Pymrio - a Python module for automating input output calculations and generating reports

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Abstract—In the last decades, globalization has led to complex supply chains spanning multiple countries. Likewise, environmental pressures caused by production of a certain product are spread across countries. As a consequence, the environmental impacts of consumption are more and more determined by impacts occurring abroad. Environmental extended multi regional input output (EE MRIO) analysis emerged as the prevailing tool to account for all impacts along the global supply chain. EE MRIOs facilitate the tracing of goods and its embodied (upstream) environmental impacts from the producer to the final consumer. Therewith it is possible to analyse global pollution and resource use through the whole supply chain and consequently calculate environmental (for example carbon-, water-, land-footprints) accounts.

Compiling global MRIO is a complex task, and to date half a dozen such tables / databases have been compiled. Most of these databases are freely available. However, their structures differ from model to model, and handling/analysing MRIOs needs a certain degree of training.

The Python module pymrio aims to ease the handling of global EE MRIOs. With just a couple of commands it is possible to calculate footprints of products, regions or per capita. It allows to aggregate countries to regions (eg. EU, continents) and to modify the sector classifications.

To date, a parser for the recently published EXIOBASE 2 global MRIO has been implemented. The parser for the World Input Output Database (WIOD) and the upcoming EXIOBASE 3 EE MRIO time series is currently in the testing phase. Once a certain MRIO is parsed, various methods can be applied such as restructuring the satellite accounts or aggregation of regions and sectors. Pymrio automatically checks the parsed EE MRIO for missing data necessary for calculating standard EE MRIO accounts (such as footprint, territorial, impacts embodied in trade) and calculates all missing tables.

Various data visualization methods help to explore the dataset. They extract data from various data tables and allows to compare different perspectives (territorial, footprint, impacts embodied in trade) among countries. In addition, reports can be generated (available in various formats like html, latex, rst) for all stressor/impact data available in the MRIO database, either for absolute accounts or per capita. Calculated results can be exported in various format (Excel, csv, sql).

The guiding principle for the development of pymrio was that an EE MRIO database can effectively represented as an object in an object oriented programming language as for example Python. Parsing a specific EE MRIO database into an instance of such an object guarantees consistent methods for handling and analysing different (MR)IOs.

The development of pymrio follows best practice of scientific computing including unit testing and frequent integration tests. Every implemented algorithm and data handling function is accompanied by a corresponding test harness which ensures the formal correctness of the function. The full source code is available on a public code repository (github: https://github.com/konstantinstadler/pymrio) together with an extensive documentation and tutorials.

In the near future, development of pymrio will focus on providing an automatic analysis of EE MRIO time series and to improve the data visualisation capabilities. Among others we plan to implement report generation function which automatically generate flow maps of environmental pressures embodied in trade flows and of chloropeth maps for the estimated footprint accounts.