Network Analyst – Optimize Your Fleet of Vehicles with the VRP Solver

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Outline

- Vehicle Routing Problem
- Basic Modeling Options
- Rest API and Python API
- Demos
  - Multiple-Capacity Routing
  - Incremental Assignment and Multiple-Day Routing
  - Automation with APIs

Optimize Your Fleet of Vehicles with the VRP Solver
Vehicle Routing Problem

What is it?

Given the business rules, assign several stops to many routes and sequence them in the least-cost way.

1. Account for constraints
2. Assign orders to routes and sequence them
3. Minimize operating costs and improving customer satisfaction
# Vehicle Routing Problem

**How can I use it?**

<table>
<thead>
<tr>
<th>Credit</th>
<th>Ready-To-Use VRP Service</th>
<th>User Published VRP Service</th>
<th>Solve VRP Geoprocessing Tool</th>
<th>Network Analyst VRP Layer</th>
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<td>Custom App</td>
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</tbody>
</table>

Optimize Your Fleet of Vehicles with the VRP Solver
Basic Modeling Options

Problem Inputs

- Orders
- Depots
- Routes
- Breaks
- Specialties
- Zones
- Seed Points
- Renewals
- Order Pairs
- Barriers

Unassigned Orders

Least-Cost Solution

Optimize Your Fleet of Vehicles with the VRP Solver
Home Appliance Delivery Demo
Multiple Capacity Routing

• Delivery, Pick-up, and exchange of large appliances
• Cost per hour and cost per mile
• Constraints:
  - Truck capacity: volume and weight
  - Truck cannot make U-turns
  - Truck must park on correct side of the street for residential customers
  - 10-hour workday and lunch breaks
  - 2-hour or 4-hour appointment times

Optimize Your Fleet of Vehicles with the VRP Solver
Home Appliance Delivery Demo

Optimize Your Fleet of Vehicles with the VRP Solver
Home Appliance Delivery Demo

Re-cap

- Pickup and Delivery
- Multiple Capacities
- U-turns and Curb Approach
- Time Windows
- Breaks
- Balancing Work Loads

Optimize Your Fleet of Vehicles with the VRP Solver
Health Inspection Demo
Incremental Assignment and Multiple-Day Routing

• Inspect clinics and hospitals
• Certain clinics and hospitals are overdue for their yearly inspection and so must be visited this week
• Inspections spread across one week
• Clinics/hospitals open only during certain days or times
  - Any afternoon
  - Monday only
  - Monday, Wednesday or Friday
  - Tuesday or Thursday except during lunch hour
Health Inspection Demo

Optimize Your Fleet of Vehicles with the VRP Solver
Health Inspection Demo

Re-cap

• Required/Additional Stops
• Multiple Days

Optimize Your Fleet of Vehicles with the VRP Solver
REST API for VRP

- Flexibility of input and output formats
- Synchronous and Asynchronous modes of execution
- No need to install additional software locally, just consume the service
- Publish a VRP GP service on ArcGIS server or consume online service at the cost of credits
Request URLs for VRP

- **Synchronous Execution**
  - **Execute Job**
    EditVehicleRoutingProblem/execute?token=<yourToken>&<parameters>

- **Asynchronous execution**
  - **Submit Job:**
    https://logistics.arcgis.com/arcgis/rest/services/World/ VehicleRoutingProblem/GPServer/
    SolveVehicleRoutingProblem/submitJob?token=<yourToken>&<parameters>
  - **Get Job Status:**
    https://logistics.arcgis.com/arcgis/rest/services/World/ VehicleRoutingProblem/GPServer/
    SolveVehicleRoutingProblem/jobs/<yourJobID>?token=<yourToken>&f=json
  - **Get Output:**
    https://logistics.arcgis.com/arcgis/rest/services/World/ VehicleRoutingProblem/GPServer/
    SolveVehicleRoutingProblem/jobs/<yourJobID>/results/<outputParamName>?token=<yourToken>&f=json
Home Appliance Repair Demo
Workflow with Rest API and Python API

• REST API:
  - Repairing large appliances
  - Submitting a Rest API request
  - Retrieving the output and sending it to the drivers

• Python API:
  - Automating the workflow from planning to navigator with Python API

Optimize Your Fleet of Vehicles with the VRP Solver
Home Appliance Repair Demo

Optimize Your Fleet of Vehicles with the VRP Solver
Home Appliance Repair Demo

Re-cap

- REST API and Python API for ArcGIS
- Planning through ArcGIS Enterprise
- Have a full logistics plan
- Send individual routes to navigator
Success in numbers

- Pima County (2016):
  - Used for Building Inspector routing plan
  - Saved $33,000 per vehicle
  - Reduced mileage by 34%
  - Saving $197,000 per year on mileage and inspectors’ time
Resources

Try it!


• Rest API Tutorial: https://developers.arcgis.com/labs/rest/get-optimized-routes-for-multiple-vehicles/

• Python API notebook: https://developers.arcgis.com/python/guide/performing-network-analysis-tasks-asynchronously/

• Community: https://geonet.esri.com/community/gis/analysis/network-analyst

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Network Analyst - Optimize Your Fleet of Vehicles with the VRP Solver

This session introduces the capabilities of the Network Analyst vehicle routing problem (VRP) solver. We’ll focus on modeling and solving real-world problems, incorporating complex constraints such as multiple-capacity routing, incremental assignment, multiple-day routing, time windows, and specialties. We will also discuss a workflow from planning to the distribution of routes to drivers.