Innovative Approaches to Vehicle Routing Problems

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SAS EXPLORE

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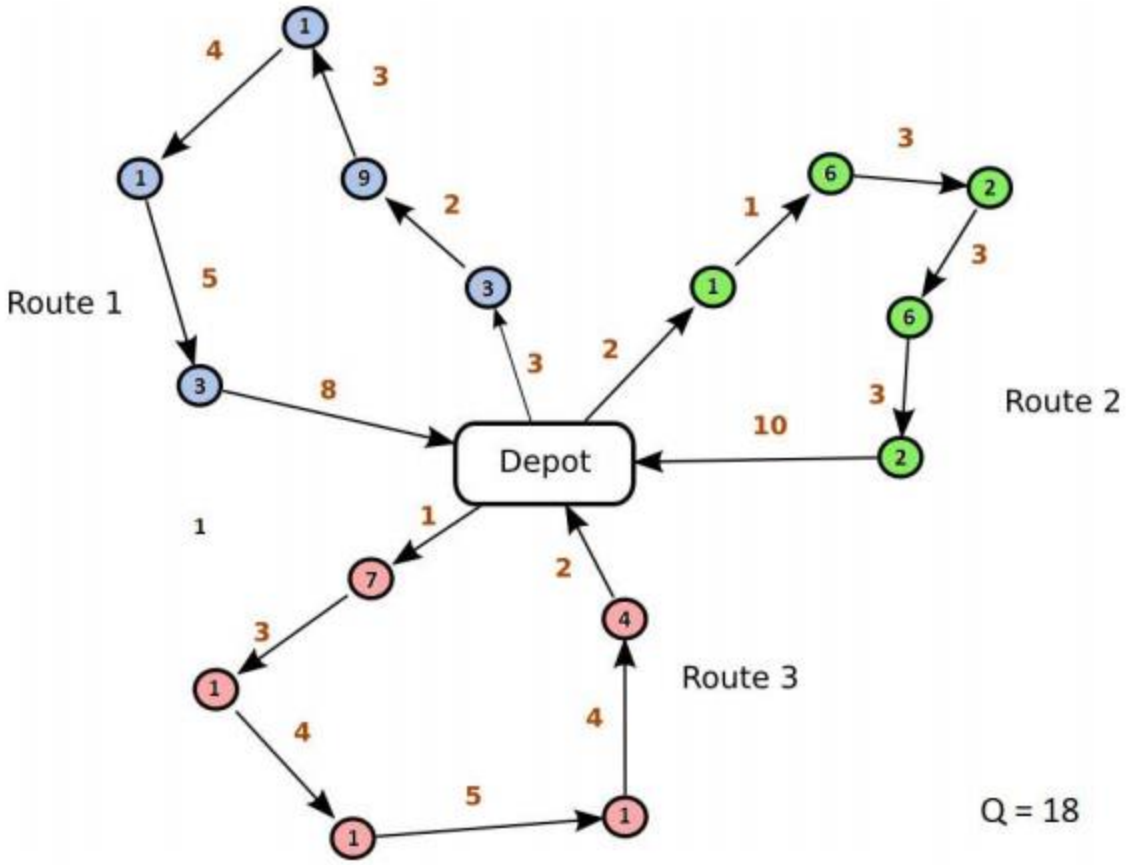
Vehicle Routing Problem (VRP)

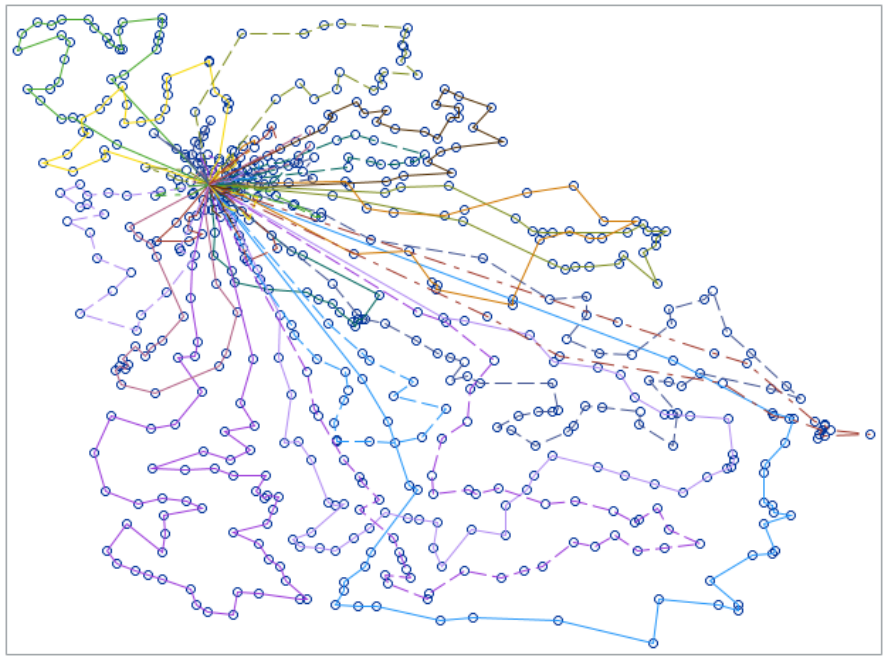


SAS Communities Post

Scaling up Vehicle Routing Problem

Posted 02-17-2021 12:32 PM (652 views)

I have an optimization model that assigns facilities to a distribution center and now I want to begin routing vehicles to serve those assigned facilities. I've worked through the vehicle routing problem, and even adapted it to work with my data. The problem I am having is it seems to work fine for less than 50 nodes and 10 trucks. I need to do something more like 300 nodes and up to 100 trucks.



Re: Scaling up Vehicle Routing Problem

Posted 02-18-2021 09:31 PM (478 views) | In reply to RobPratt

WOW!

In this case using less is fine, in the actual case as I continue to build out there will be some time constraints and that may actually drive truck count upwards.

Thanks so much for testing it.....now to figure out the upgrade path to get to this enhancement.

Proof-of-Concept Overview

- SAS Optimization experts and customer's analytics team
- Optimize delivery routes for small set of cities
- SAS results provided insight into current business operations
- Significant improvements over actual route patterns in use today
- Customer is in process of migrating to SAS Viya 4

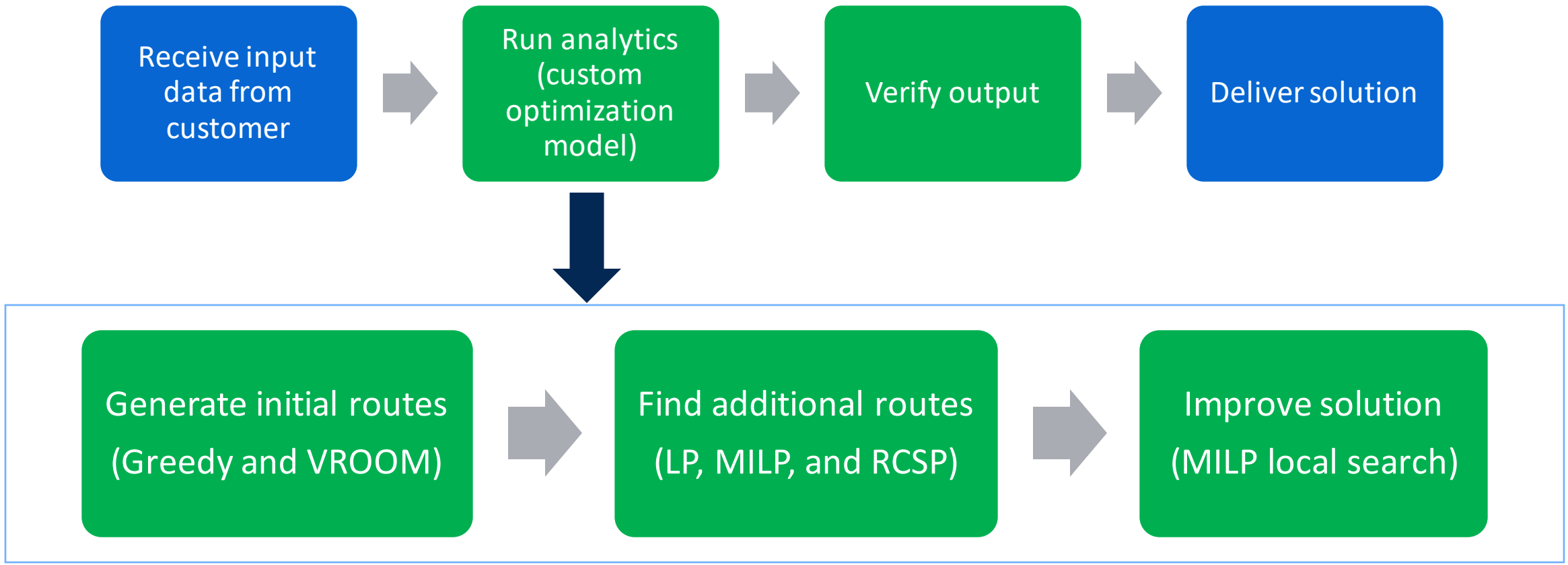
VRP Solver in SAS Viya 4 vs. Customer Requirements

VRP Solver	Customer Requirements
Objective: Minimize total transportation distance	
Constraints and Assumptions	
Every customer visited by exactly one vehicle	Split delivery (workaround: split high-demand nodes)
No service time at customer	Service times (can absorb into travel times)
No time windows for arrival at customer	Time windows
Homogeneous capacity across vehicles	Heterogeneous capacity
Every vehicle eligible to visit every customer	Vehicle-customer eligibility rules

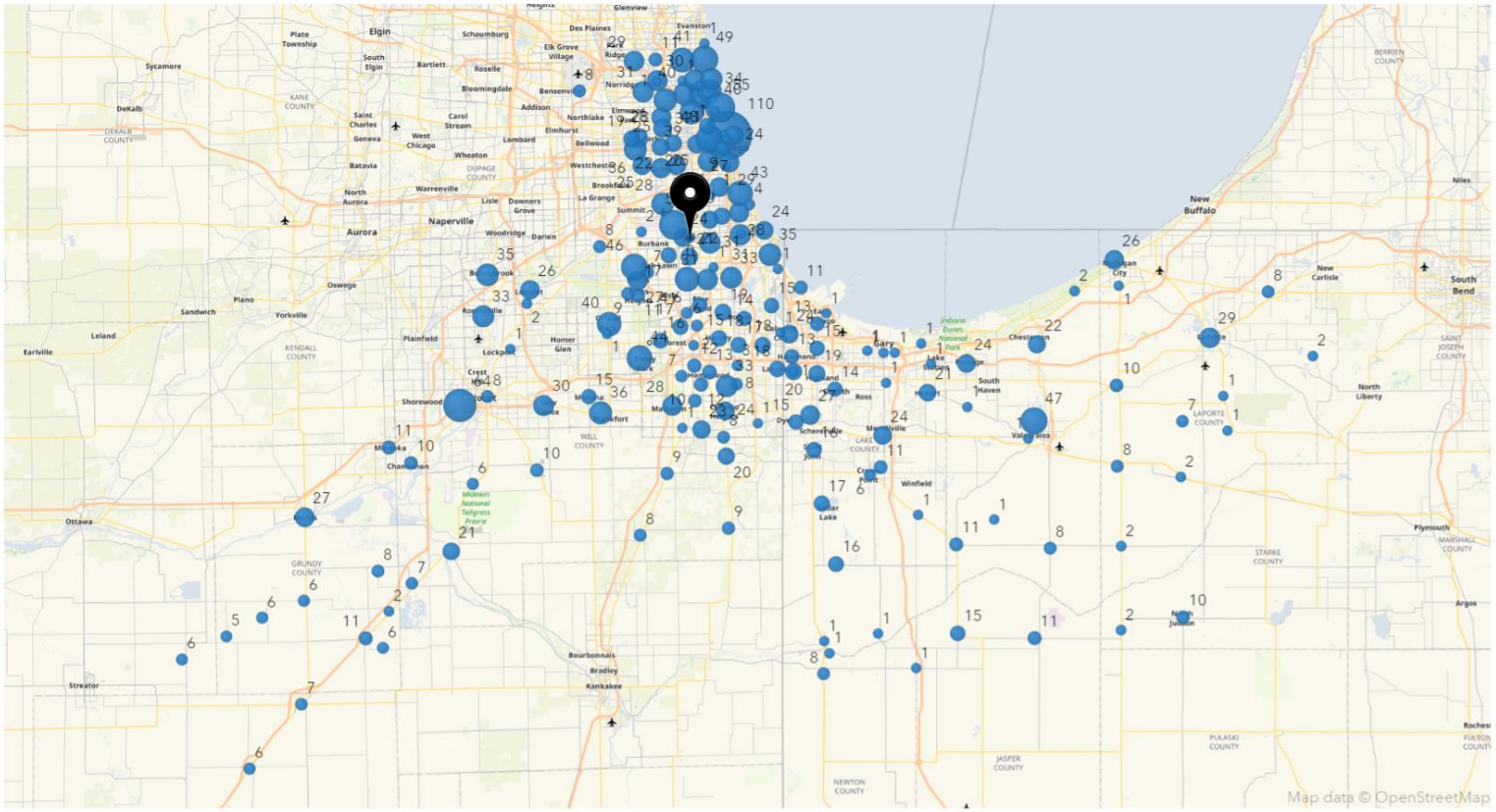
Customized Algorithm

- Mixed Integer Linear Programming (MILP) formulation
- Column generation algorithm: generate new routes dynamically
- Implemented in PROC OPTMODEL (SAS Optimization)
- COFOR loop to solve independent subproblems concurrently
- Uses open source tools (C++) under the hood
  - VROOM: generates initial solutions
  - cspy: solves resource-constrained shortest path subproblems
- Local search improvement heuristic (MILP)
- Typically, 1-2% optimality gaps within a few minutes

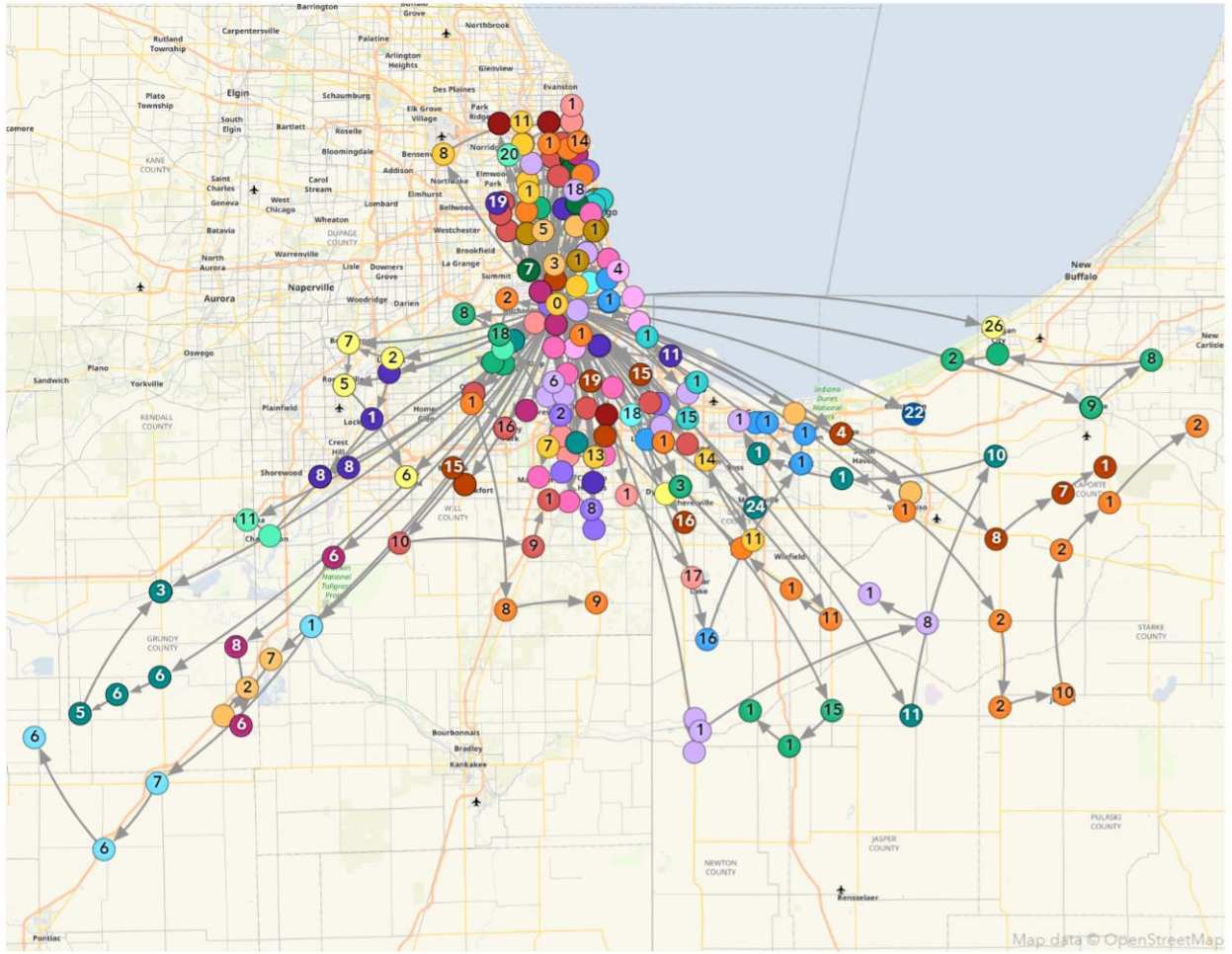
Analytical Process



Sample Input Data



Sample Output Data



Future Enhancements

- Split delivery
- Hubs
- Nonlinear costs
- Infeasibility analysis
- Route length restrictions

EURO Meets NeurIPS 2022 Vehicle Routing Competition

- 150 teams registered
- 50 teams submitted
- Approximately 800 submissions from all teams

5	Miles To Go Before We Sleep paper | slides | code	Brandon Reese (SAS) Steven Harenberg (SAS) Laci Ladanyi (SAS) Rob Pratt (SAS) Yan Xu (SAS)

- https://euro-neurips-vrp-2022.challenges.ortec.com

Key Takeaways

- Customer requests often drive innovations and superior solutions.
- The flexibility of SAS Optimization enables creating a specialized solver.
  - Much more effective than general-purpose solvers
- SAS Viya 4 has unique features that are not available in SAS 9.

Thanks!

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