Generic Optimization and ML at CERN

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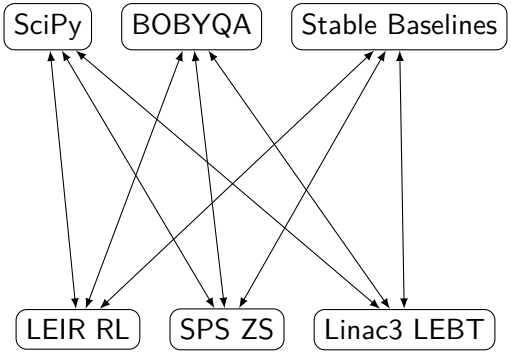
Motivation

- many different optimization problems at CERN
- many different optimizers with different APIs
- each optimization problem involves complex machine communication
- operators don't want to juggle Python scripts!



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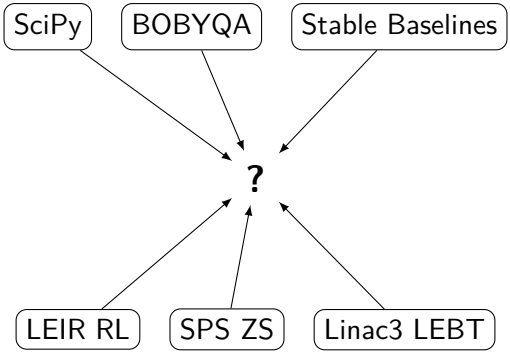
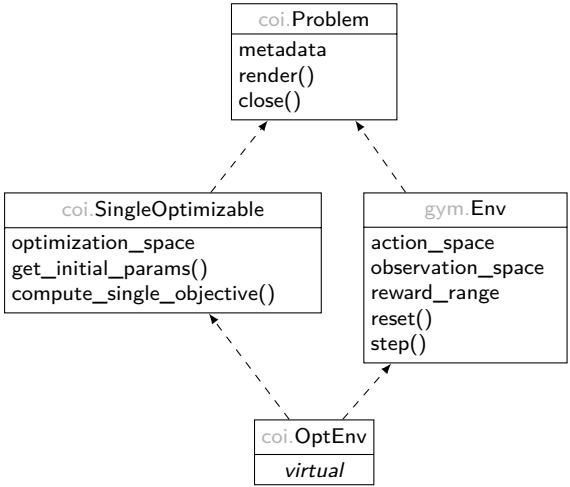


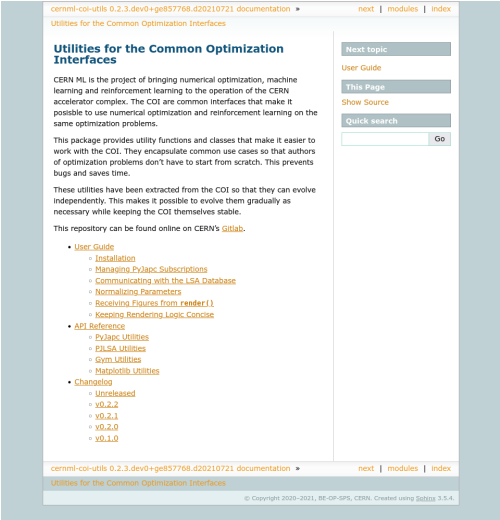
Common Optimization Interfaces (COI)

- based on OpenAI Gym for RL
- extends the system to numeric optimization
- extend Gym's metadata system with CERN-specific info
  - which accelerator?
  - communicates with machines?
  - wants to plot additional data?

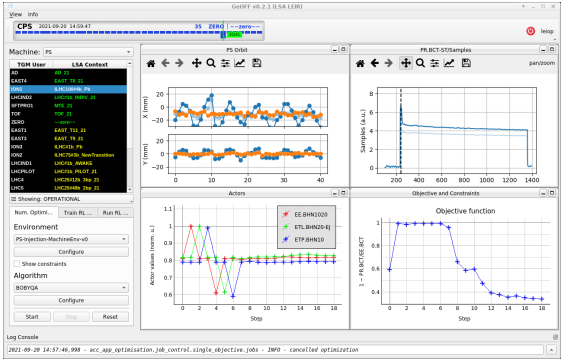


COI Utilities

- separate package for faster versioning
- encapsulate many common tasks
- modular thanks to `extras-require`: only provides what is needed



Generic Optimization Frontend & Framework (GeOFF)



- PyQt5-based GUI
- lists, configures and runs optimization problems
- built-in list of optimizers
- very extensible: optimization problems are loaded as plugins (also at runtime!)

Usage

1. implement class that inherits from COI (~ 300 lines of code)
   - declare metadata
   - implement machine communication
   - add plotting (if any)
2. dynamically load package into GeOFF

Optionally:

3. turn code into package (provided by Acc-Py)
4. add to CERN package index via Gitlab CI (provided by Acc-Py)
5. notify us
6. get package integrated into GeOFF

Use cases

- PS: steering from PS to n-TOF
- Linac3: LEBT steering
- LEIR:
  - transfer line from Linac3
  - cooler bumps
  - multi-turn injection
  - transfer line to PS
- SPS:
  - tune adjustments
  - ZS alignment
  - longitudinal blowup
  - crystal shadowing
- ISOLDE: generic transfer line optimizer under investigation

Next steps

- Bayesian optimization
- turn GUI into modular components
  - provide each part *and* the whole GUI as a library
  - experiments & machines can package GUI with their own plugins
  - gives control back to the users, avoids bottleneck
- data recording, automatic model training
- integration with Machine Learning Platform