MOCA – A PYTHON PACKAGE FOR UNCERTAINTY ANALYSIS IN LIFE CYCLE ASSESSMENT

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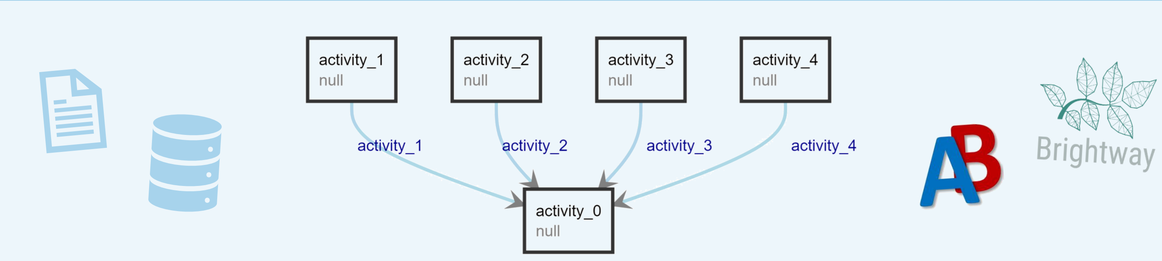
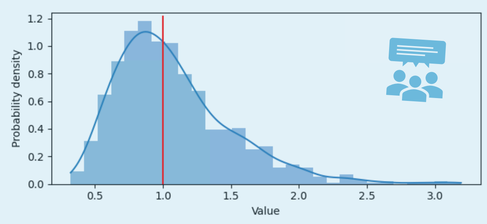
1 Your Brightway2 Database

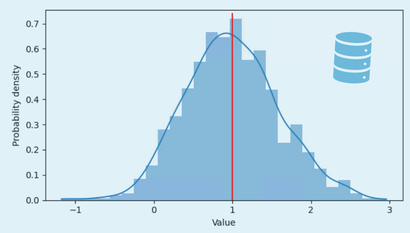


2 Add Uncertainty Information

2a Pedigree Approach



2b Statistical Distributions

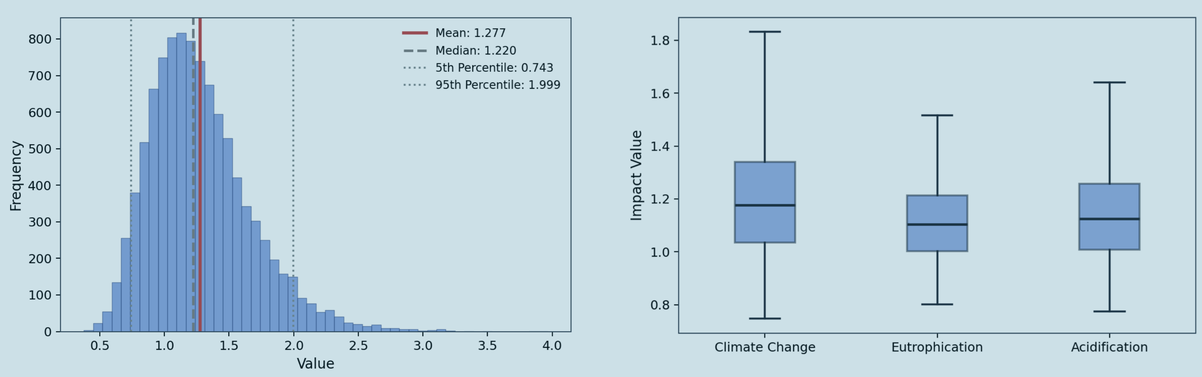


3 Perform Monte Carlo Simulation

```python
# specify the LCIA method / characterisation model
lcia_method_name = "EF v3.1"

# build the demand dictionary for the Monte Carlo LCA
demand = {bw.Database("foreground").get("fg_activity_0"): 1}

# initialize the Monte Carlo LCA
mc_lca = moca.MonteCarloLCA(demand, lcia_method_name)

# execute the parallelised Monte Carlo simulation
mc_lca.execute_monte_carlo(iterations=10000)

# print statistics and save results to JSON
mc_lca.print_stats(impcats=["climate change [kg CO2-Eq]"])
mc_lca.results_to_json()
```

```
Performing Monte Carlo simulation for demand: activity_0
Current progress: 100%|████████████████████| 10000/10000 [08:20<00:00, 19.98it/s]
Monte Carlo results for demand: activity_0

Impact category: climate change [kg CO2-Eq]
  Mean: 61.85037903925503
  Std: 5.092451617470817
  Min: 50.16415397166987
  Max: 74.47234994065315
  Percentiles:
    5th percentile: 53.681342624566874
    10th percentile: 55.143281179408 67
    25th percentile: 58.1031072829331
    50th percentile: 61.6587294410994
    75th percentile: 65.48962639621114
    90th percentile: 68.89347054458806
    95th percentile: 70.61673605833266
```

4 Analyse the Resulting Distribution of Results



Try it for yourself!

GitHub Repo

Documentation

The treatment of uncertainty is a central issue in life cycle assessment (LCA), especially when results are used to support decision-making processes. However, many LCA studies still skip this step because it requires additional knowledge, effort and computational resources.

The Idea Behind MOCA

- New Python package for fast and easy-to-use Monte Carlo Simulations
- Designed to plug into your existing Brightway2 setup with minimal changes
- Planned to be extended towards more uncertainty analysis methods and automated visualisation tools

How Does Monte Carlo Simulation Work?

Monte Carlo Simulation uses repeated random sampling to account for uncertainty in an LCA. Instead of assigning one fixed value to an input, uncertain parameters are described by probability distributions.

For each simulation run, a different set of input values is sampled and the LCA is recalculated. Repeating this thousands of times produces a distribution of possible results, showing not only the expected impact but also its uncertainty.

Reduced Computational Effort via Parallelisation

Thousands of LCA calculations can take considerable computation time when performed one after another.

MOCA splits the calculations into multiple processes that can be executed simultaneously on multiple CPU cores. This parallelisation allows many simulation runs to be performed at the same time and can substantially reduce the overall computation time.

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