Vehicle Routing
Mini-Case Assignment

Introduction

The routing of vehicles through a distributor can have a major effect on transportation costs incurred by a firm. Vehicle routing directly affects labor, fuel, and maintenance expenses; influences revenue by the level of service provided to customers; and drives assets by the number of vehicles maintained in the fleet.

This module and accompanying homework assignment expose the student to several heuristics used in vehicle scheduling. Mixed integer linear programming can be employed to solve several routing problems, but are outside the scope of tis module. The techniques covered in this homework assignment include:

- Closest next
- Ray sweep
- Savings
- Load consolidation

Learning objectives:

Following this assignment, you should be able to:

- Apply the closes next heuristic to a single vehicle routing problem originating and returning to a central distribution center
- Critique the initial results obtained from the closest next heuristic and suggest several actions to improve the routing of the vehicle
- Employ the Ray sweep method for routing multiple vehicles from a single distribution center when capacity constraints limit the volume carried by each vehicle
- Combine the closest next with the Ray sweep method to route individual vehicles. Students should understand how pick-up or delivery affects the routing of the vehicles
- Apply the savings approach to route multiple vehicles among multiple customers in order minimize total distance traveled
- Determine the effect of temporal postponement on transportation costs by calculating and comparing the costs of individual versus consolidated shipments

Grading:

Your assignment will be graded using a rubric that employs the following weights:

Graded Element		Weight
Closest next		20%
• Ability to apply the technique and generate an initial solution	5%	
• Apply principles of vehicle routing to critique the initial solution	7.5%	
• Development of a revised solution that incorporates vehicle routing principles	7.5%	
Ray sweep		25%
• Determine the appropriate number of vehicles given capacity constraints and customer demand	10%	
• Develop a route for each vehicle	10%	
• Indicate how pick-up or delivery affects the vehicle route	5%	
Savings approach		35%
• Calculation of distances and savings for initial customer pairings	10%	
• Selection of routes yielding the greatest savings in distance traveled	5%	
• Calculation of combined routes savings and distances	15%	
• Selection of routes yielding greatest savings in total distance traveled and resulting in required number of vehicles to be routed	5%	
Load consolidation		20
• Calculation of transportation charges o By day o By location o Total for week o For consolidated loads	15%	
• Discussion of recommendation and how effect on customer service will alter final solution	5%	

Submission Format

You must show all of your work to receive full credit.

For problems 1 and 3, you may print and annotate the charts from the ppt file in the assignment area. However, you need to ensure any questions are fully answered. You may handwrite any answers on the same sheet or include a separate sheet with the written answers for these problems.

Problems 2 and 4 may be handwritten or typed. The complete assignment should be scanned and saved as a single pdf. The file should be named:

YourLastname_Hmwk2.pdf

Files submitted to canvas in formats other than pdf, doc, docx, xls, and xlsx will not be accepted.

Resources:

If you require additional information to complete the assignment, I recommend:

Module 5B, Vehicle Routing presentation. The narrated Powerpoint presentation contains a step-by-step approach for employing each of the four heuristics.

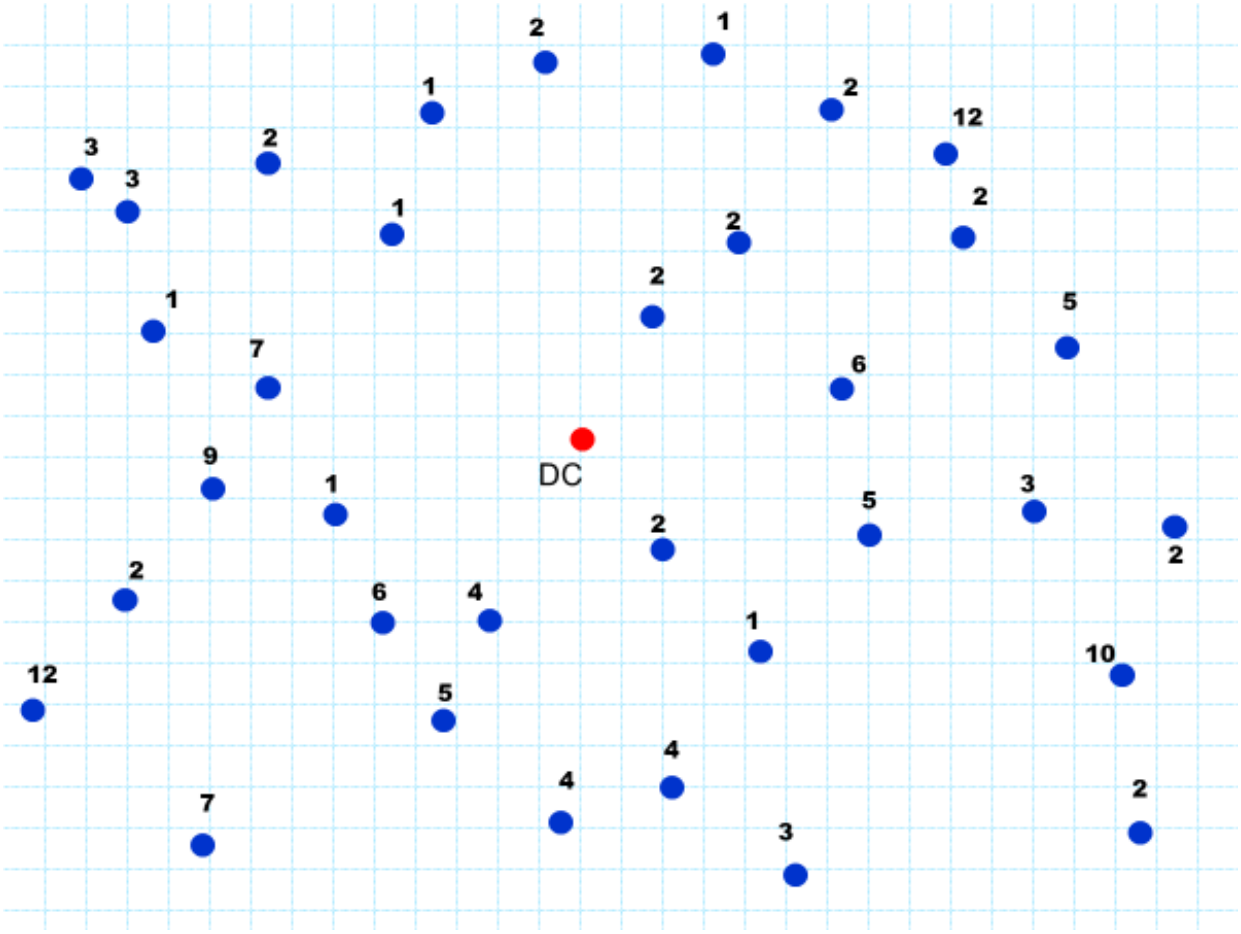
Vehicle Routing example homework. This file contains a previously assigned vehicle routing homework assignment and the solution to each problem. You are strongly encouraged to practice your calculations using this example homework.

Assignment:

The vehicle routing assignment consists of four parts: closest next (15%), Ray sweep (25%), Saving approach (35%), and load consolidation (25%).

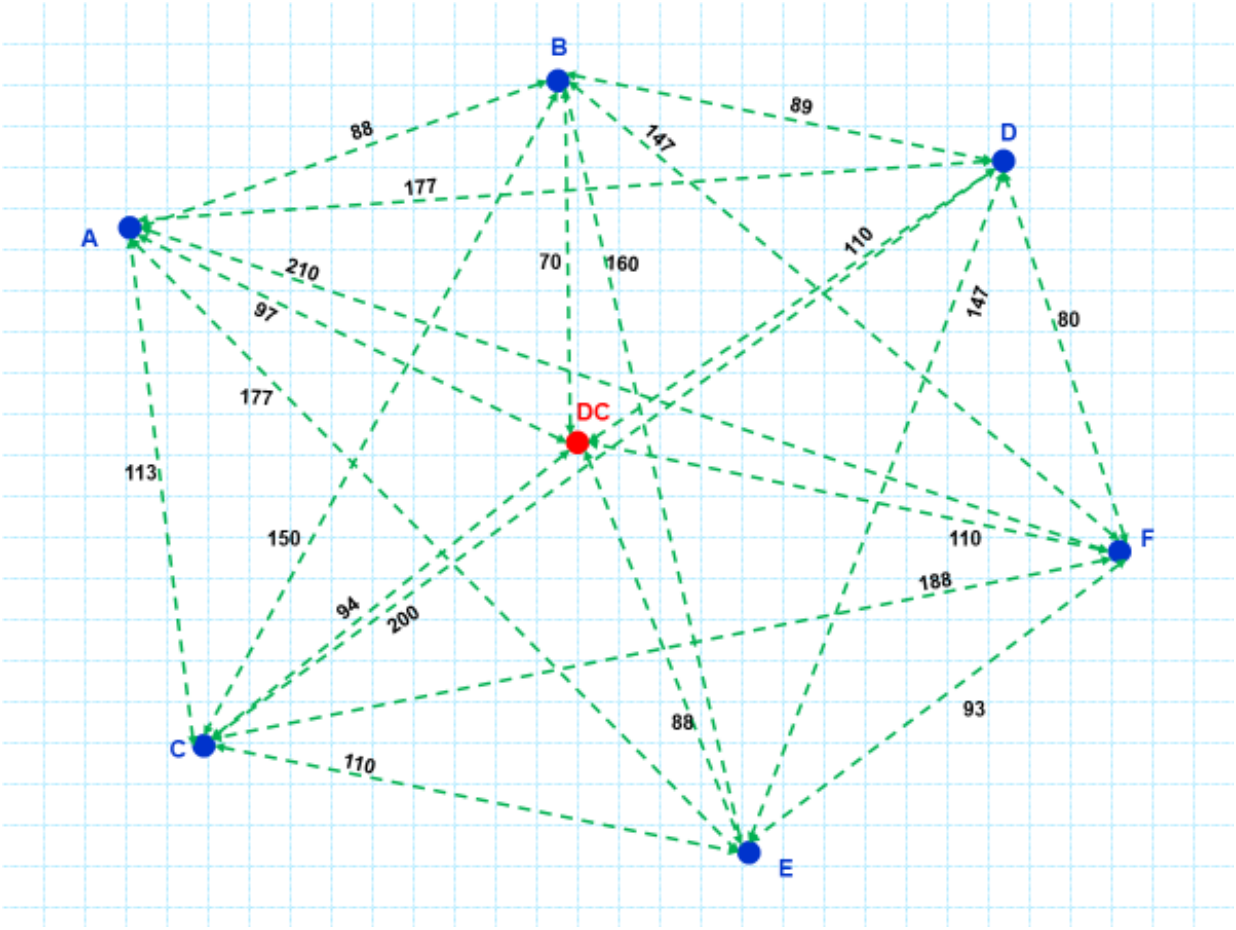
Problem 1. Pohlen Manufacturing and Logistics (PM&L) uses vans to deliver parts to outlying suppliers (circles labeled with numbers). The parts are delivered to each supplier from the manufacturing plant (red circle labeled "DC"). A typical day's deliveries are shown in the geographic region shown below. The delivery quantities are shown in thousands of units. PM&L uses vans that can transport a maximum of 15,000 units. To complete a route generally requires the entire day. PM&L wants to determine how many routes (trucks) are needed, which stops should be made on the routes, and which sequence the stops should be served by the route truck. (Note: delivery quantities are in 1000s of units. For example: 6 represents 6000 units).

Please note: a large version of the figure below is available for download—see homework charts posting in Canvas under the Homework #2 assignment.



Note: to completely answer this problem, you must (1) show the route for each truck; (2) indicate the direction traveled on each route; (3) clearly state the number of required trucks; and (4) indicate how the route would change if delivering parts.

Problem 2. The Transportation Manager for PM&L Northeast Region supports a network of six customers on a daily basis. The customers are supported through the use of **two delivery trucks**. PM&L employs the *Savings* approach in the Northeast Region. The Transportation Manager wants to determine the routes the trucks will take, which stops should be made on the routes, and which sequence the stops should be served by the route trucks. How should the truck tours be sequences as to minimize total ton miles? **You must show savings calculation to receive credit!**



The next page provides tables to assist in your analysis.

The following table provides the distance between locations shown on the previous page.

	DC	A	B	C	D	E	F
DC	0	97	70	94	110	88	110
A	97	0	88	113	177	177	210
B	70	88	0	150	89	160	147
C	94	113	150	0	200	110	188
D	110	177	89	200	0	147	80
E	88	177	160	110	147	0	93
F	110	210	147	188	80	93	0

The following table provides the initial set of savings by combining routes to include two customers.

Route	Separate	Combined	Savings
AB	334	255	79
AC	382	304	78
AD	414	384	30
AE	370	362	8
AF	414	417	-3
BC	328	314	14
BD	360	269	91
BE	316	318	-2
BF	360	327	33
CD	408	404	4
CE	364	292	72
CF	408	392	16
DE	396	345	51
DF	440	300	140
EF	396	291	105

Please note: you do not have to keep the locations in the same order when building routes. For example, if the pairs having the greatest savings were AF, BC, DE (don't assume these should be used for your solution!). The possible combinations would be:

AFBC, AFDE, BCDE (These are for example purposes only!)

When determining the combined distance, you should first circle the four points on the above diagram. You should then apply the heuristics of no crossed paths and a "tear drop" shape. Simply start at the DC and then draw a "loop" through the points that returns to the DC. You can start with any of the four points. If you take this approach, then you will select the order that produces the most savings. If your route crosses paths, doubles back, or does something that increases miles, then you will not obtain the most savings and will most likely lose points!

Problem 3. You have been asked to route a single pickup and delivery truck through the following network. Each customer must be contacted. How would you route the truck? What are the potential problems with your solution? What actions would you consider to improve your solution? If you could use multiple trucks, then how would you revise your solution (assume more than one truck can be used in answering this question)? Why?

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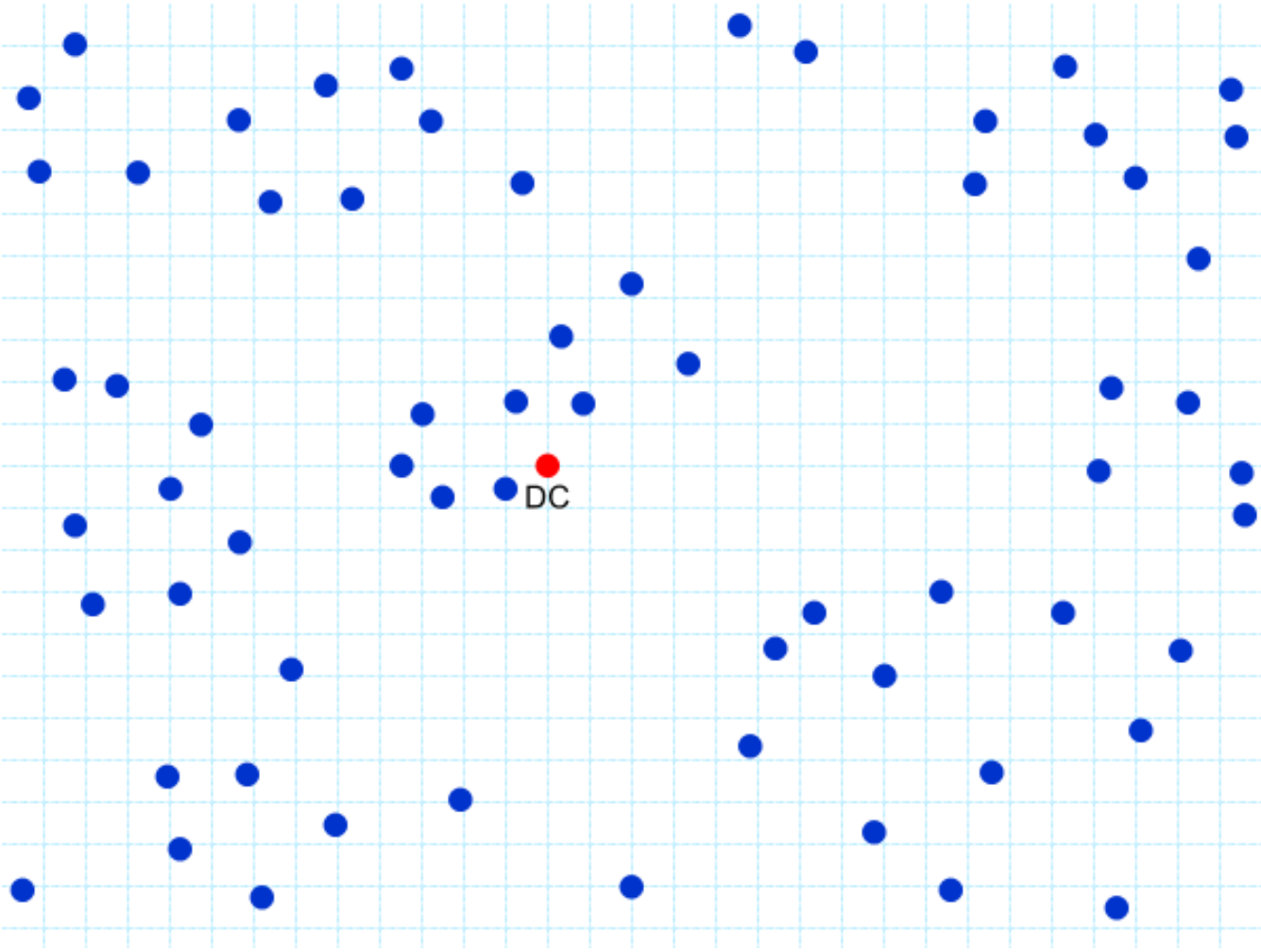

Problem 4. You have been asked to replace the regular dispatcher who is out sick. Your company is located in Denton, TX and ships to three different customers on a regular basis. Depending on the volume shipped (CWT) and distance, your carrier assigns different rates. During the last 10 months, your firm has averaged the following orders and rates:

Volumes in lbs	Day One	Day Two	Day Three	Total
Houston	28,950	32,000	45,000	105,950
San Antonio	22,550	25,000	19,000	66,550
Las Cruces	17,000	9,000	25,000	51,000

Rates per CWT	Day One	Day Two	Day Three	Total
Houston	$ 120.00	$ 142.00	$ 100.00	$ 95.00
San Antonio	$ 95.00	$ 102.00	$ 125.00	$ 88.00
Las Cruces	$ 71.00	$ 75.00	$ 102.00	$ 92.00

Note: all rates are expressed in dollars per CWT. You need to convert the weight to CWT and determine the total cost. Distance has been previously factored into the rate per CWT.

1. What analysis would you perform and why?

2. What are the results of your analysis (show calculations to support)?

3. What would you recommend to your firm? Your customer? What actions could your firm and customer take to implement these recommendations?