Case Study 1: Assigning Students to Schools

Adapted from Hillier and Lieberman, Case 4.3
by Prof. Susan Martonosi
Honor Code: Do not read the case in the textbook

Due September 30, 2009. You will work in *pairs* on this assignment and will hand in one document per pair. You must acknowledge any resources/people consulted.

The Clamona school board has made the decision to close one of its middle schools (sixth, seventh and eighth grades) at the end of this school year and reassign all of next year's middle school students to the three remaining middle schools.

The school district provides bussing for all middle school students who must travel more than approximately a mile. The annual bussing cost per student from each of the six residential areas of the city to each of the schools is shown in the following table (along with the other basic data for next year), where \$0 indicates that bussing is not needed (average distance is less than a mile), and a dash indicates an infeasible assignment. The annual cost of bussing students less than a mile is \$0 per student. The annual cost of bussing students traveling from 1 to 1.5 miles is \$200 per student, and that of students traveling 1.5 to 2 miles is \$300 per student. Each additional half mile interval adds \$100 per student.

Region	No. of Students	Percentage in 6th Grade	Percentage in 7th Grade	Percentage in 8th Grade	Average Bussing Cost per Student		
					School 1	School 2	School 3
1	450	32	38	30	\$300	\$0	\$700
2	600	37	28	35	---	\$400	\$500
3	550	30	32	38	\$600	\$300	\$200
4	350	28	40	32	\$200	\$500	---
5	500	39	34	27	\$0	---	\$400
6	450	34	28	38	\$500	\$300	\$0
				School Capacity	**900**	**1100**	**1100**

Each school has a maximum capacity, given in the table. The table shows the percentage of each region's middle school population that falls into each of the three grades. The school attendance zone boundaries can be drawn so as to split any given area among more than one school, but assume that the percentages shown in the table will continue to hold for any partial assignment of a region to a school.

Clamona is considering eliminating some bussing to reduce costs. Option 1 is to continue bussing to all students living more than 1 mile from school. Option 2 is to eliminate bussing for students traveling 1 to 1.5 miles. Option 3 is to also eliminate bussing for students traveling 1.5 to 2 miles.

You have been hired as an operations research consultant to assist the Clamona school board in determining how many students in each area should be assigned to each school *and* which of the three bussing plans to adopt. The Clamona school board wants to minimize the total bussing cost. However, of equal concern are the inconvenience and safety problems caused by forcing students to walk or bicycle a substantial distance (more than a mile, and especially more than 1.5 miles). Therefore, they want to choose a plan that provides the best trade-off between these two factors. Furthermore, the school board would like each school to have roughly equal proportions of sixth, seventh and eighth graders.

Formulate and solve appropriate *linear* programs (only) to form a recommendation for the Clamona school board. State clearly any modeling assumptions you make in your solution and assess how well your solution meets the stated criteria. Also discuss any other advantages or disadvantages present in your solution. Your report should take the form of an "executive summary": a 2-3 page report directed to the Clamona school board that summarizes your results and recommendations. Your model formulations and any computations that support your argument should be included in appendices. The total length of your document should not exceed 10 pages. The purpose of this case study is to develop your modeling abilities and to familiarize you with the process of operations research. As such, you will be graded based on your success at incorporating the ambiguously stated constraints and conflicting objectives into a linear programming model, your assessment of the strengths and weaknesses of your model, and your written presentation of the solution to your intended audience.

Names: _____

Grading Rubric for Case Study 1
Assigning Students to Schools

Please use this rubric sheet as the cover page of your report.

Format and Writing

____1 pt Report submitted on time.

____1 pt Clean paper (few typos; few distracting grammatical hiccups; clear structure and composition; appendices, tables and figures are well-labeled and easy-to-read).

____1 pt Report is within page limits (2-3 pp. main report; up to 10 pp. with appendices).

____2 pts Appropriately written for target audience (Clamona school board)
0 = Technical content too low (insufficient discussion of methodology) *or* too high (technical terminology used unnecessarily or without explanation).
1 = Technical content occasionally too high or too low.
2 = Methodology is explained as necessary, with unfamiliar terms explained using common language.

Technical Content

____1 pt A linear programming model was created and solved.

____1 pt Assumptions made in the model are clearly stated and assessed.

____2 pts Ambiguously stated constraints were incorporated into the model
0 = Constraints were ignored, without justification
1 = Attempt was made to incorporate the constraints, but method was incorrect or not well justified.
2 = Constraints were incorporated correctly into the model and clearly explained.

____1 pt Assesses how well solution meets criteria given in problem statement and how trade-offs were weighed.

Total: _____

Observe that only five points out of ten are awarded based on technical content! Poorly written reports will not receive a passing grade. Reports that appear not to have been proofread will be returned unread.