📊 Evolutionary Dynamics of Pleiotropy: Analysis and Visualization

This repository contains code to analyze and visualize the temporal dynamics of pleiotropy ($\Delta\pi$) in evolving populations across rugged fitness landscapes. The data are generated from simulations varying in **landscape ruggedness** (K) and **mutation rate** (μ), and the plots illustrate how pleiotropy evolves over time from diverse starting positions.

🔍 Key Features

- **Trajectory Visualization**: Plots mean pleiotropy change over time from 21 different starting conditions.
- **Confidence Intervals**: Displays 95% confidence intervals across 50 replicates using raw data, not just the means.
- **Drift Baseline**: Includes a genetic drift baseline (red line) with its own 95% CI and range envelope for comparison.
- **Parameter Grid**: Automatically creates a 4×3 grid of subplots for all combinations of K (1, 3, 5, 7) and μ (0.0001, 0.001, 0.01).
- **High-Quality Output**: Generates publication-ready figures with well-separated lines and color-coded confidence bands.

📁 Main Components

- collector: Raw data from simulations, grouped by starting condition, trait, and replicate.
- collectorShrunk: Smoothed and binned mean trajectories for each condition.
- collectorCI: Confidence intervals computed directly from all raw replicate data points.
- driftCollector: Contains drift simulation data used as a neutral benchmark.

📈 Output

Each subplot:

- **Black thin lines**: Mean $\Delta\pi$ from each start condition
- **Blue shaded regions**: 95% confidence intervals across replicates
- **Red dashed line**: Mean drift trajectory
- **Red shadow**: Drift 95% confidence interval
- **Gray area**: Full range (min-max) of drift outcomes

🛠 Requirements

- Python 3.x
- Libraries: numpy, pandas, matplotlib, pickle

📌 Notes

- The code assumes precomputed simulation outputs stored in .csv files and .p (pickle) format.
- Confidence intervals are calculated using the formula:

CI95%=x̄±1.96×sn\text{CI}_{95\%} = \bar{x} \pm 1.96 \times \frac{s}{\sqrt{n}}

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