An Introduction to Multiobjective Simulation Optimization with ParMOO

Tyler Chang

Mathematics and Computer Science Division,
Argonne National Laboratory

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Review of Single-Objective Optimization

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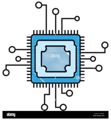

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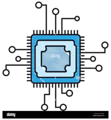

place new component

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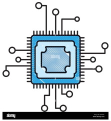

place new component

$$\min_{x \in [0,1]} f(x)$$

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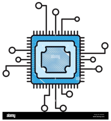

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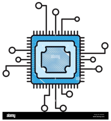

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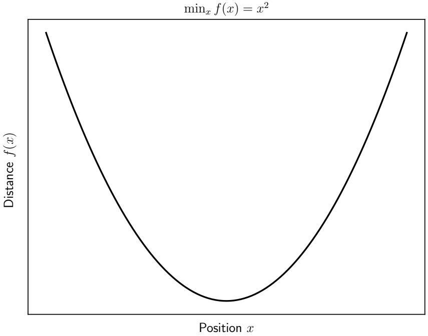
$$f(x) = x^2$$

Gradient Descent



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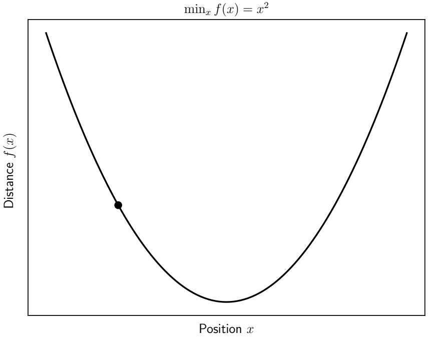

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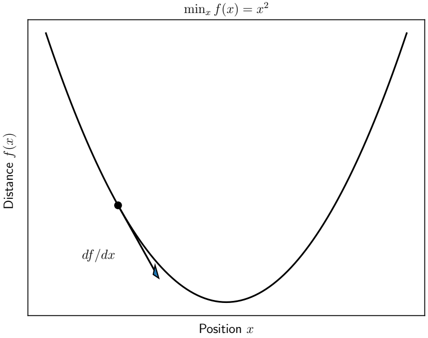
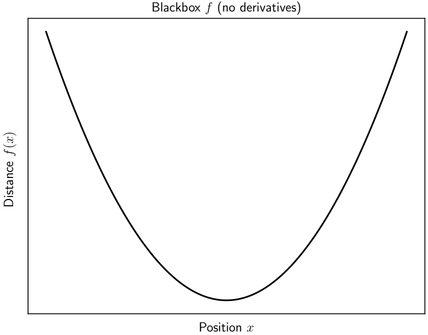


Surrogate Modeling



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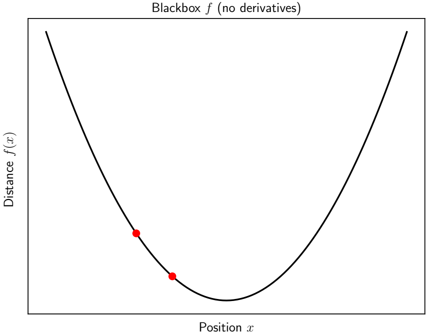

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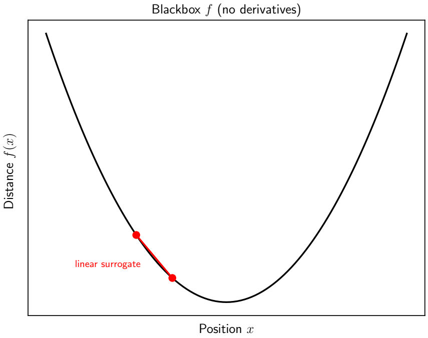

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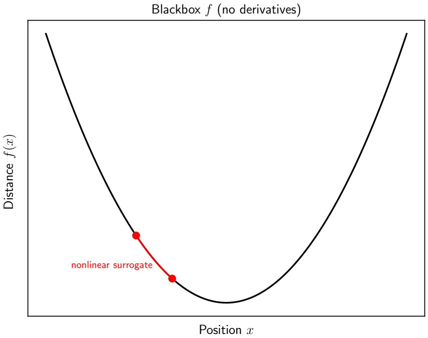

Multiobjective Optimization

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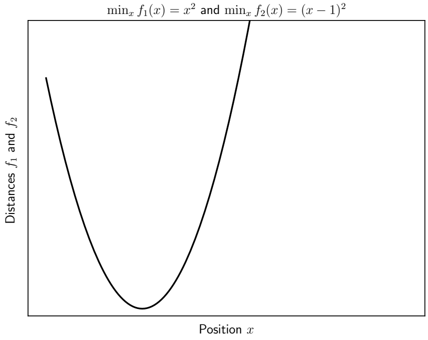

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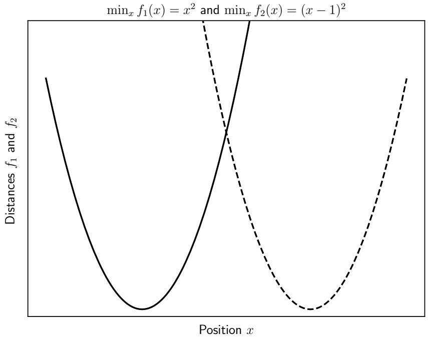

Dominance Relation

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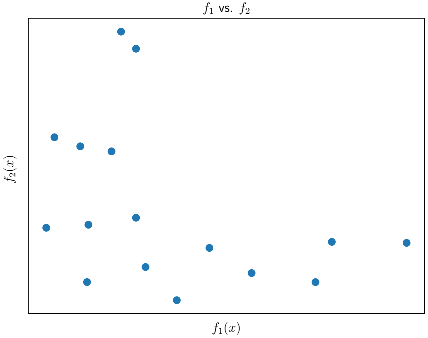

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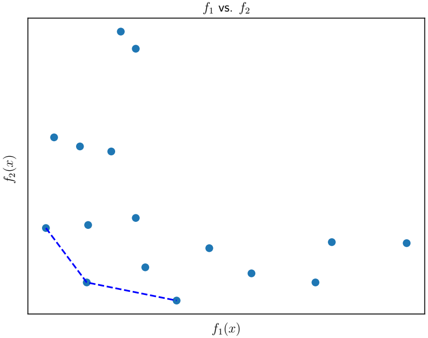

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$$\min_{x \in \mathbb{R}^n} (f_1(x), f_2(x), \ldots, f_o(x)) = F(x)$$

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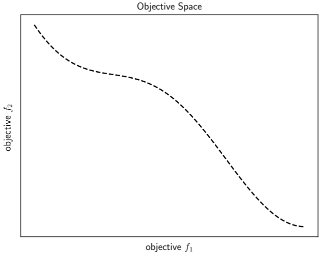

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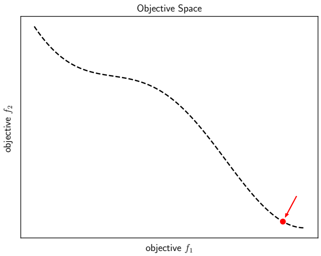

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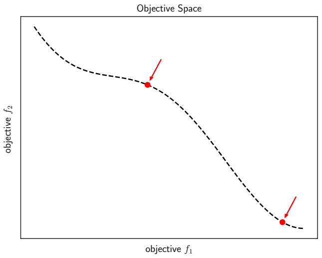

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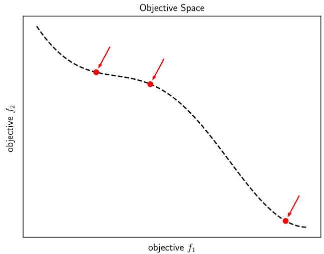
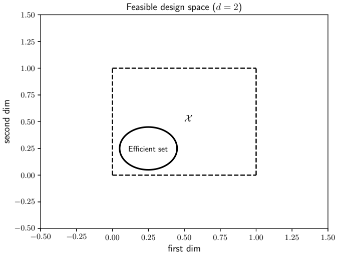


Multiobjective *Simulation* Optimization

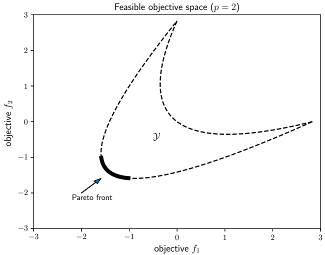
Problem setting:

Input variables



$$F : \mathcal{X} \to \mathcal{Y}$$

Objective space



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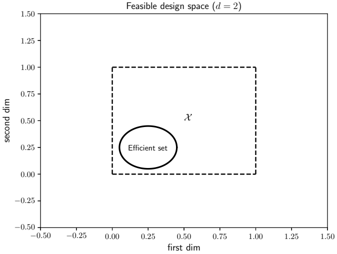
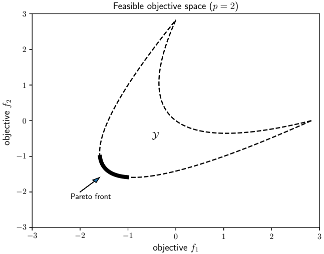


Blackbox process

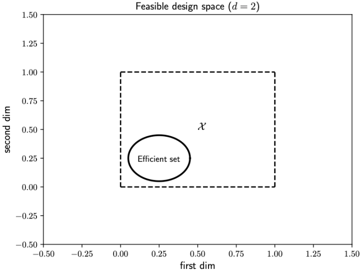
Numerical simulation?
Real-world experiment?
Build a prototype?
Run a test?

$$F : \mathcal{X} \rightarrow \mathcal{Y}$$

Objective space

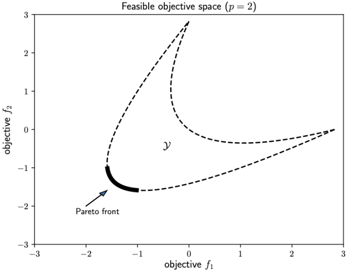


ParMOO



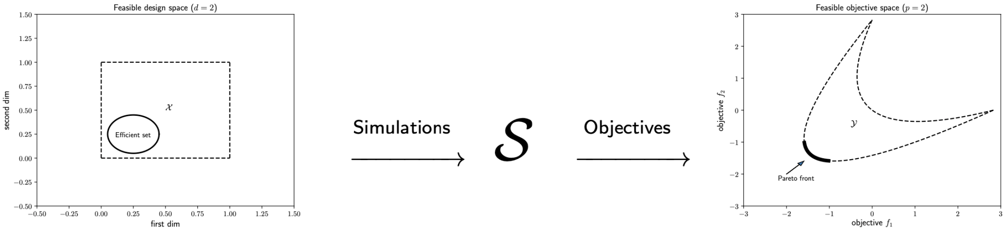
Design space

Objective Functions



Objective space

ParMOO



Design space

Objective space

ParMOO Solver Components

https://parmoo.readthedocs.io/en/latest/quickstart.html

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- Search/DOE technique

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- Search/DOE technique
- Surrogate model
- Acquisition function
- Single-objective solver

Tutorial

ParMOO – Other Topics

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- Constraints

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- Constraints
- Categorical variables
- Adding derivative option to objectives/constraints
- Logging and checkpointing
- Parallel solve using `libEnsemble`
- Integration with `MDML` (on the `feature/MDML` branch)

Resources

E-mail: tchang@anl.gov
E-mail: parmoo@mcs.anl.gov

ParMOO is under review with JOSS

GitHub: github.com/parmoo/parmoo
Docs: parmoo.readthedocs.io
PyPI: pip install parmoo

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