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

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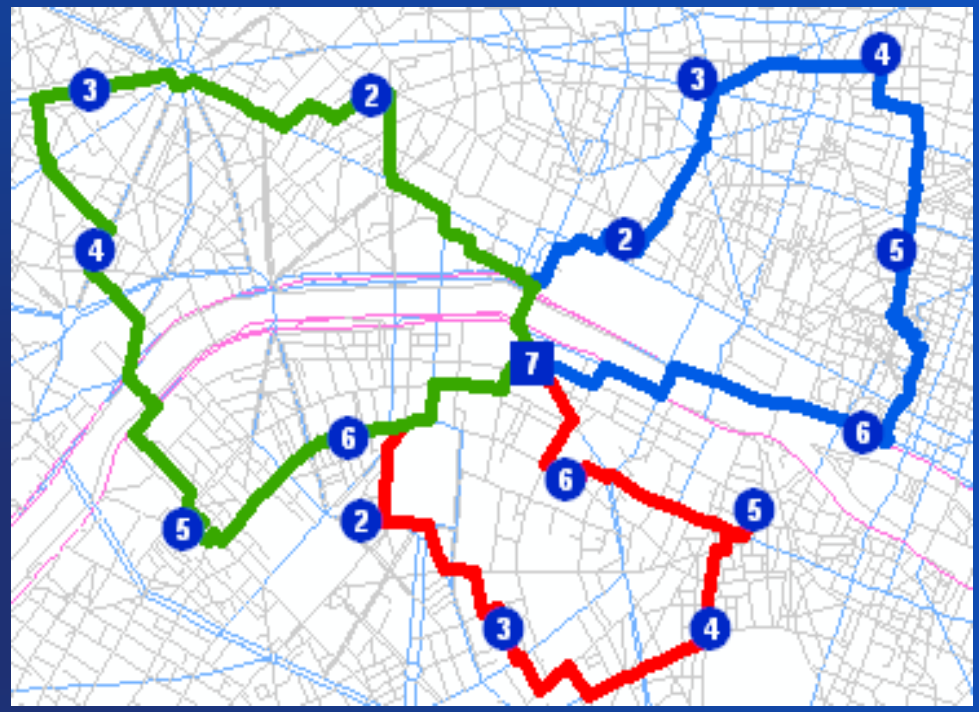
SEE WHAT OTHERS CAN'T

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
Credits — **Ready-To-Use VRP Service**	✓	✓	✓	✓	✓
NA extension — **User Published VRP Service**	✓	✓	N/A	✓	✓
NA extension — **Solve VRP Geoprocessing Tool**	✓	✓	N/A	N/A	✓
NA extension — **Network Analyst VRP Layer**	✓	Future	N/A	N/A	✓

Optimize Your Fleet of Vehicles with the VRP Solver

Under Construction

Improvements in 10.7.1, 2.4, and beyond

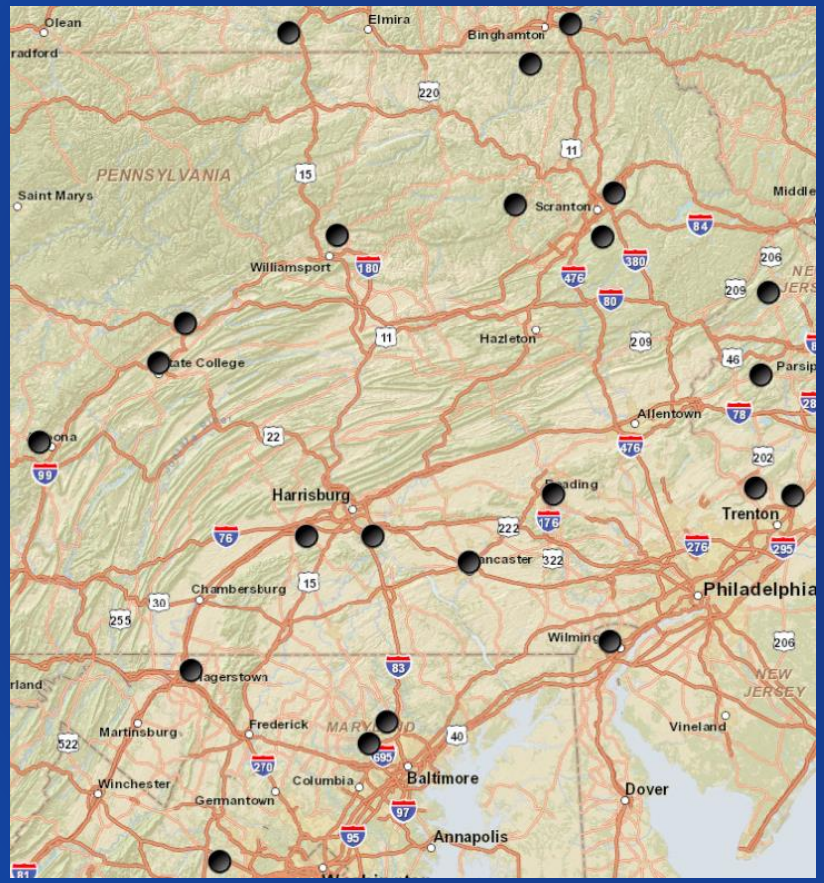
- Route solver has improved quality and performance when resequencing stops (TSP)
- Very basic VRP model has improved clustering and performance
  - Optimize for Local Orders
  - Full details of requirements are at the end of the presentation

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

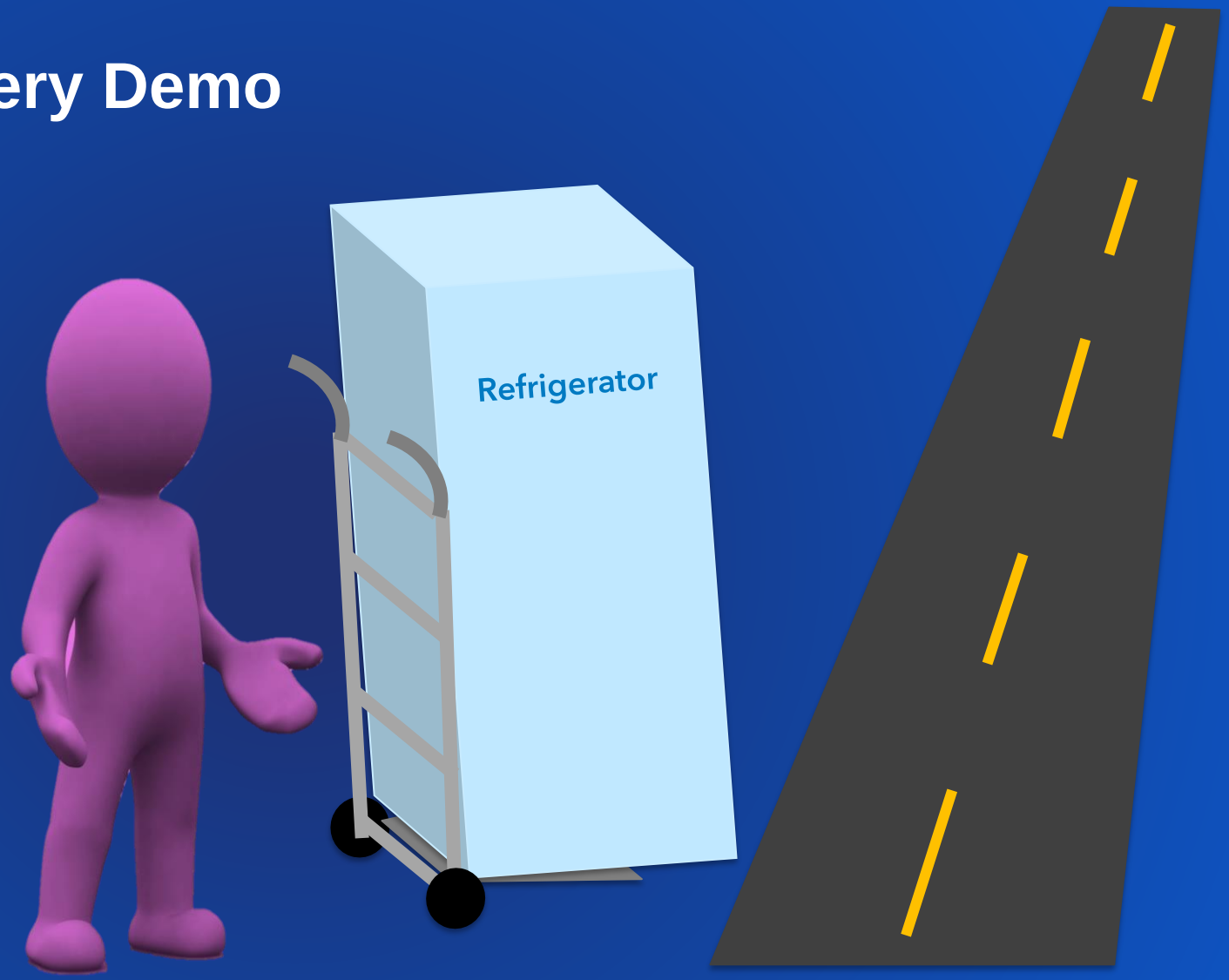
Home Appliance Delivery Demo

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



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**

    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**

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/
- **ArcGIS API for Python notebook:** https://developers.arcgis.com/python/sample-notebooks/finding-routes-for-appliance-delivery-with-vrp-solver/
- **Community:** https://geonet.esri.com/community/gis/analysis/network-analyst

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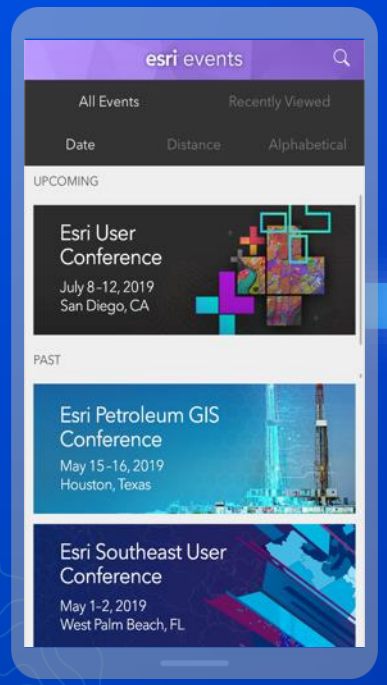
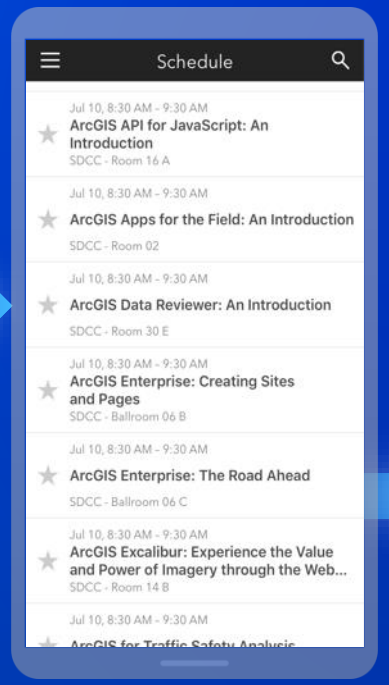
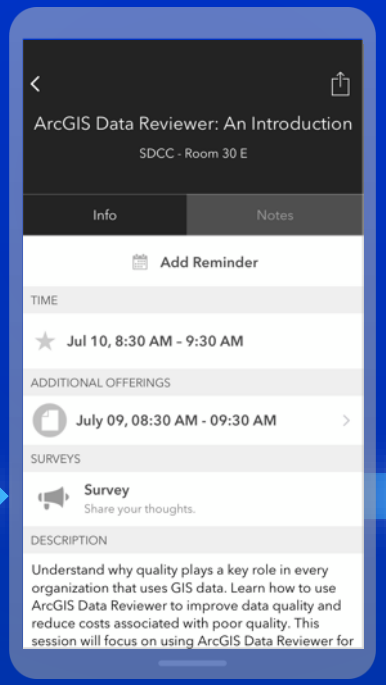


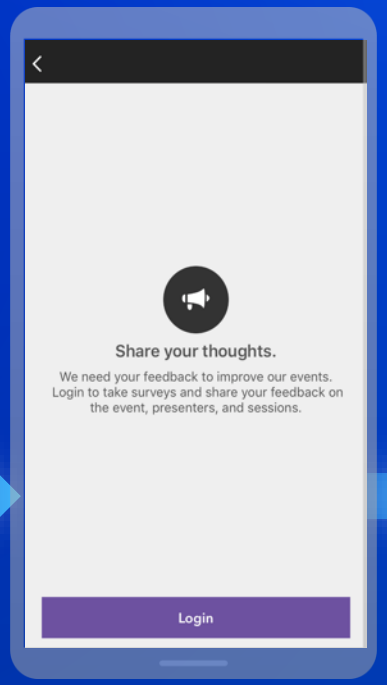
Select the session you attended



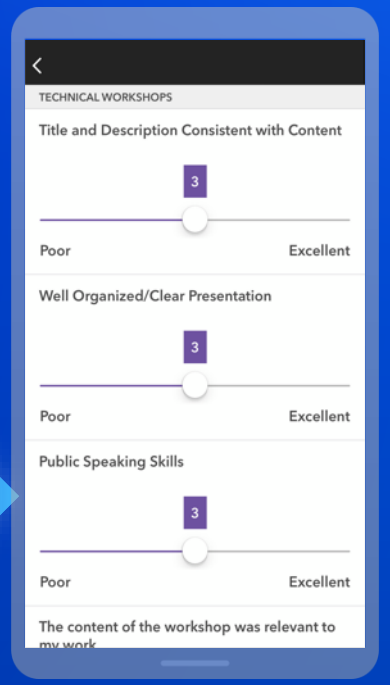
Scroll down to “Survey”



Log in to access the survey



Complete the survey and select “Submit”



See Us Here

Network Analyst Presentations

	Tuesday July 9	**Wednesday** July 10	**Thursday** July 11
8A			
9A	Network Analyst: An Introduction - Room 30B Network Analyst: Using the Python API - Room 16B	Network Analyst: Automating Workflows with Geoprocessing - Room 30D	
10A		Network Analyst: Creating High Density Routes with the VRP Solver - Demo Theater 10	Network Analyst: Automating Workflows with Geoprocesssing - Room 30A
11A	Publish Your Own Network Analysis Services with ArcGIS Enterprise - Demo Theater 10		Building Routing Applications with ArcGIS Online - Demo Theater 07
12P			
1P	Network Analyst: Creating Network Datasets - Room 30B Navigator for ArcGIS: Connecting to Preplanned Routes - Room 30A	ArcGIS Enterprise: Deep Dive into Geoprocessing Services - Room 03 Network Analyst: Solving Transportation Analysis Problems with Public Transit Data - Room 30B	ArcGIS Online: Routing and Network Analysis using Web Services - Room 33C
2P			
3P	**Network Analyst: Optimize Your Fleet of Vehicles with the VRP Solver - Room 30B** Navigator for ArcGIS: An Introduction - Room 15A	**Network Analyst: Optimize Your Fleet of Vehicles with the VRP Solver - Room 30B** Navigator for ArcGIS: Connecting to Preplanned Routes - Demo Theater 09	Network Analyst: Using the Python API - Room 30A
4P		Network Analyst: Creating Network Datasets - Room 30B	Network Analyst: An Introduction - Room 16A
5P			

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Optimize for Local Orders

- **Benefits: The Optimize for Local Orders solver override will help improve the route clustering, sequencing of orders within a route, and the solver performance (on average faster solve times).**

- **Set the Solver Overrides Parameter: {"OptimizeForLocalOrders" : "1"}**

Optimize for Local Orders

- **Required VRP parameters for using Optimize for Local Orders**
  - **All routes are homogeneous, i.e., they all have the same settings except for Name**
  - **The routes start and stop at the same depot**
  - **Routes do not have MaxTotalTravelTime or MaxTotalDistance constraints**
  - **There must be enough routes to service all the orders**
  - **Only a single Depot**
  - **Orders do not have time windows**
  - **Orders quantities are one-dimensional and only DeliveryQuantities**
  - **Orders cannot have inbound arrival times or outbound departure times**
  - **All orders must have an assignment rule of Override (3)**
  - **No Breaks, Renewals, Specialties, OrderPairs, or Route Zones**
  - **Must have dynamic seed points for all routes when using the ArcMap Layer or have "Spatially Cluster Routes" set to true when using a the Solve VRP GP tool or service**

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.