A Python Package for Resilience of Complex Systems

The pyRoCS Python package is a compilation of functions designed to support quantitative characterization, evaluation, and learning to inform improvements in complex systems.

OBJECTIVE

Complex systems are ubiquitous and can be physical systems (e.g., electric grid) or organizational systems (e.g., companies or even subfunctions of an organization). The functions within pyRoCS specifically focus on quantifying the resilience of complex systems by measuring their ability to withstand, operate through, and recover from a disruption.

Existing mathematical equations for resilience analysis are found within multiple domains including information theory, biological sciences, and complex systems. This package synthesizes and refactors equations from these various domains to generalize their implementations in a Python environment.

TOOL OVERVIEW

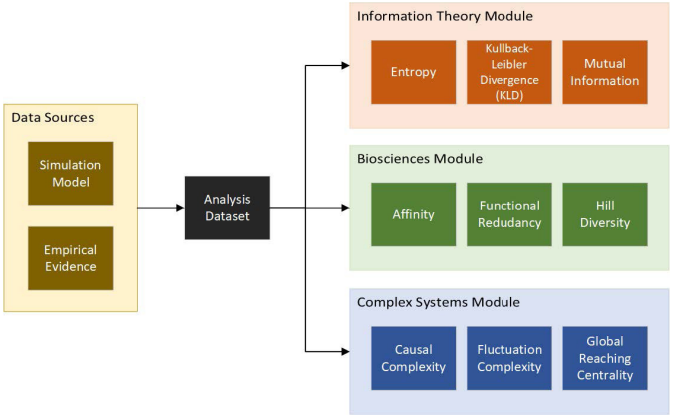
The pyRoCS package includes mathematical formulations of equations from three domains:

- Information theory
- Biosciences
- Complex systems

These domains have advanced how we quantify, store, and communicate information (information theory); explore interactions between species (biosciences); and consider non-linear interactions between system components (complex systems).

Functions within pyRoCS are organized into modules that reflect the disciplines from which they originate. While they have distinct origins, the functions can also be applied to the resilience analysis of any complex system.

Accordingly, their formulations and associated documentation have been generalized in this package and modified to support usability (e.g., exposing more inputs to the user and diversifying the types of data structures accepted by the calculations).



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APPLICATIONS

The functions within pyRoCS can be applied to either empirical datasets or simulation environments.

Two tutorials are included in the online documentation with examples demonstrating how the functions can be used to:

a) compare a dataset with a subset to characterize how representativeness the former is of the latter, and

b) characterize the layout of different organizational structures.

We are actively exploring the application of pyROCS functions to various areas, including physical security, energy transitions, media narratives, and organizational behaviors. Additional metrics may be added to the package as dictated by research interest.

Package and documentation are available at: github.com/sandialabs/pyrocs.

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