**Step 7 — Final deterministic configuration (frozen) and comparison to the initial baseline**

**Why this step?**

Before we move to robustness under uncertainty, we need one strong **deterministic** plan per instance to serve as our reference. Freezing a single best configuration makes results reproducible and gives a fair “anchor” for the robust methods we’ll test next.

**What we did (method)**

1. **Chose a single best OR-Tools configuration** using the evidence from the Step 6 sweep (all configurations reached 100% feasibility across families). We then re-ran that chosen configuration on every instance and **froze** the outputs.
2. **Saved the final plans** (one per instance) and built a **comparison table vs the original baseline** (greedy baseline from Step 5). Paths for the frozen outputs and the comparison CSV are recorded in your Step 7 summary.

**What we produced (artifacts)**

* **Final solutions folder:** data/final/current (all per-instance JSON plans).   
  Each JSON contains fields like instance, vehicles, travel\_distance, feasible, and the list of routes (customer indices in visit order). Example fields can be seen in the saved plans (e.g., C101).
* **Comparison table:** data/reports/final\_vs\_baseline.csv, which contrasts baseline vs final: distance, vehicles, and % improvement.
* **Step 7 text summary:** the file you generated with overall stats, per-family stats, and the Top-10 instance improvements.

**Results (what we got)**

**Coverage**

* The final table includes **50 instances** (those with a valid baseline/final pair).

**Overall improvement vs baseline**

* **Mean distance improvement:** **+26.26%** (i.e., final distance is ~26% shorter than baseline on average).
* **Average distance delta:** **−381.6** (same distance units as the instances).
* **Average vehicle change:** **−0.78** vehicles (slight reduction).
* Distribution: min +5.62% improvement; upper quartile around +31.26%; maximum +35.65%.

**By family**

* **C (clustered):** mean +22.38% and −269.68 distance units; vehicles roughly unchanged (−0.12). (n=17)
* **R (random):** mean +28.94% and −424.02; vehicles −1.15 on average. (n=20)
* **RC (mixed):** mean +27.19% and −462.72; vehicles −1.08 on average. (n=13)

**Top 10 instance gains (examples)**

* **R206:** +35.65% (8→8 vehicles; 1494.9→962.0).
* **C108:** +34.67% (11→10; 1269.0→829.0).
* **RC206:** +34.51% (9→9; 1893.3→1240.0).   
  (See your Step 7 summary for the full Top-10 list.)

**Example frozen plans**

* **C101** final plan: 10 vehicles; travel\_distance 829.0; routes detailed per vehicle.
* **RC205** final plan: 9 vehicles; travel\_distance 1269.0; routes listed.   
  (Your folder contains similar JSON for each instance.)

**How to read these results**

* The **distance reductions are large** (≈ 22–29% by family), while **fleet size stays similar or slightly lower** (0 to −1 vehicle on average depending on the family). This means most of the gain comes from **better routing/ordering**, not from cutting vehicles aggressively—which is usually desirable for service quality.
* Step 6 already showed **100% feasibility across all sweep tags**, so choosing a final tag was safe and reproducible.

**What this enables next**

With a single deterministic plan frozen per instance, we now have a **stable baseline** to test robustness. The next steps will:

1. **Generate realistic travel-time scenarios** (correlated traffic noise) and
2. Evaluate/optimize **robust** variants (quantile-buffer, Γ-robust, SAA), comparing **on-time % vs cost** against these final deterministic plans.

Abstract :  
We selected and froze a single best OR-Tools configuration from the Step 6 sweep, then re-solved every original Solomon instance to produce one reproducible deterministic plan per case (saved as JSON + a comparison table). Against the initial greedy baseline, the frozen plans cut total route distance by about **26% on average** while keeping fleet size similar or slightly lower (typically **0 to −1 vehicle**), with consistent gains across all families (C, R, RC ≈ **22–29%**). Several instances achieved **>30%** distance reductions (e.g., R206, C108, RC206), confirming that most improvements come from smarter sequencing rather than aggressive vehicle cuts. This step establishes a clean, high-quality deterministic reference for the rest of the project and gives us a fixed anchor to evaluate robustness (on-time performance under variability) in the next steps.