# Exercise 2: *GSEMO Results + Trade-offs*

## Setup

We used the standard multi-objective formulation:

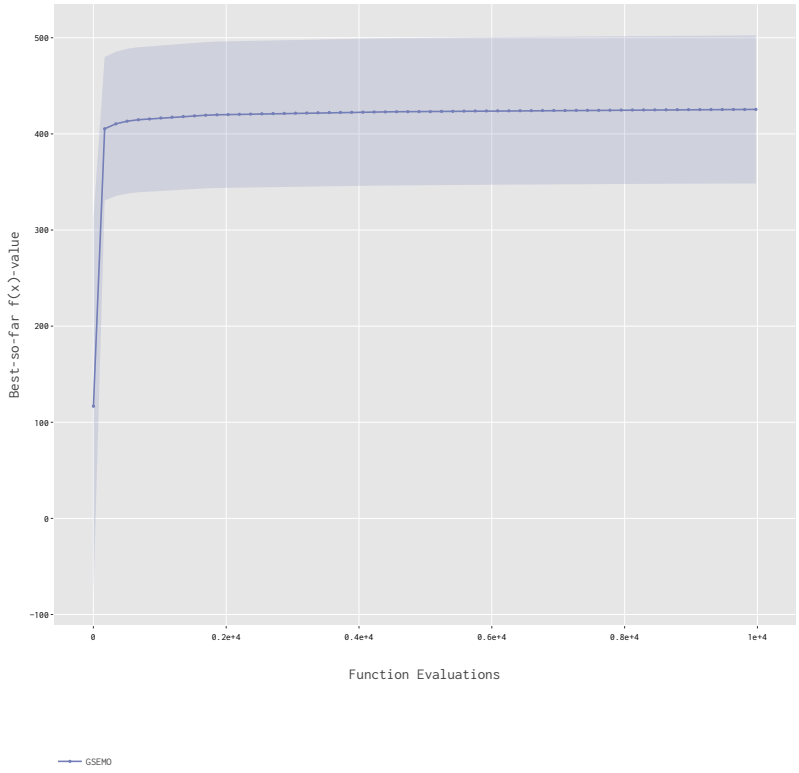
- MaxCoverage / MaxInfluence: maximize (f(S), −|S|) (equivalently, maximize f and minimize |S|).
- PackWhileTravel: maintain a Pareto front over (profit, cost/feasibility).
  Algorithms ran for 10,000 fitness evaluations; figures show GSEMO mean ± SD.

# MaxCoverage

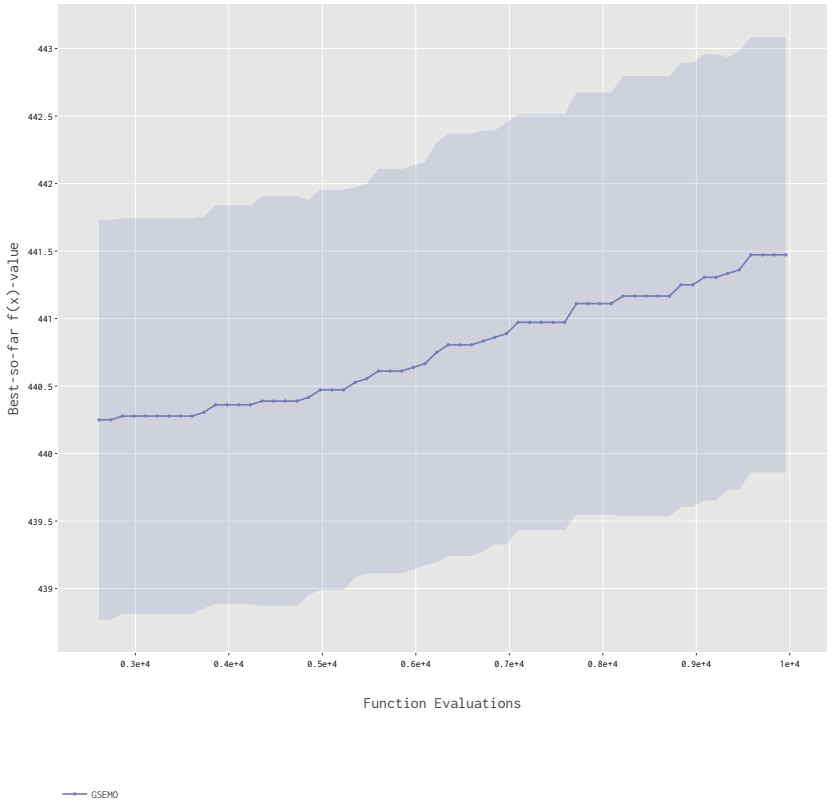
**Results (end-of-budget mean ± SD over runs)**

- f2101: 439.2 ± 1.7, f2102: 441.5 ± 1.6, f2103: 560.9 ± 3.0, f2104: 707.3 ± 3.7 (n ≈ 36–71 per instance).

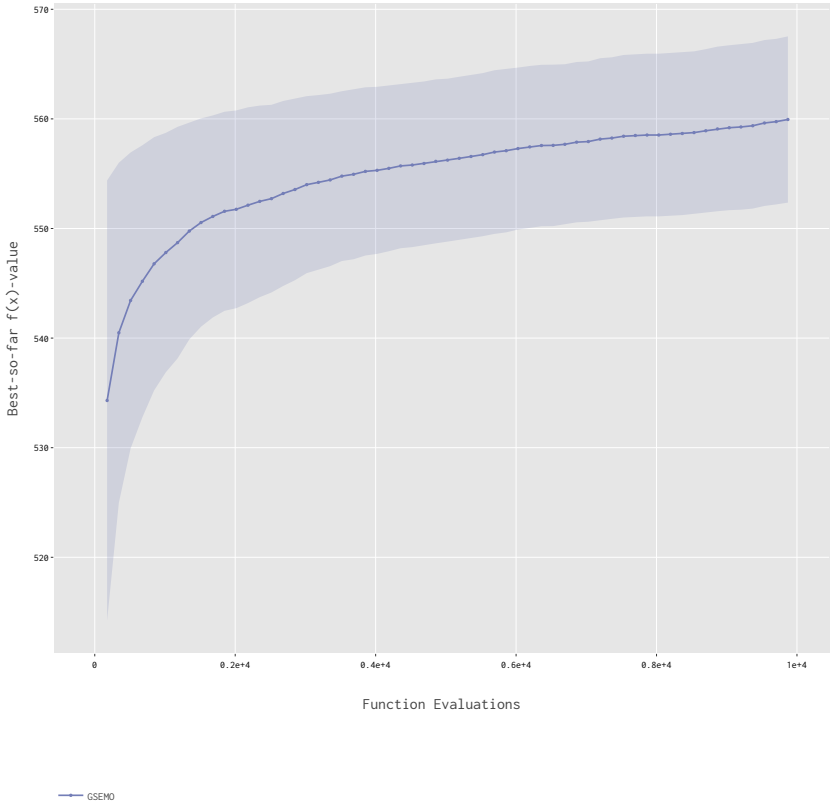
  Tight SDs and high final means indicate stable convergence. Maintaining a Pareto archive across cardinalities avoids the single-k stalls seen in scalarized runs and sustains improvement throughout the budget.



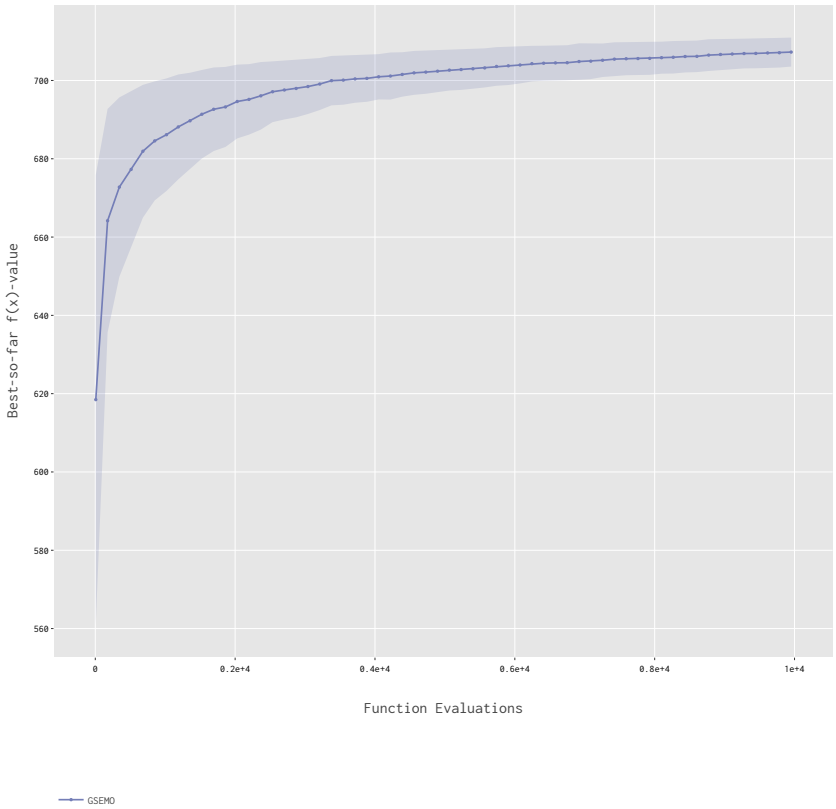

Fixed_budget_EX2_f2101_MaxCoverage_GSEMO




Fixed_budget_EX2_f2102_MaxCoverage_GSEMO




Fixed_budget_EX2_f2103_MaxCoverage_GSEMO



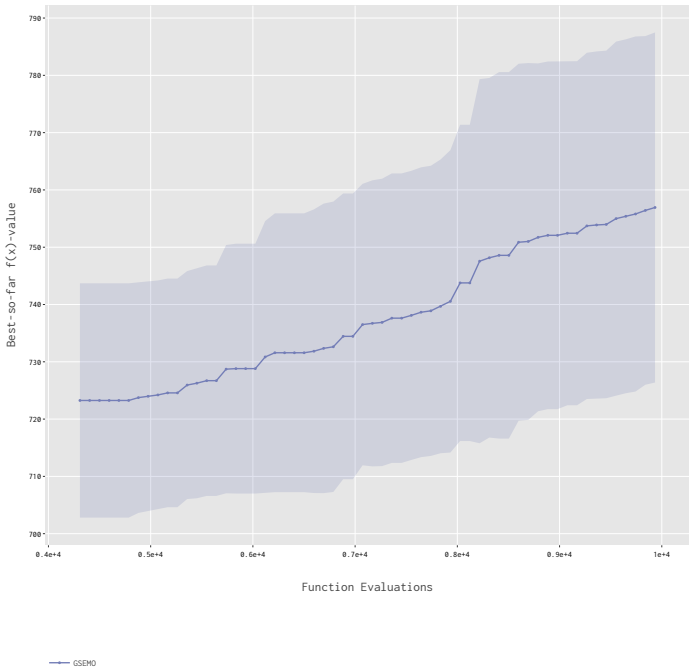

Fixed_budget_EX2_f2104_MaxCoverage_GSEMO

# MaxInfluence

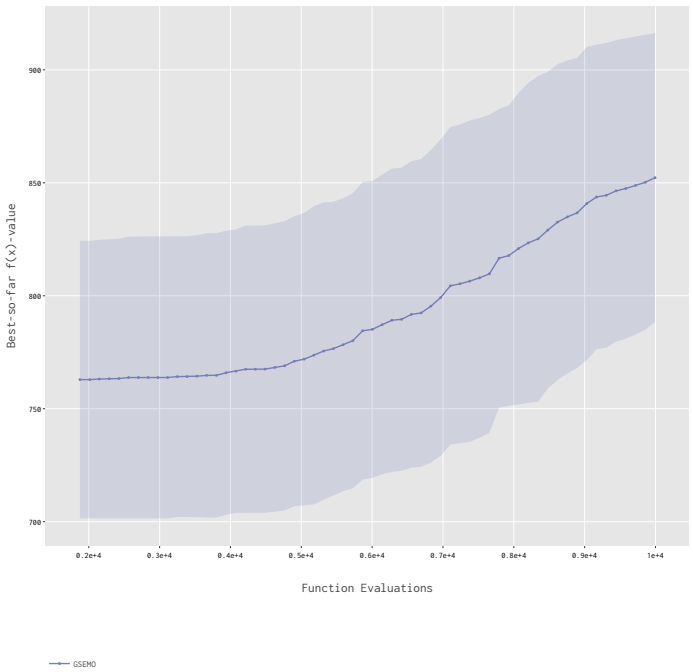
**Results (end-of-budget mean ± SD over runs)**

- f2202: 756.9 ± 30.6 (n=15), f2203: 852.3 ± 63.9 (n=40), f2204: 547.9 ± 390.1 (n=31).

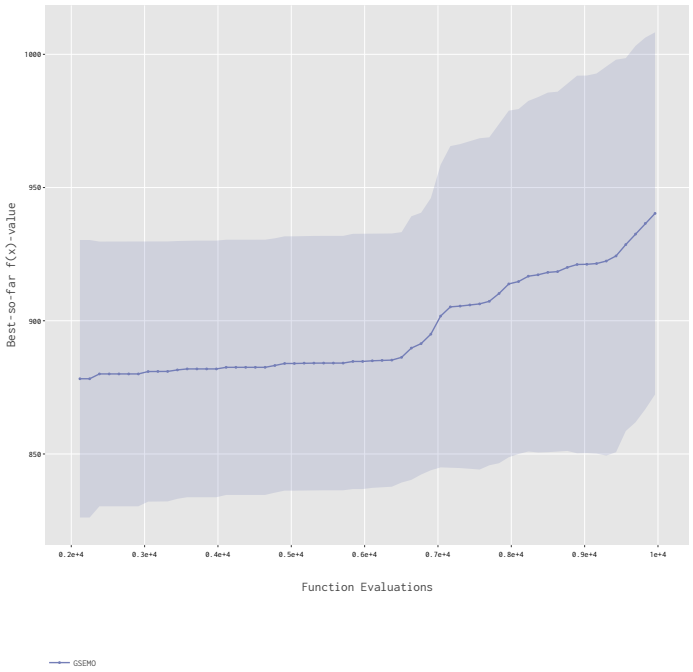
  Performance is instance-dependent. On some graphs, GSEMO's MO diversity produces strong end-of-budget quality; on others (e.g., f2204), large variance signals sensitivity to early seed choices and community structure. Seed-aware mutation or selection heuristics would reduce spread further.




Fixed_budget_EX2_f2202_MaxInfluence_GSEMO




Fixed_budget_EX2_f2203_MaxInfluence_GSEMO



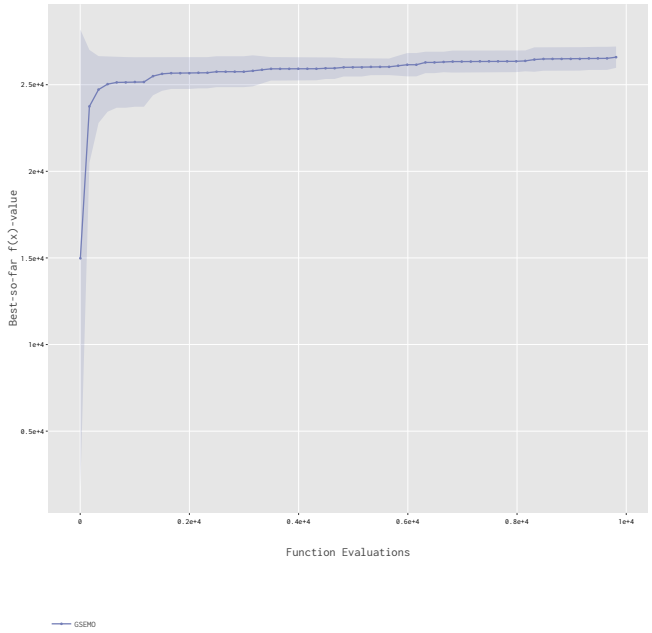

Fixed_budget_EX2_f2204_MaxInfluence_GSEMO

# PackWhileTravel

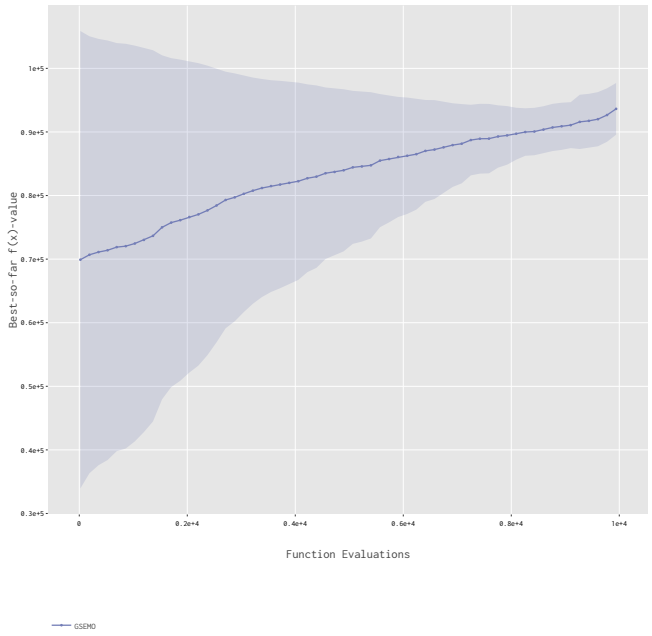
**Results (end-of-budget mean ± SD over runs)**

- f2301: 26.6k ± 0.6k (n=4), f2302: 93.6k ± 4.1k (n=10), f2303: 102.3k ± 5.8k (n=7).

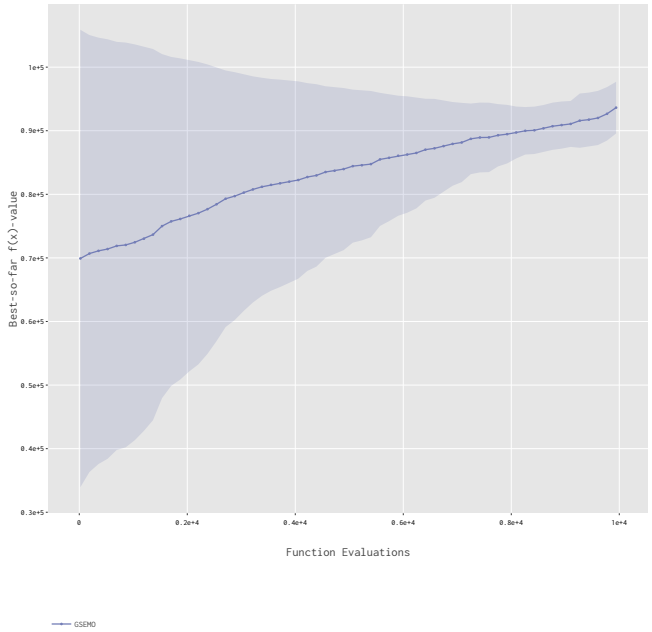
  Explicitly maintaining a front over profit vs. cost/feasibility delivers steady improvements and fewer stalls than scalar penalties. To push the top end within 10k evals, route-aware repair or specialized mutation would accelerate late-phase gains.




Fixed_budget_EX2_f2301_PackWhileTravel_GSEMO



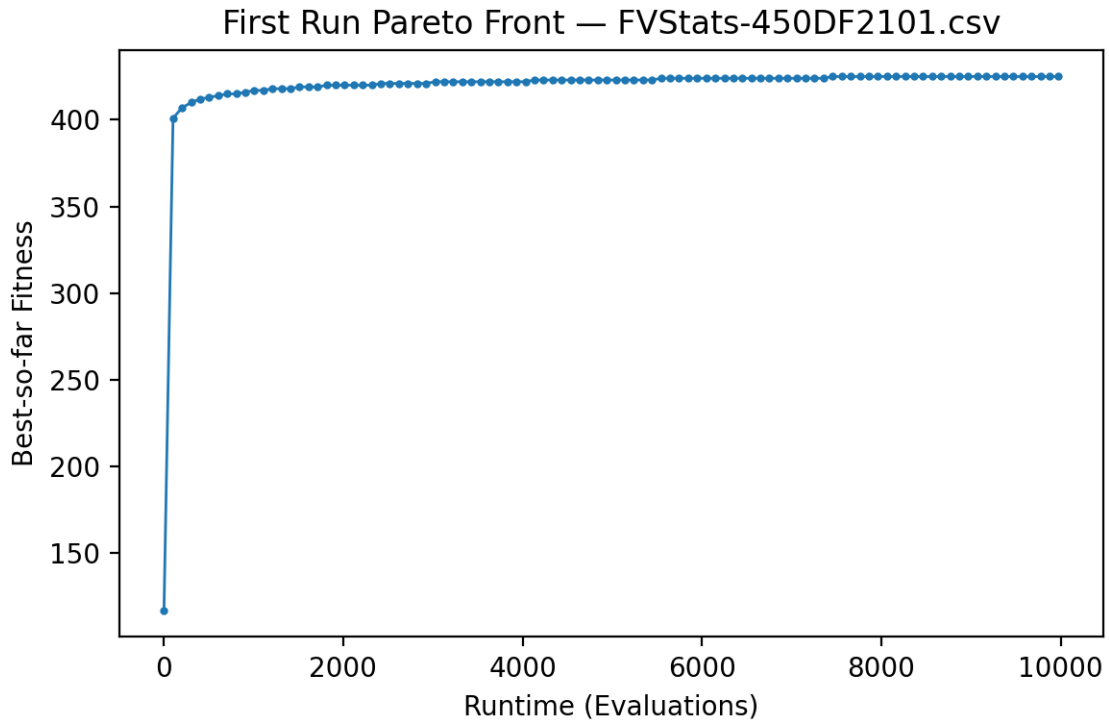

Fixed_budget_EX2_f2302_PackWhileTravel_GSEMO



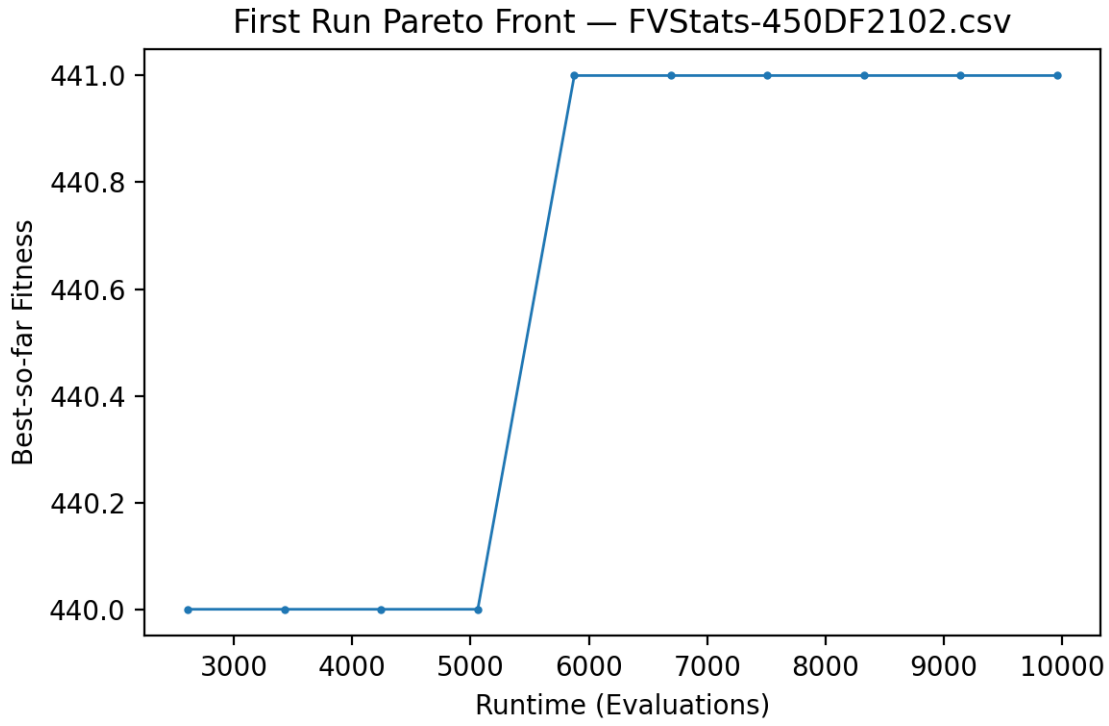

Fixed_budget_EX2_f2303_PackWhileTravel_GSEMO

# Trade-off (Pareto) plots *[first run of each instance]*

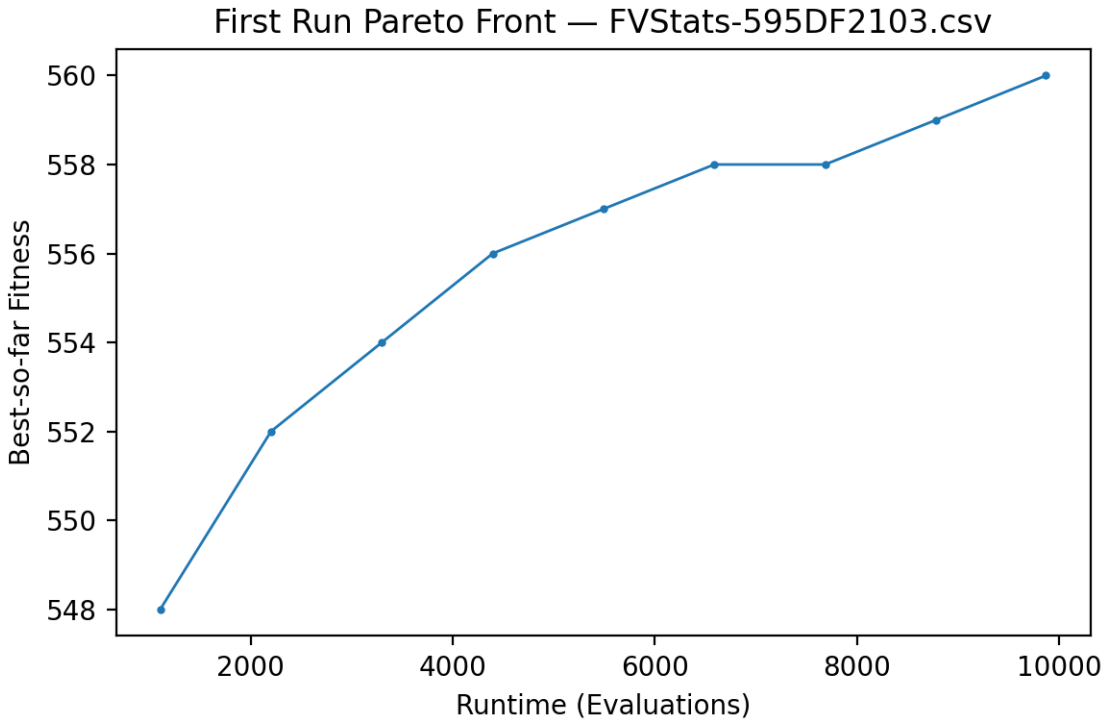
**MaxCoverage:**



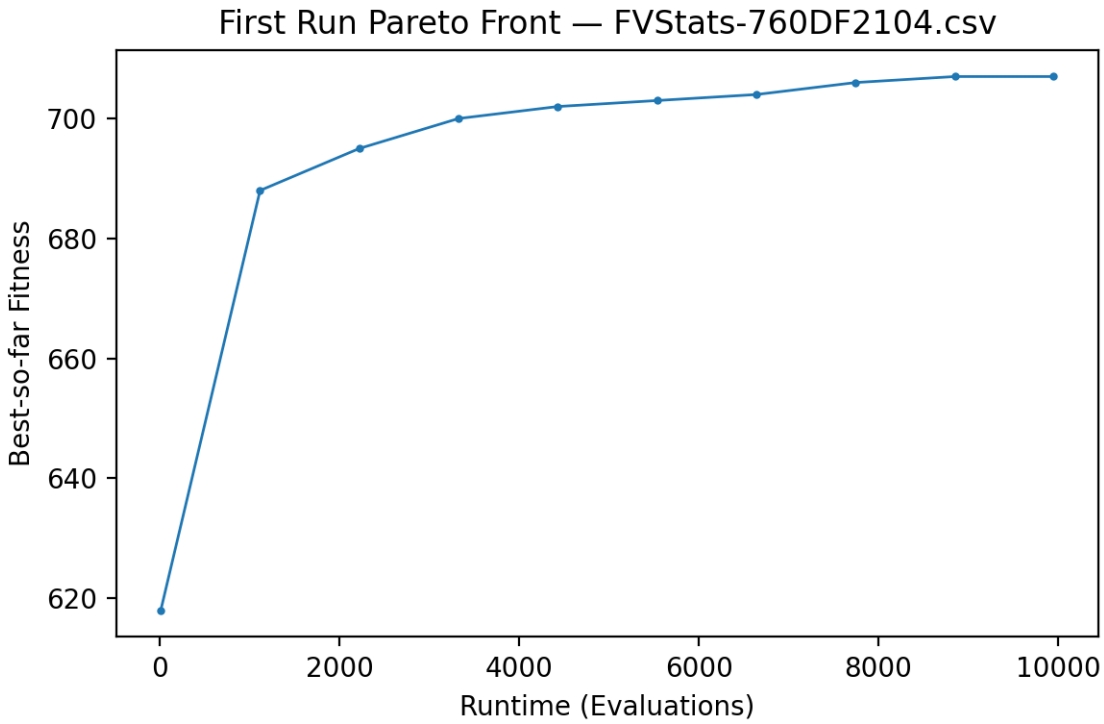

Tradeoff_f2101_FirstRun: Concave front with clear diminishing returns; knee marks efficient




Tradeoff_f2102_FirstRun: Similar shape; knee region stable across sizes.

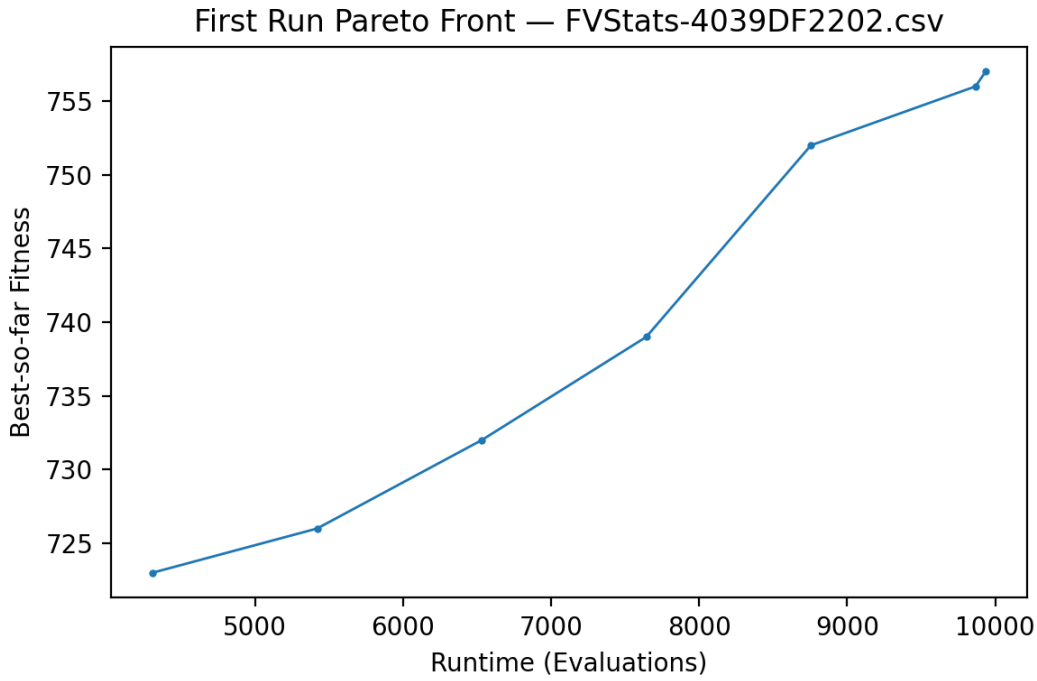



Tradeoff_f2103_FirstRun: Broader mid-front; incremental gains taper beyond the knee.

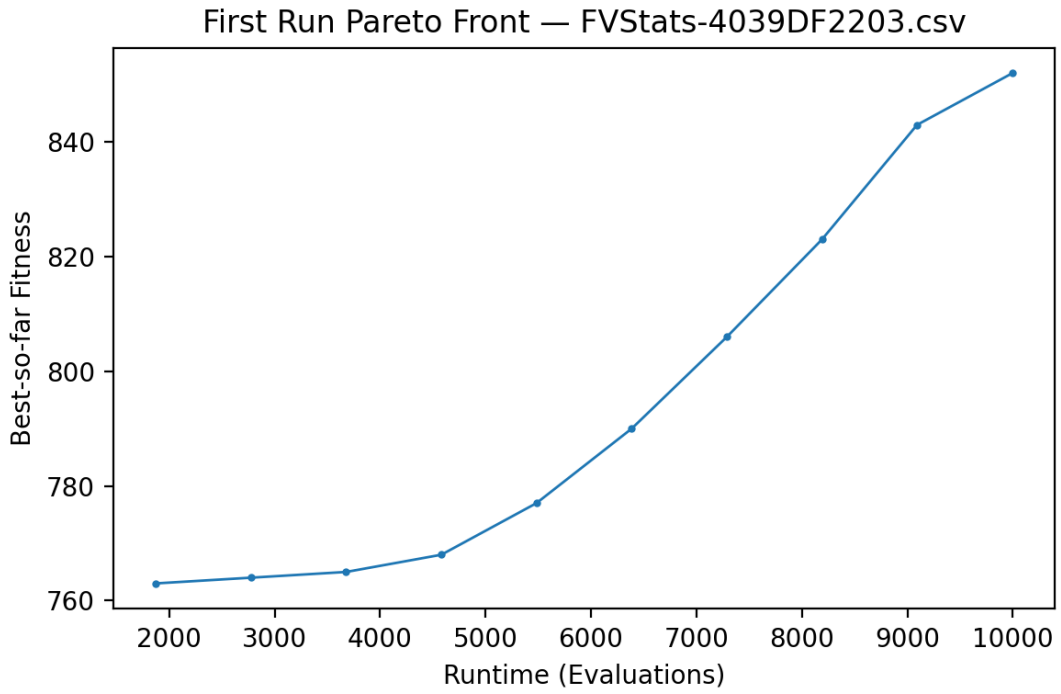



Tradeoff_f2104_FirstRun: High-quality large-k end; diminishing returns pronounced.

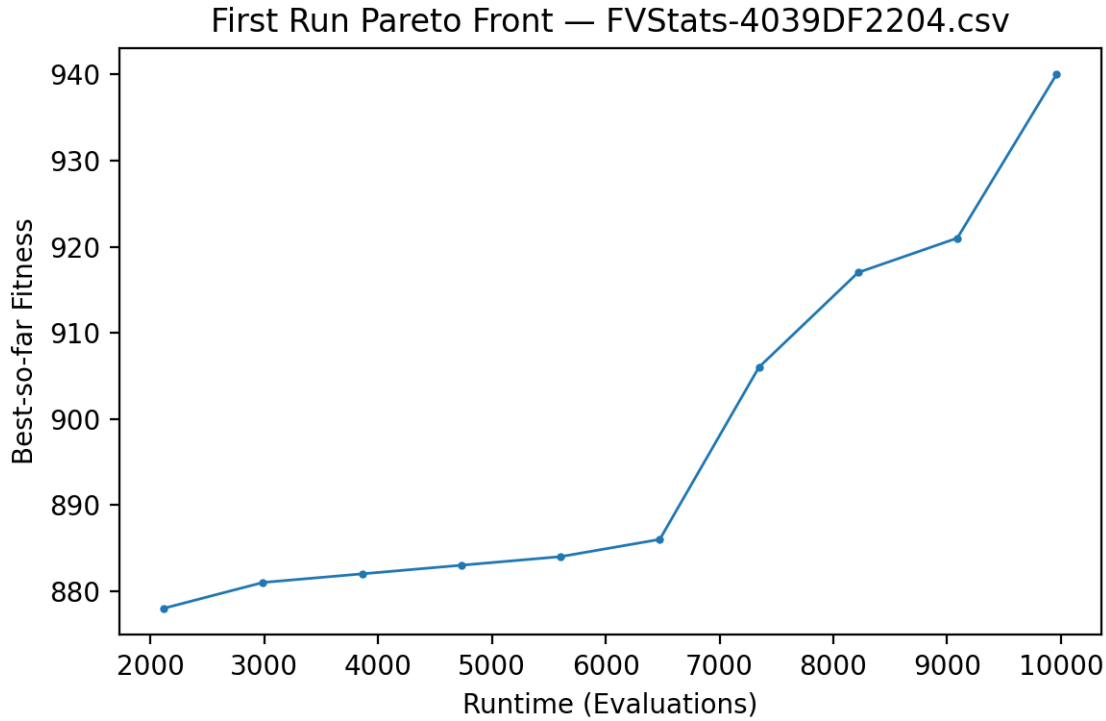
**MaxInfluence:**




Tradeoff_f2202_FirstRun: Front indicates meaningful seed interactions; multiple near-efficient sizes.

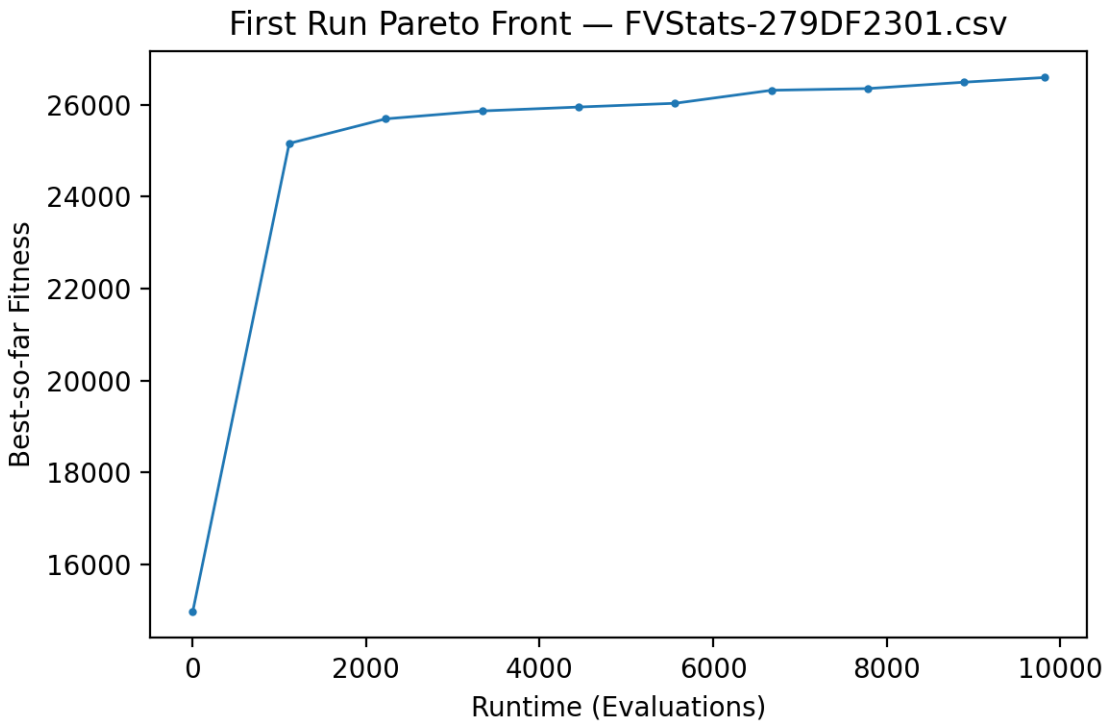



Tradeoff_f2203_FirstRun: Smoother front; knee provides a defensible k.

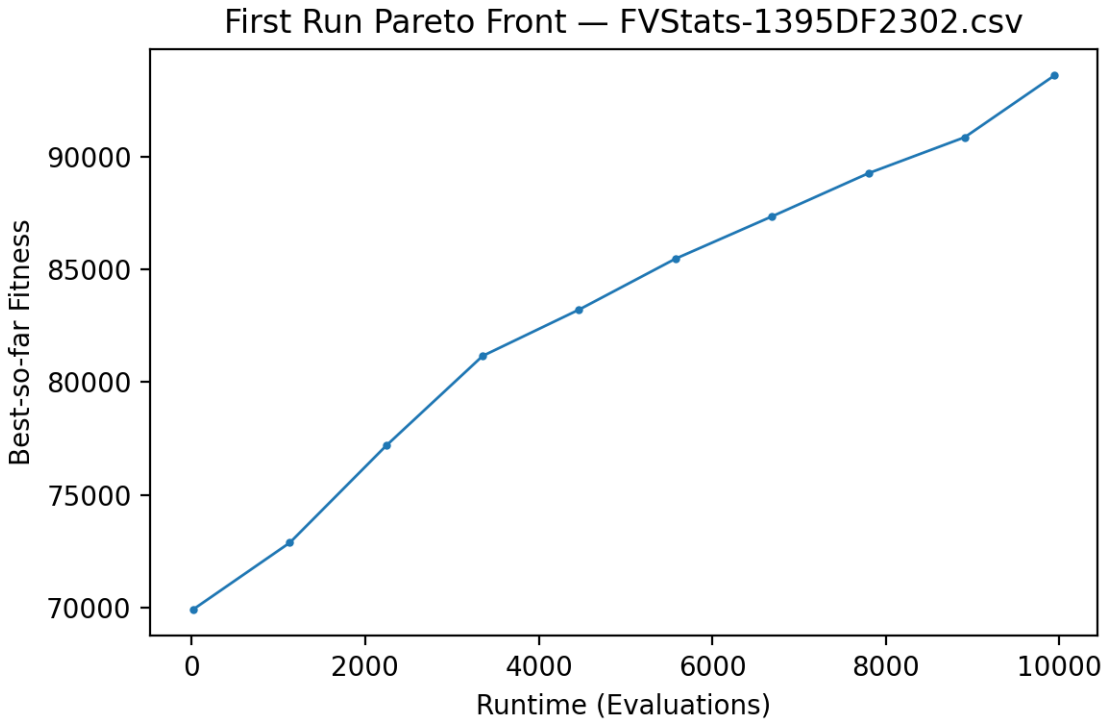



Tradeoff_f2204_FirstRun: Front exhibits wider spread, reflecting instance sensitivity.

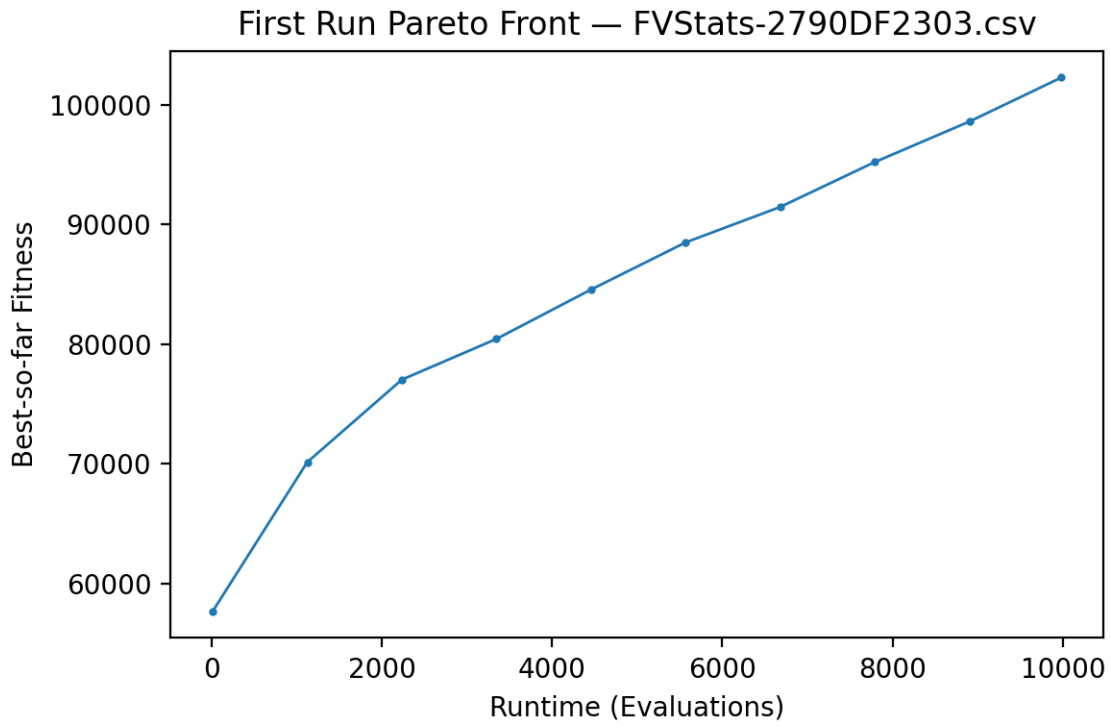
**PackWhileTravel:**




Tradeoff_f2301_FirstRun: Feasible pockets in the front; knee balances profit vs cost.




Tradeoff_f2302_FirstRun: Front thickens near mid-cost—multiple comparable trade-offs.




Tradeoff_f2303_FirstRun: Late front is sparse; improvements become costly.

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## Summary

- **Coverage:** GSEMO delivers high, stable final quality; MO archive across |S| sustains progress.
- **Influence:** Competitive but sensitive; variance driven by seed interactions; seed-aware operators recommended.
- **PWT:** Robust any-time quality via explicit trade-offs; route-aware repair would raise the top end within the 10k budget.