Butterfly App Summary

What It Is

Butterfly is a high-performance quantum circuit simulator written in Mojo. It provides a fast statevector backend, multiple execution strategies, and visualization utilities for inspecting quantum states and circuit behavior.

Who It's For

Developers and researchers who want to experiment locally with quantum algorithms, circuit fusion, and performance benchmarking in Mojo.

What It Does

- Simulates quantum circuits with a statevector backend.
- Offers scalar, SIMD, parallel, grid, and fused grid execution strategies.
- Performs circuit fusion for common gate pairs and grid row-local kernels.
- Imports a subset of QASM 3 for interoperability.
- Visualizes states as tables, 2D grids, and step-by-step animations.
- Includes benchmarking harnesses to compare strategies and kernels.

How It Works (Architecture)

- `QuantumState` stores amplitudes as separate real/imag arrays.
- `Transformation` and `GateTransformation` represent operations; `Circuit` is an ordered list.
- Fusion is a rewrite pass that combines adjacent gates (same-target or specialized pairs).
- `ExecContext` selects an execution strategy; executor dispatches scalar/SIMD/grid kernels.
- Data flow: Circuit -> fusion pass -> execution strategy -> kernels mutate QuantumState -> visualization views.

How To Run (Minimal)

- Install Pixi and the Mojo toolchain. (Not found in repo)
- From repo root: `pixi run mojo run -I . tests/test_visualize_grid_state.mojo`
- Optional: `pixi run mojo run -I . tools/circuit_cli.mojo -- --prompt`