



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

Heather Moe

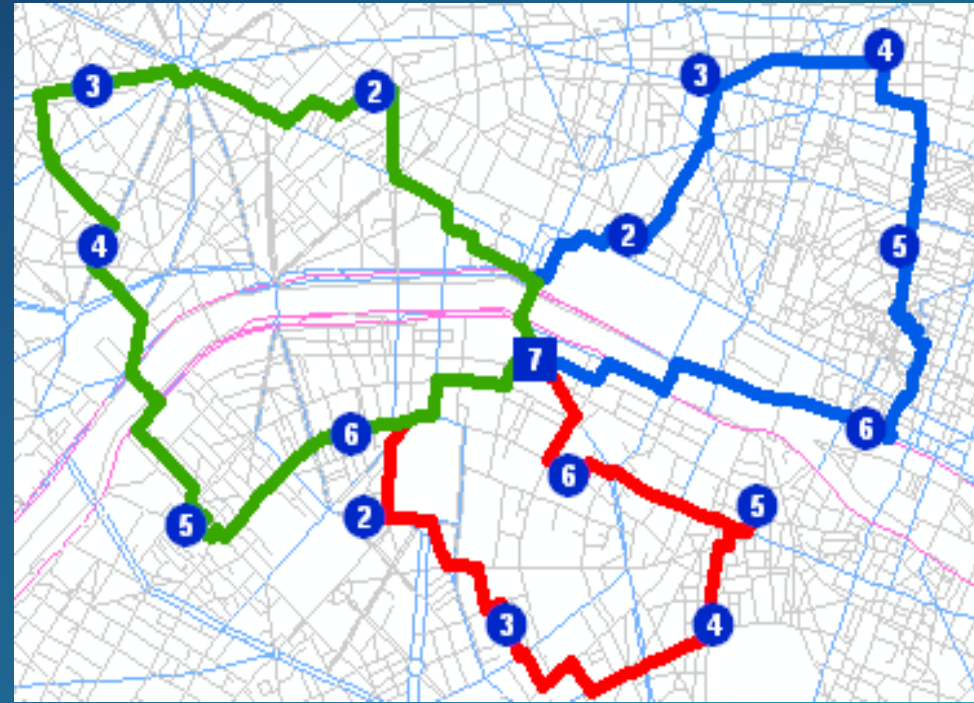
Shubhada Kshirsagar

ESRI USER CONFERENCE

GIS
INSPIRING
WHAT'S
NEXT

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



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



Optimize Your Fleet of Vehicles with the VRP Solver

Vehicle Routing Problem

How can I use it?

	 ArcMap	 ArcGIS Pro	 ArcGIS.com	 Route Planner	 Custom App
 Ready-To-Use VRP Service	✓	✓	✓	✓	✓
 User Published VRP Service	✓	✓	N/A	✓	✓
 Solve VRP Geoprocessing Tool	✓	✓	N/A	N/A	✓
 Network Analyst VRP Layer	✓	Future	N/A	N/A	✓

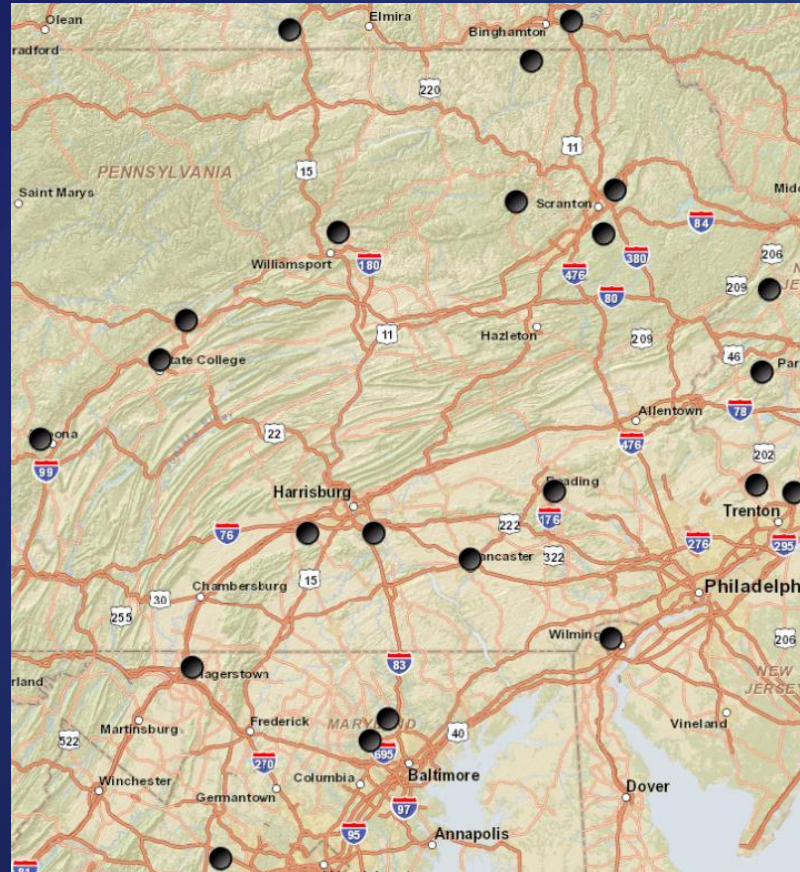
Optimize Your Fleet of Vehicles with the VRP Solver

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**



The background features a dark blue gradient with an abstract graphic on the left side. This graphic consists of numerous overlapping, semi-transparent geometric shapes in various colors including shades of blue, teal, green, orange, and red. A semi-transparent map of a city street grid is visible within the graphic, with several white circular markers placed at various points on the grid. The overall aesthetic is modern and data-driven.

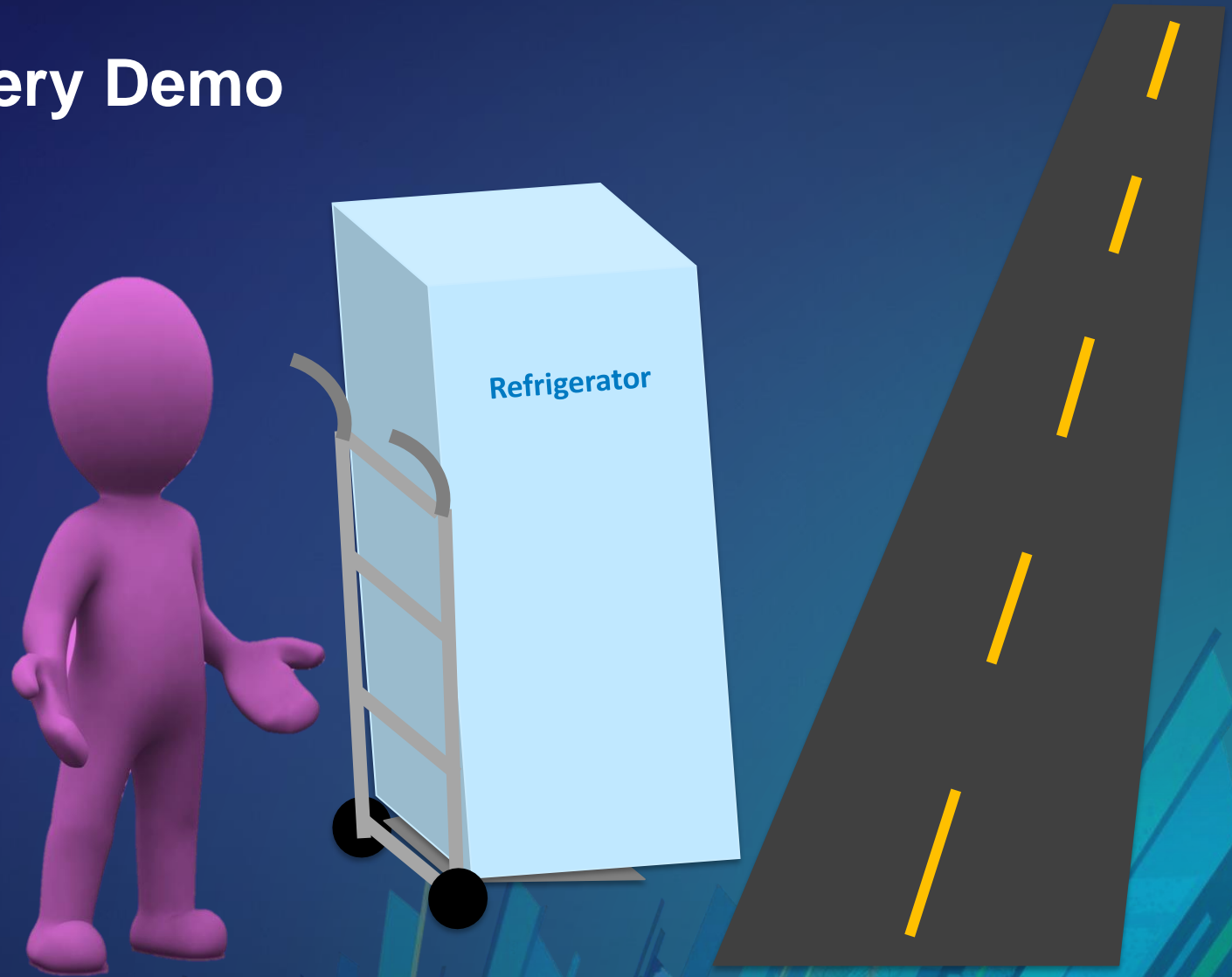
Home Appliance Delivery Demo

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



An abstract graphic on the left side of the slide. It features a dark blue background with numerous overlapping, semi-transparent rectangular shapes in various colors including teal, light blue, orange, red, and purple. These shapes are arranged in a way that suggests depth and movement. In the center of this graphic, there is a small, semi-transparent map fragment showing a street grid and several circular markers, likely representing inspection locations.

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**

- <https://logistics.arcgis.com/arcgis/rest/services/World/VehicleRoutingProblemSync/GPServer/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

An abstract graphic on the left side of the slide. It features a dark blue background with numerous overlapping, semi-transparent rectangular shapes in various colors including teal, light blue, orange, red, and purple. These shapes are arranged in a way that suggests depth and movement. In the center of this graphic, there is a small, semi-transparent map fragment showing a street grid and several circular markers, possibly representing service locations or data points.

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



Optimize Your Fleet of Vehicles with the VRP Solver

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!

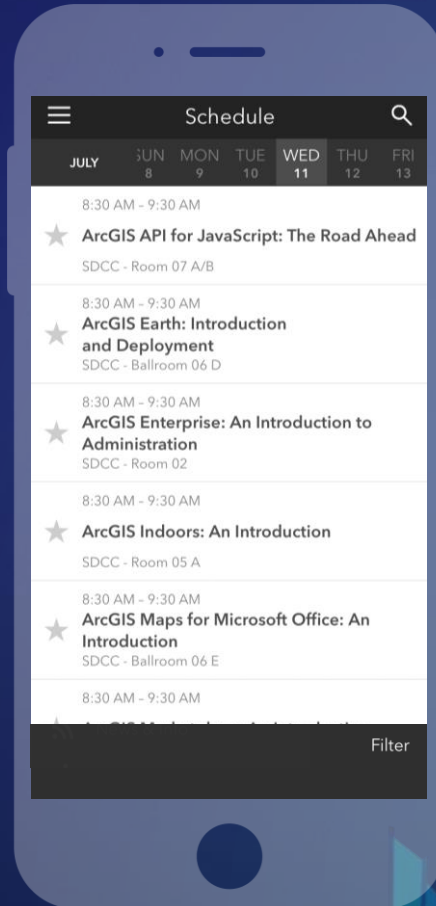
- **ArcMap Tutorial:** <http://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/about-the-network-analyst-tutorial-exercises.htm>
- **Vehicle routing problem properties:** <http://desktop.arcgis.com/en/arcmap/latest/extensions/network-analyst/vehicle-routing-problem.htm>
- **Vehicle Routing Problem REST API:** <https://developers.arcgis.com/rest/network/api-reference/vehicle-routing-problem-service.htm>
- **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>

Please Take Our Survey on the App

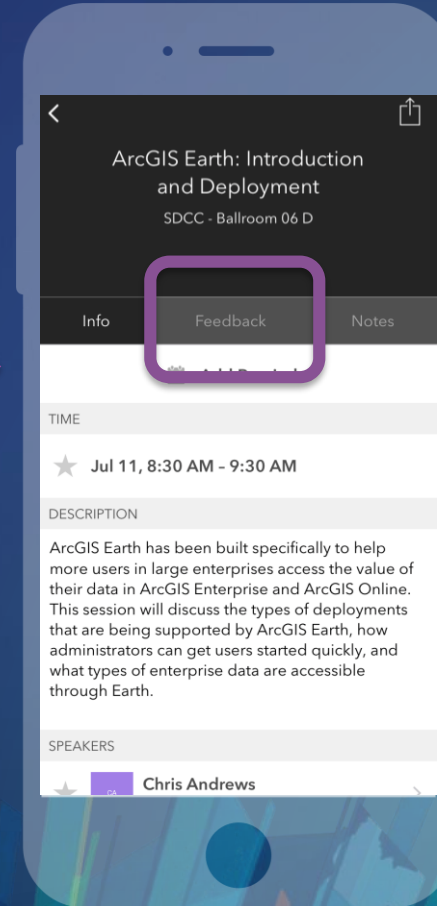
Download the Esri Events app and find your event



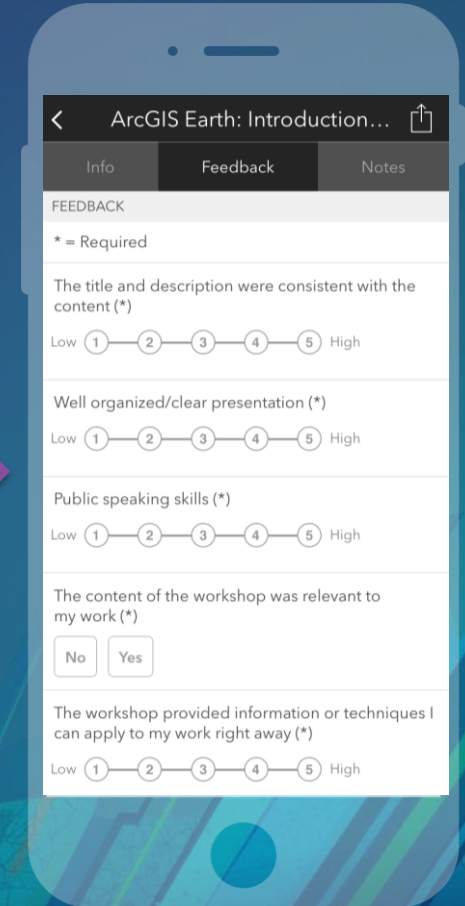
Select the session you attended



Scroll down to find the feedback section



Complete answers and select "Submit"



See Us Here

Tuesday July 10

8A	Network Analyst: Creating Network Datasets - Room 30 C	
9A		
10A	Network Analyst: An Introduction - Room 30 C	StreetMap Premium: Adding Custom Roads - Room 16 A
11A		
12P		
1P	GeoAI Deep Dive: Implementing Machine Learning Solutions with ArcGIS - Room 05 B	Navigator for ArcGIS: An Introduction - Room 15 A
2P	ArcGIS API for Python Integrating Machine Learning and Deep Learning - Demo Theater 08	
3P		
4P	Network Analyst: An Introduction - Room 30 C	
5P		

Wednesday July 11

8A	Network Analyst: Solving Large Transportation Analysis Problems - Room 29 D	
9A		
10A	Network Analyst: Optimize Your Fleet of Vehicles with the VRP Solver - Room 33 C	
11A	ArcGIS Enterprise: Publish Your Own Network Analysis Services - Demo Theater 05	
12P	Navigator for ArcGIS: Connecting to Preplanned Routes - Demo Theater 09	
1P	Network Analyst: Automating Workflows with Geoprocessing - Room 30 A	
2P		
3P		
4P	Network Analyst: Creating Network Datasets - Room 33 C	
5P		

Thursday July 12

8A	Public Transit Data: Spatial and Network Analysis - Room 07 A/B	
9A		
10A	Building Routing Applications with ArcGIS Online or ArcGIS Enterprise - Demo Theater 10	Navigator for ArcGIS: Connecting to Preplanned Routes - Demo Theater 05
11A		
12P		
1P	ArcGIS Online: Routing and Network Analysis - Room 07 A/B	
2P		
3P	Network Analyst: Automating Workflows with Geoprocessing - Room 31 A	
4P	Network Analyst: Solving Large Transportation Analysis Problems - Room 30 D	Network Analyst: Optimize Your Fleet of Vehicles with the VRP Solver - Room 33 C
5P		





esri

THE
SCIENCE
OF
WHERE

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.