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Project 4: Excavation and Fill Plan for Rocks-R-Russ

Math Modeling
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Problem

Problem: Rocks-R-Russ is currently excavating three sites and filling four sites in support of a large construction project. Excavations at sites A, B and C are producing 150, 400, and 325 cubic yards of dirt per day, respectively. The fill sites D, E, F and G require 175, 125, 225 and 450 cubic yards of dirt per day. Fill dirt can also be purchased from a source H at a cost of $5 cubic yard. The cost of shipping fill dirt is about $20 per mile for a truckload of 10 cubic yards. The following table gives the distances between sites in miles.

	Destinations			
Source	D	E	F	G
A	5	2	6	10
B	4	5	7	5
C	7	6	4	4
H	9	10	6	2

Table taken from Professor de Moor

Goal: Find the transportation plan that minimizes the cost to Rocks-R-Russ. We will also be examining the maximization the usage of the available dirt from each sources, considering we are able to purchase dirt from source H.

Commentary

Assumptions

To begin, our model assumes that the dirt from all fill sites are uniform, meaning there are not different types of rocks. We will also be upholding the requirements of each site in our model. Another assumption we must make is that we cannot overfill or over-dig for dirt at the sources.

Method

Primal/Dual: The primal requires an objective function and constraints. Our objective function is the cost of moving dirt. Each of the unique 16 variables map a source to a sink. In our program, we calculated the cost for a trip (not including source H) from source to sink. The constraints of our primal is the amount of dirt being filled. We have stated the amounts above in the table.

Results

In our program, we learned that the cost of the plan is $7950 which was calculated through our primal and $7475 found by our dual. This suggests that one is preferable over the other. However, we can change the constraints and limitations to further explore the overall cost. Our model only considers purchasing dirt from source H to transport to sink G. The table represents our model (in cubic yards) with limitations of our constraints:

		Destination		
Source	D	E	F	G
A	25	125	0	0
B	150	0	0	250
C	0	0	225	100
H	0	0	0	100

Analysis

If we did not consider H as being a source, the transportation from source C to sink G would increase by 100. This results in maximizing dirt in sources A,B,and C. The following table represents the elimination of source H:

		Destination		
Source	D	E	F	G
A	25	125	0	0
B	150	0	0	250
C	0	0	225	200
H	0	0	0	0

As we continue to explore these adjustments, we can see that source C appears to be a big limiting factor for the overall cost. Our program calculates a saving of $100 based on the adjustments of removing source H (Primal: $7850 and Dual: $7475). Through our calculations and analysis, we should suggest the plan to eliminate source H as it would save $100.

It is interesting to note that, because our constraints and requirements are fixed, we do not have much exploration room to analyze cost efficiencies. However, if we were able to adjust the constraints, we should find that the highest averaged distance from source to sink has a great affect on the cost. The suggestion is to limit and decrease the times transported from that particular source to sink in order to eliminate costs.