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A Memetic Algorithm for Expert-Guided Multi-Week European Travel Itinerary Optimization

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GECCO '26
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THE PROBLEM

Europe is Best Explored by Ground Transportation — but Planning the Route is *Hard*

The tempting approach — a bucket list of famous cities connected by cheap flights — treats Europe as a series of urban islands. It misses medieval hilltop towns, vine-carpeted valleys, and remote alpine villages that are only reachable **by train, bus, or rental car**. And it's miserable: airports, security queues, delays, carbon.

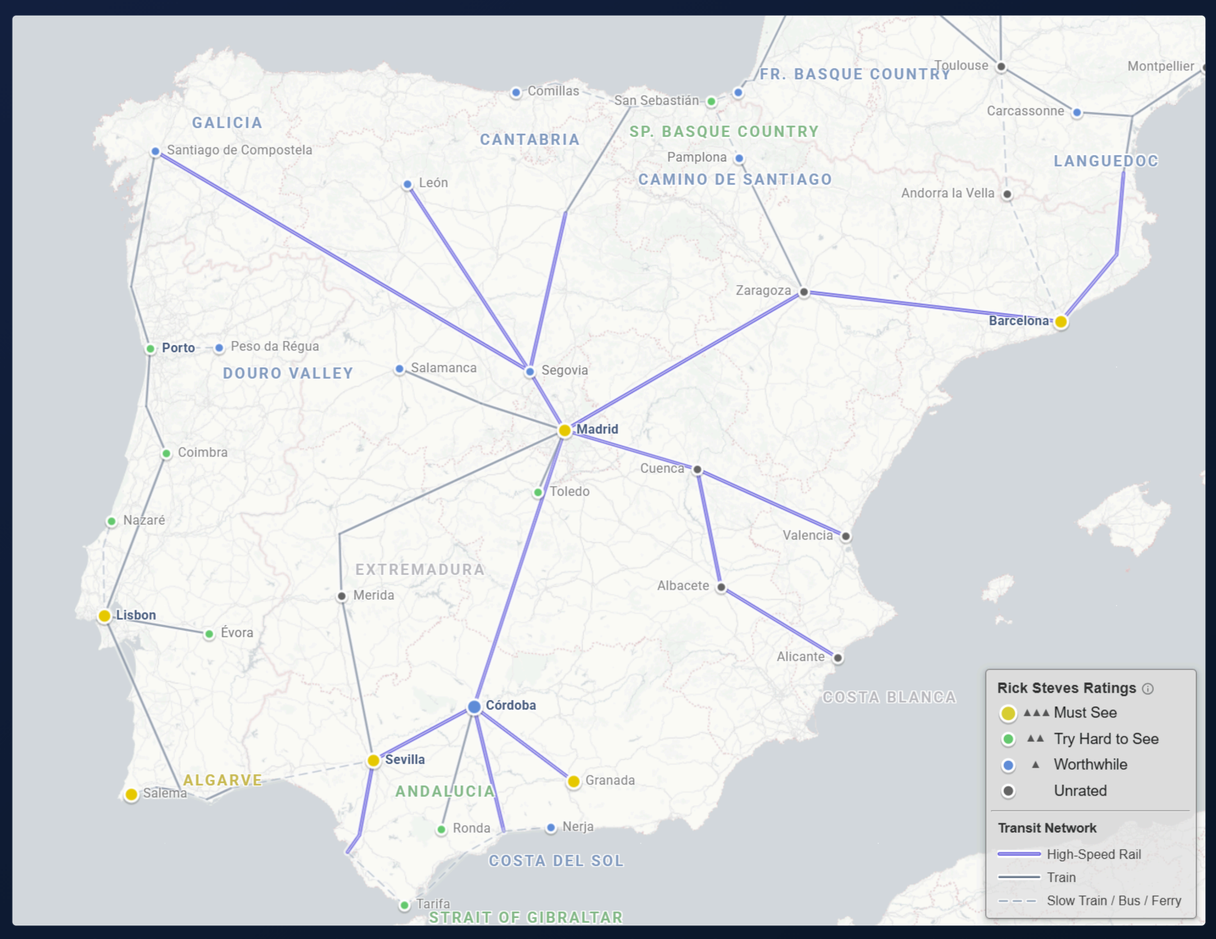
An additional challenge lies in assessing the relative value of each location. Traveler reviews, the most readily available data source, reflect satisfaction relative to expectation rather than absolute value — a hidden gem that exceeds expectations may rate higher than a world-class attraction that merely meets them. Additionally, they cannot capture **experiential overlap** — touring the Loire Valley's fifth château is less rewarding than the first, not because it is lesser, but because the style has grown familiar.

Rick Steves — America's most widely-read European travel author — provides exactly this. His guides offer robust coverage of the European continent and a self-described "sixth sense" — honed over several decades of travel research — for what typical travelers will value. His 0–3 star ratings reflect destination worth against a consistent standard. His recommended durations encode how much there is to experience in each place. And his region-based structure groups destinations that offer similar experiences, allowing the optimizer to treat regions as atomic units rather than exploit superficially similar neighbors. TripSnek encodes this information into the fitness function, alongside 17 interest categories for personalization.

100K+	1–2s	135K
Users annually	Solve time, in-browser	Real trip specs analyzed

EXPERT-CURATED MODEL OF EUROPE

A Continent Distilled into *Major Cities* and *Regions*



Spain & Portugal — expert-curated locations color-coded by Rick Steves rating. • Must See • Try Hard to See • Worthwhile. Rail network overlaid.

★ KEY INSIGHT — REWARD AGGREGATION

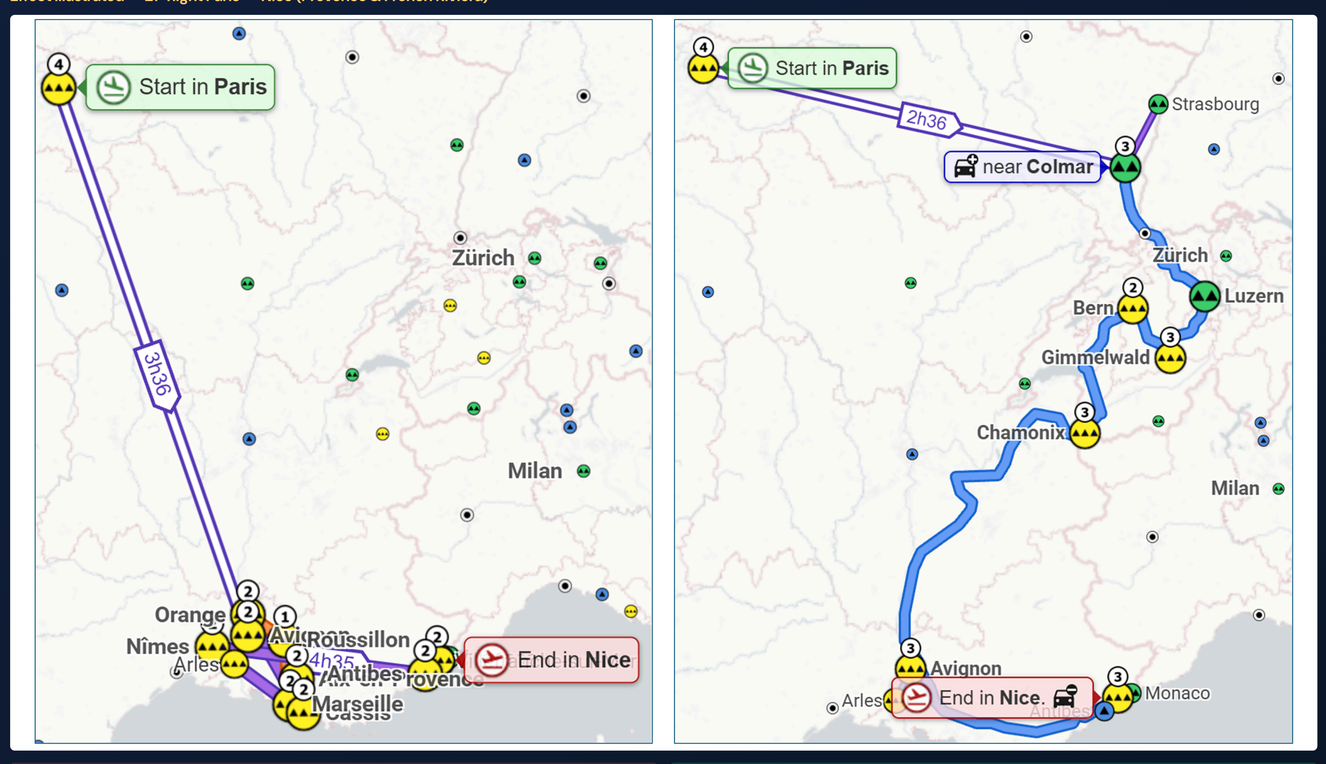
All Locations in a Destination Share *One Pooled Reward*

Cinque Terre — five cliff villages, one reward

The five villages of Italy's **Cinque Terre** are breathtaking — and nearly **indistinguishable in quality and aesthetic**. They are also well connected to each other by short, frequent milk-run trains. Whether you sleep in Vernazza and daytrip to Manarola, or the reverse, the experience is roughly the same.

Without aggregation, the optimizer clusters nights across all five to harvest high fitness while going nowhere new. **This generalizes across most regions of interest.**

Effect illustrated — 21-night Paris → Nice (Provence & French Riviera)



✗ Without Aggregation
Clusters **9 adjacent Provence & Riviera cities** — high fitness, terrible trip

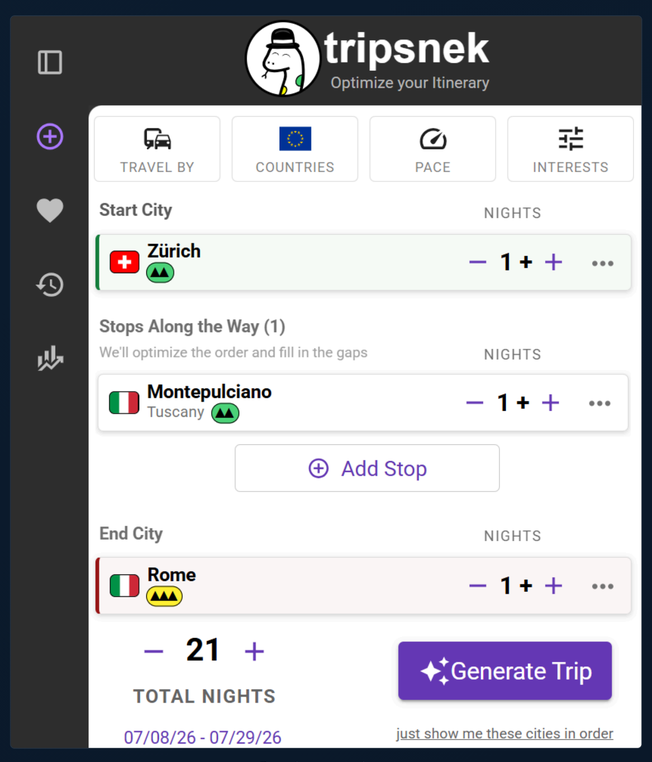
✓ With Aggregation
Diverse route through **Alsace, Switzerland, the French Alps** — genuinely excellent

THE SYSTEM

From Constraints and Preferences to *Optimized Itinerary*

User Specifies

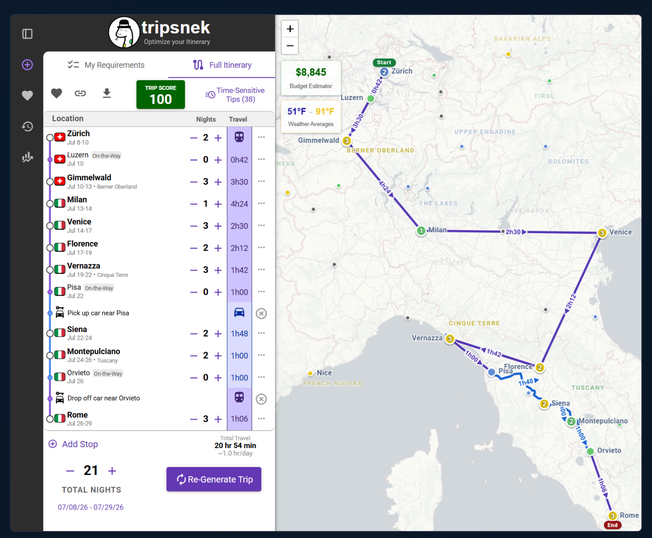
- → Start & end city
- → Total nights (up to 60)
- → Required stops + min nights
- → Travel mode (rail / car / mixed)
- → Pace preference
- → Interests (16 categories)



Requirements input

TripSnek Optimizes

- ✦ Stop selection & ordering
- ✦ Night allocation per stop
- ✦ Day trip assignments
- ✦ Car rental pickup / dropoff
- ✦ Cross-border penalty avoidance
- ✦ Pacing within daily budget
- ✦ Flights where appropriate



Generated itinerary — list + map, trip score, booking tips

ABLATION STUDY · 1,000 REAL TRIP SPECIFICATIONS

What Actually *Matters*

We ablated four components across 1,000 real user trip specifications, measuring contribution via Cohen's *d* (effect size). Two evolutionary components dominate:

WAMS Crowding Replacement
d = 0.48 (medium)
Maintains population diversity by targeting scarce high-value destinations — replaces least-fit among most-similar individuals

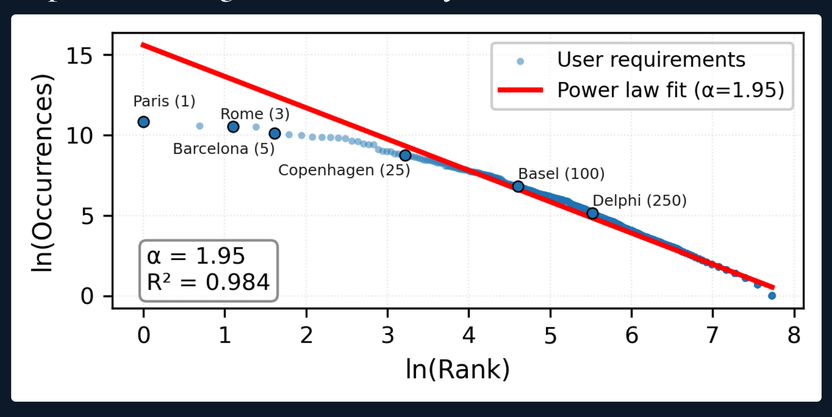
Geo-Constrained Neighborhoods
d = 0.49 (medium)
Mutations draw only from the 5–15 geographically nearest locations — good itineraries are inherently local

The two **local search operators** — night redistribution (aligning stays with expert duration recommendations) and rental boundary shift (minimizing cross-border car penalties) — provide additional significant gains.

Disabling all four together yields **d = 1.44** — a large effect. The combined fitness drop is more than twice the sum of individual drops, revealing synergistic interactions between components. Effects confirmed by paired *t*-test and Wilcoxon signed-rank.

COVERAGE VALIDATION · 727K CITY REQUIREMENTS

Expert Coverage Confirmed by *Power Law*



α ≈ 2	0.984	96.9%
Power law exponent	R^2 goodness of fit	User reqs covered by 526-city model

Top 10 cities → 40% of requirements. Top 100 → 87%. Expert curation covers the vast majority of real user needs.

Algorithm
Steady-state memetic algorithm · Population 600 · 75,000 evaluations · Per-night fitness normalization
Fitness: base visit reward (rating × interests) · per-night saturation · day trip bonus
travel time penalty · cross-border car penalty · flight hassle (−8/flight)

CITE AS
Tuohy, D. R. (2026). TripSnek: A Memetic Algorithm for Expert-Guided Multi-Week European Travel Itinerary Optimization. *GECCO Companion '26* · ACM
doi: 10.1145/3795101.3805316

Keywords
memetic algorithms · travel itinerary optimization
tourist trip design problem · fitness function design
expert knowledge integration · reward aggregation