

IWOPY: Fraunhofer IWES optimization tools in Python

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Summary

Optimization problems are described by optimization variables, which are scalars that are modified during the process of optimization; objective functions, which depend on the variables and whose values define the metric for rating the choices of the latter; and constraints, which are also functions of the optimization variables and define validity of the solution. The variables can be discrete or continuous, bounded or unbounded; the number of objectives can be one or many; and constraints can require equality or inequality. Many Python packages formulate a framework for the description of such problems, accompanied by a library of optimizers. Hence, switching from one to another optimization package can often be tedious and a meta-solution is required that can serve as a single interface to multiple optimization packages. The package `iwopy` solves this problem by providing a convenient and flexible interface which is general enough to be applicable to a wide range of optimization problems.

Statement of need

The Python package `iwopy` provides a general object-oriented formulation for optimization problems, objective functions, and optimization constraints. The optimization problem class defines the optimization variables, their bounds and their types. Objectives and constraints can then be added in an independent step to the problem, such that they can easily be exchanged and modified by the user. The framework is general enough for supporting complex science and engineering problems, and it supports single, multi and many objective optimization problems.

The core functionality of `iwopy` is to provide interfaces to other existing Python optimization packages, like `pymoo` ([Blank & Deb, 2020](#)), `pygmo` ([Biscani & Izzo, 2020](#)), or `scipy` ([Virtanen et al., 2020](#)). Once the problem is formulated within the framework sketched above, all individual optimizers from the supported linked packages can be selected and switched easily.

Note that more optimization packages are available which are not yet supported, like `pyomo` ([Bynum et al., 2021](#)), `Platypus` ([Yermanos, 2023](#)), `DEAP` ([Fortin et al., 2012](#)) and others. Each package is well suited for solving a wide range of optimization problems, and they all come with extensive user interfaces. However, `iwopy` addresses a unification of those interfaces, enabling the user to benefit from all supported optimizers without the need of extensive changes of the code base.

The design of `iwopy` has a focus on vectorized evaluation approaches, as for example often provided by heuristic algorithms that rely on the concept of populations. If the vectorized evaluation of a complete population of individual choices of optimization variables is implemented by the user, this enables a vast speed-up of optimizations compared to the one-by-one evaluation through a loop.

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