to learn using notebooks to build on it later
- I want the human friendly AB for searches in databases and quick LCIA calculations / visualisations
- I need to troubleshoot (AB giving an error)

Using jupyter notebooks only (and excel if you want)

- I want to do LCA by using the full fun of coding, which gives me a high degree of freedom



Adeline Jerome's personal workflow https://adelinejerome.github.io/seminars-for-esa/seminar_intro.html

Activity Browser – The BW2 graphical user interface (GUI)

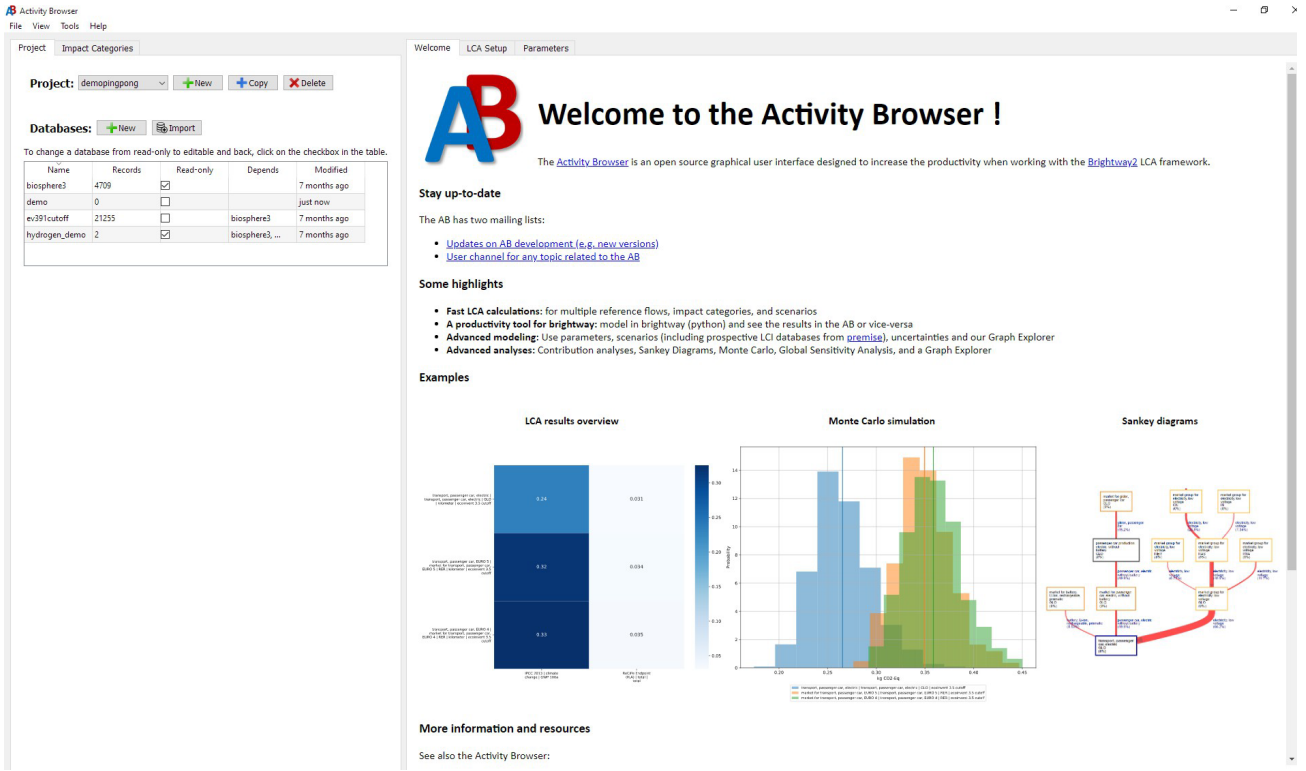
Via AB only (and excel)

What does this GUI do?

- Fast LCA calculations and advanced analysis options
- Advanced scenario modeling for prospective LCA (superstructure approach)

How can I use it?

- Install anaconda/miniconda, open the command prompt, go on github, follow the instructions
- Next time you want to open it: see next slide



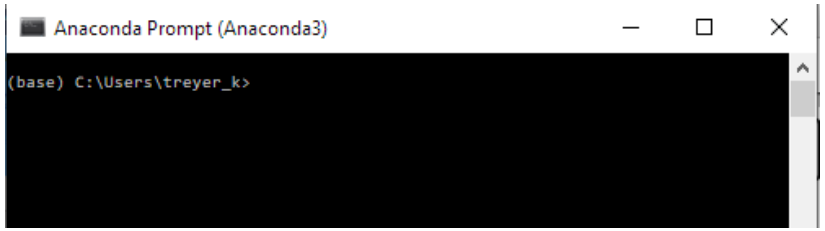
Install conda, e.g. https://docs.anaconda.com/free/miniconda/

Youtube channel with tutorials: https://www.youtube.com/@activity-browser

Installation information: https://github.com/LCA-ActivityBrowser/activity-browser

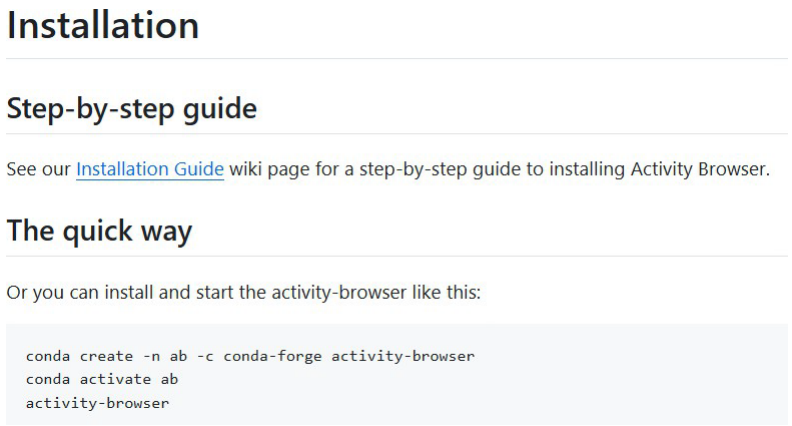
Installing, opening and maintaining AB

1. Install conda, e.g. https://docs.anaconda.com/free/miniconda/ or https://docs.anaconda.com/free/anaconda/install/



2. Open the command prompt
3. «Install» AB (do this only once):

```
conda create -n ab -c conda-forge activity-browser
```



4. Open AB:

```
conda activate ab #This activates the environment ab
activity-browser #This opens the relevant package
```

Maintaining AB (keep up with new versions):

Open command prompt, activate ab environment

```
conda update --all #updates all packages to the latest version
Or
conda update activity-browser
```

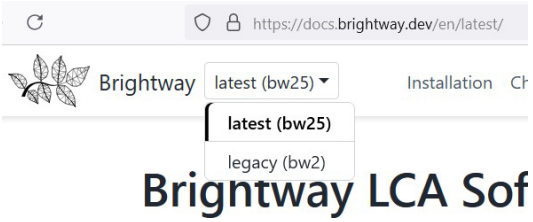
Read the messages the command prompt gives you! Sometimes you need to e.g. first update your conda (do conda update --all in your base environment), or your python version

Using Brightway - Where can I find information & support?

- Description of the software, how to install it etc.: https://docs.brightway.dev
- Example notebooks (work in progress): https://learn.brightway.dev
- Interactive place to run notebooks (advanced): https://live.brightway.dev
- Another interactive place: https://try.brightway.dev

- «Forum»: https://brightway.groups.io/g/development/subgroups

→ **Especially for beginners:** https://brightway.groups.io/g/beginners



Using Brightway - Which version should I use?

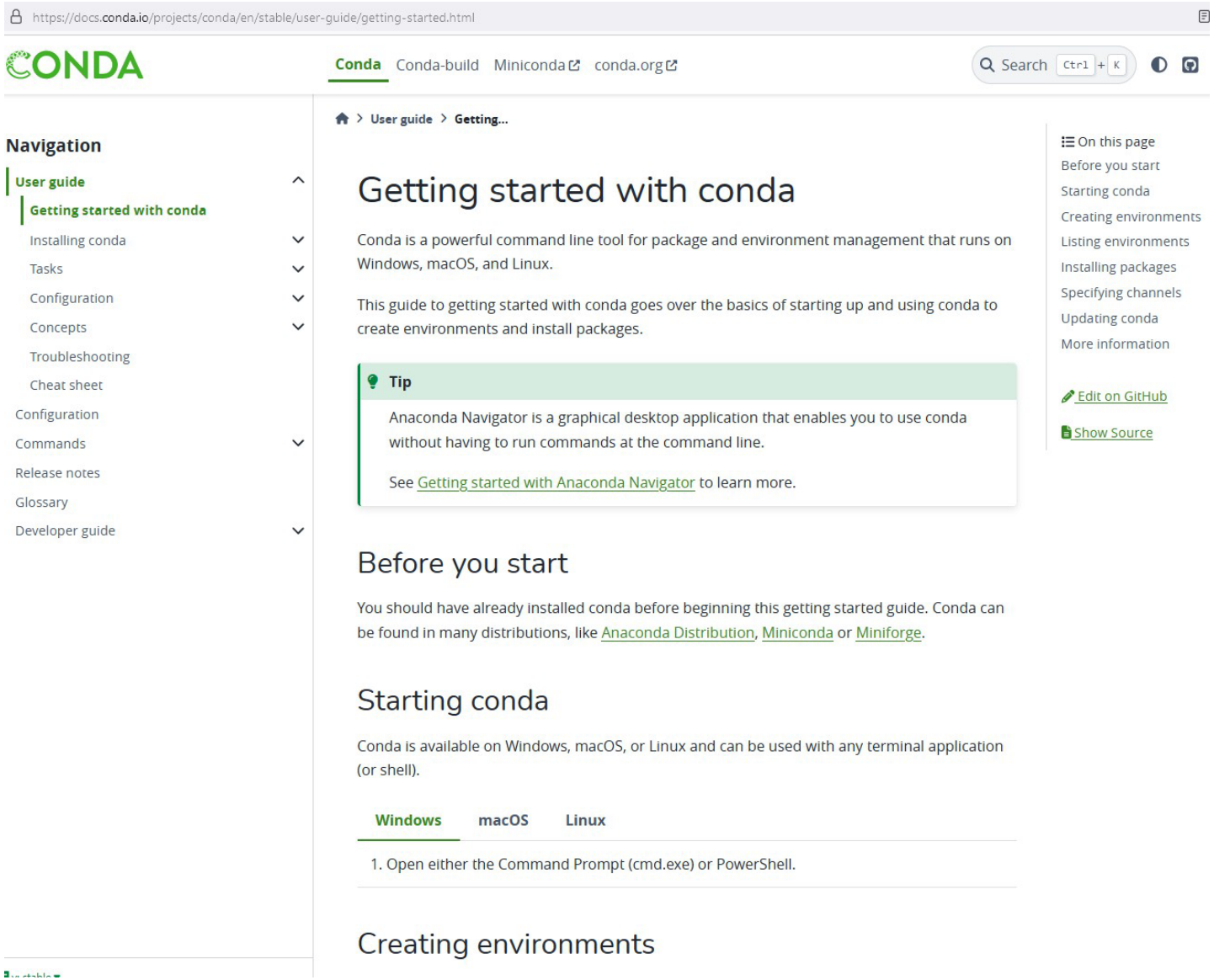
Using jupyter notebooks, AB, (and excel)

- If you want to work both in Activity Browser and jupyter notebooks, you need to use v2 (AB runs on v2).
- If you want to use BW mostly in notebooks, pick v2.5
- You can transfer a project from v2 to v2.5 in an irreversible way => as soon as you did the transfer, AB won't be able to open it again.

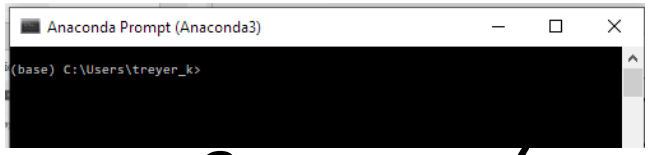
```
#open project with bw25 instead of bw2
bw2data.projects.migrate_project_25
```

- See comparison https://docs.brightway.dev/en/legacy/content/faq/brightway.html
- Basic code is not very different between v2 and v2.5, so your notebooks can run in both versions => Try to write in the «2.5 language», and only adapt the code if something doesn't exist in v2

Getting started - *install conda*



Installation, opening, upgrading (prompt window)



- ***Open your (ana-/mini-)conda prompt window*** – this is always the start of your work with bw!
- ***«Installing»*** = creating a conda environment and attaching the bw package to it:

```
conda create -n yourenvname brightway2 jupyterlab
```

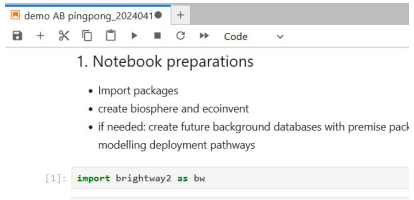
- ***Starting = opening bw:*** we want to open a jupyter notebook in the environment you want to work in by doing this:
- open anaconda prompt

(`conda env list` for knowing which envs you have)

```
conda activate yourenv
```

- `jupyter lab` or `jupyter notebook`)
- Upgrading:

```
activate yourenvname
conda update
conda conda update -c conda-forge brightway
```



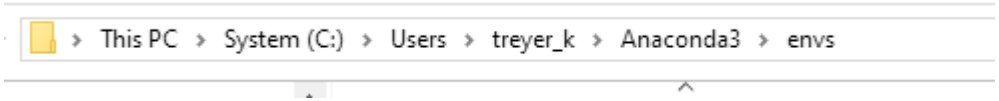
Working with BW (jupyter notebook)

- Open a **jupyter notebook** in an editor, and use the environment you want

- For beginners I recommend the use of jupyter notebooks, AB and excel.

Environments: AB and BW «talk to each other»

- You can install activity browser ONCE on your computer in the environment «ab».
- For each new project, you create an own environment.
- AB is connected to these other environments, and any project you create is directly visible also in AB!
- Your environments are stored in your conda folder, i.e. they are usually to be found in one central folder on your machine



→ Anaconda can eat up a lot of storage space because the indiviual envs are rather large.

→ Make sure to delete unused envs also in the conda folder

→ Clear Cache from time to time

→ See https://docs.anaconda.com/anaconda-notebooks/notebook-storage-memory/

Sounds cool, but how can I transfer my projects from another software into BW? Not without pain…

Source	Tool	TRL	Notes
EcoSpold 1	bw2io	8	Could require elementary flow harmonization
EcoSpold 2	bw2io	9	Most stable import format
OLCA Schema (JSON-LD)	bw2io	4	Broken with new JSON-LD version
OpenLCA (direct)	openlca2bw	5	Not all features supported
Excel (BW template)	bw2io	8	Most stable import format
Excel (Custom)	bw2io+	N/A	Must be developed by user
ILCD	bw2io fork	4	Unmaintained?
SimaPro CSV	bw2io	7	Could requires elementary flow harmonization