SIMSOPT: A python/C++ framework for stellarator optimization

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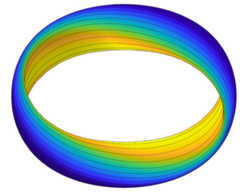


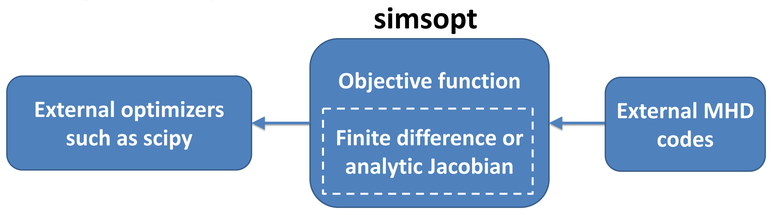
Simsopt[1] Objectives

- Optimize magnetic field and coils to achieve good plasma confinement.
- Classes to define geometric objects for stellarators.
- Representations of magnetic fields and their analytic derivatives and a fast Biot-Savart kernel.
- Interfaces for VMEC and SPEC MHD codes
- Highly efficient parallelized finite difference gradient

Salient Features

- Distribution: python wheels, conda packages, and containers
- Containers come with VMEC and SPEC codes
- Supports python versions 3.7 – 3.10
- Works on Linux, Mac, and Windows (via WSL2)
- Comprehensive suite of integrated and unit tests
- Well documented code

Design Concepts



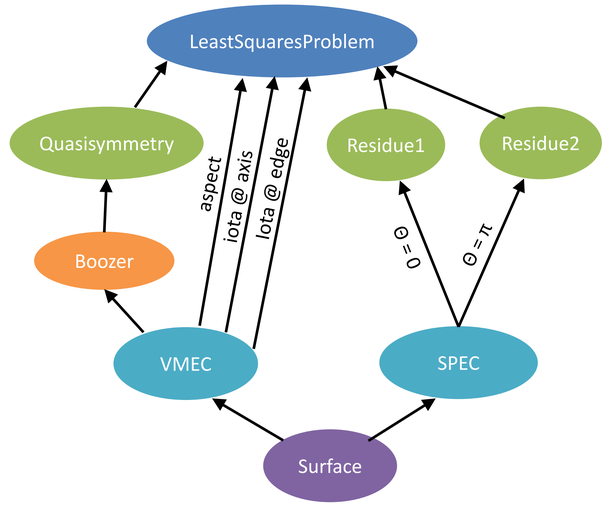
Optimizable:

1. Fundamental class of simsopt
2. Provides graph like framework to generate objective function
3. Defines one or more output functions
4. Supports caching of outputs
5. Depends on zero or more other **Optimizable** objects
6. Has zero or more local degrees of freedom (DOFs)

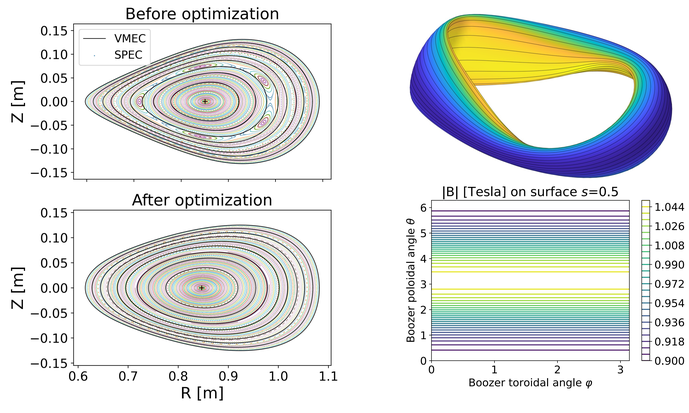
DOFS:

1. The local DOFs (***x***) of the Optimizable objects combine to form global DOFs (***X***)
2. Can be dynamically frozen (or fixed)
3. The global free DOFs form the parameter space of the optimization problem

Magnetic Island and Quasi-symmetry Optimization[2]



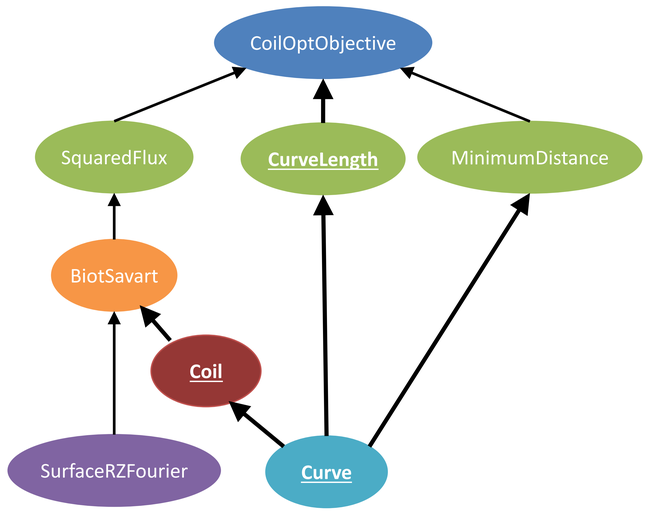
- **LeastSquaresProblem, Quasisymmetry**, **Boozer**, **Residue**, **VMEC**, **SPEC**, and **Surface** are sub-classes of **Optimizable** base class
- **LeastSquaresProblem** provides L2 norm residues
- **VMEC** and **SPEC** objects depend on a single **Surface** object
- **MPI** based parallelized finite difference scheme for gradients



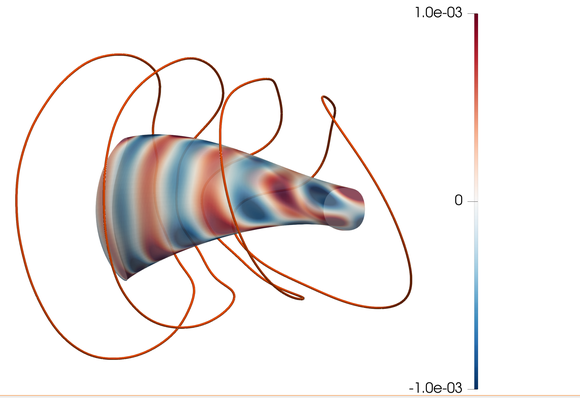
To access the poster and for other relevant links, scan the QR code.

Acknowledgements: B.M. and C.Z. are supported by the US DOE Contract No. DE-AC02-09CH11466. M.L., F.W., A.G., and R.J. are supported by a grant from Simons Foundation (560651, ML).

Stage II Coil Optimization



- Underlined objects represent a list of same type objects
- **SurfaceRZFourier** initialized from magnetic surface optimized in Ref [3]
- All the classes are again sub-classes of Optimizable class
- Analytic derivatives are used



References

[1] M Landreman, B Medasani, F Wechsung, et al, *JOSS* 6, 3525 (2021).

[2] M Landreman , B Medasani, & C Zhu, *Phys Plasmas* 28, 092505 (2021).

[3] M Landreman & E J Paul, *arXiv*:2108.03711 (2021).