OptiProfiler: A Benchmarking Platform for Optimization Solvers

Cunxin Huang, Tom M. Ragonneau, Zaikun Zhang
(corresponding: cun-xin.huang@connect.polyu.hk)

Contribution highlights

We present **OptiProfiler**, a benchmarking platform for optimization solvers with a current focus on **derivative-free optimization (DFO)**. OptiProfiler provides:

- **Automated benchmarking** with performance profiles, data profiles, and log-ratio profiles,
- **Flexible testing environments** with multiple built-in features and problem libraries,
- **Easy-to-use interface** requiring only a few lines of code.

Website & Documentation

`https://optprof.com`

Why OptiProfiler?

Benchmarking is essential in optimization research, yet existing tools have limitations:

- Performance profiles are often implemented with basic code aimed at experts,
- Many platforms lack support for customizable testing environments,
- Reproducibility and result tracking are often overlooked.

OptiProfiler addresses these needs:

Simple usage for beginners

Multiple degrees of freedom for experts

Automatic generation of high-quality profiles

Reliable methodology for benchmarking

Trackable experimental results for reproducibility

Quick start

Installation:

```
git clone https://github.com/optiprofiler/
  optiprofiler.git
% Go to the directory and run the following
  command in the MATLAB command window
setup
```

Simple usage:

```
benchmark({@fminsearch, @fminunc})     % Default

% Custom options
options.feature_name = 'noisy';
options.noise_level = 0.1;
scores = benchmark(solvers, options)
```

Built-in features

OptiProfiler provides multiple testing environments through **features**:

Feature	Description
`plain`	Original problem
`perturbed_x0`	Randomly perturb initial guess
`noisy`	Add noise to function values
`truncated`	Truncate to given precision
`permuted`	Randomly permute variables
`linearly_transformed`	Apply linear transformation to the variables
`random_nan`	Randomly set values to NaN
`quantized`	Quantize function values

Example with customized noisy feature:

```
options.feature_name = 'noisy';
options.noise_type = 'relative';
options.distribution = 'gaussian';
options.noise_level = 0.01;
benchmark(solvers, options)
```

Problem library

Default: S2MPJ (by Gratton & Toint) — Problems in MATLAB, Python, Julia; no MEX files needed.

Built-in: MatCUTEst for MATLAB (by Zhang) and **PyCUTEst** for Python (by Fowkes & Roberts)

Problem selection:

```
options.ptype = 'u';     % Unconstrained
options.mindim = 6;
options.maxdim = 100;
options.plibs = {'s2mpj', 'matcutest'};
```

Types: Unconstrained (`'u'`), Bound-constrained (`'b'`), Linearly constrained (`'l'`), Nonlinearly constrained (`'n'`)

Benchmarking tools

Performance profile (Dolan & Moré, 2002; Moré & Wild, 2009):

$$\rho_s(\alpha) = \frac{1}{|\mathcal{P}|}\left|\{p \in \mathcal{P} : r_{p,s} \leq \alpha\}\right|,$$

where $r_{p,s} = t_{p,s}/\min\{t_{p,s} : s \in \mathcal{S}\}$ is the relative cost.

Data profile (Moré & Wild, 2009):

$$\delta_s(\alpha) = \frac{1}{|\mathcal{P}|}\left|\left\{p \in \mathcal{P} : \frac{t_{p,s}}{n_p+1} \leq \alpha\right\}\right|.$$

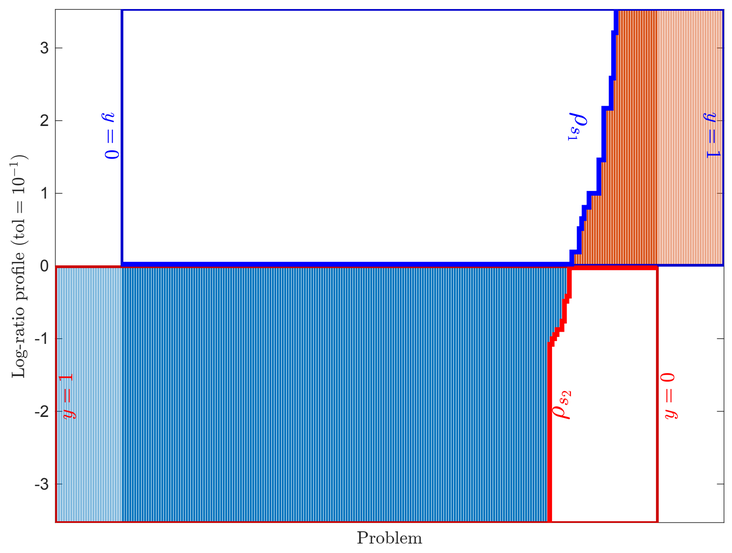
Log-ratio profile: When comparing two solvers, displays $\log_2(t_{p,s_1}/t_{p,s_2})$ sorted in ascending order.

History-based vs. Output-based:

- **History-based**: Cost to first reach convergence test
- **Output-based**: Total cost if output passes test

Equivalence: performance ⇔ log-ratio

When comparing two solvers, the **shaded area** in log-ratio profile corresponds to the **Area Above the Curve** of performance profile.



Generated outputs

OptiProfiler automatically generates:

- Summary PDF of all profiles,
- Detailed profiles at multiple tolerance levels,
- Solver scores based on AUC,
- History plots for each problem and solver,
- Time-stamped results for reproducibility.