Reproducibility Package
Chaotic PID/PIDD Evolutionary Optimization

This document describes all components required to reproduce the results of:

R. Vrabel
Evolutionary Optimization on Chaotic Closed-Loop Landscapes: A Comparative Study
Submitted to *Evolutionary Computation* (MIT Press).

The package contains the full experimental workflow used in the article:

- `run_experiments.py` – executes PSO and DE across 50 runs
- `compute_statistics.py` – computes summary statistics, robustness, PSI
- `generate_latex_tables.py` – generates table fragments
- `requirements.txt` – minimal dependency list

Installation

Python 3.12 or newer is recommended.

```
py -m pip install requirements
```

Dependencies:

- numpy
- scipy
- pandas
- mealpy 3.0.3

Running the Experiments

1. Optimization runs

```
python run_experiments.py
```

Output:

- `all_runs.csv` - raw results from all optimization runs (controller, algorithm, seed, cost, runtime).
- `best_gains.csv` - best-performing PID and PIDD controller parameters (minimizers of the cost function).
- `plot_PID.eps` - closed-loop simulation of the uncontrolled system, the best PID–PSO, and the best PID–DE solution
- `plot_PIDD.eps` - analogous simulation using the best PIDD–PSO and PIDD–DE solutions.

2. Compute statistics

```
python compute_statistics.py
```

Outputs:

- `summary_statistics.csv`
- `psi_statistics.csv`

3. Generate LaTeX tables

```
python generate_latex_tables.py
```

Outputs:

- `latex_table_summary.tex`
- `latex_table_psi.tex`

Reproducibility Notes

- Canonical PSO and DE.
- Independent random seed for every run.
- Closed-loop simulation uses Radau IIA solver on $t \in [0, 25]$.
- Controller gains in $[0, 10]$.
- PSI computed using performance pair (J, time), which is monotonic with evaluation count under fixed simulation budget.

Suggested Repository Structure

```
chaotic-pid-evolutionary-study/
|
|-- run_experiments.py
|-- compute_statistics.py
|-- generate_latex_tables.py
|-- README.pdf
|-- requirements.txt
|
|-- example_output/
|-- all_runs.csv
|-- summary_statistics.csv
|-- psi_statistics.csv
|-- latex_table_summary.tex
|-- latex_table_psi.tex
```

```
|-- plot_PID.eps
|-- plot_PIDD.eps
```

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