

COT 5405: Advanced Algorithms
Fall 2012 Assignment 1
Due: 5pm, 15 Oct 2012

1. (20 points) Give the dual of the following linear program.

$$\begin{aligned} &\text{Minimize } x_1 - 4x_2 \\ &\text{Subject to:} \\ &3x_1 + 2x_2 \geq 4 \\ &2x_1 - x_2 \geq 6 \\ &4x_1 - 2x_2 \geq -2 \\ &-3x_1 - 5x_2 \geq -3 \\ &x_1, x_2 \geq 0 \end{aligned}$$

2. (20 points) Given the following instance of Knapsack: *profits* (4, 20, 12, 12, 2), *sizes* (2, 7, 4, 4, 1), and *capacity* 9, find a factor $1/2$ approximation yielded by the FTPAS we discussed in class. Show all the steps in the algorithm.

3. (20 points) Given the following instance of set cover: *sets* {a, b}, {a, c, d}, {b, d, e}, and {a, b, e}, with *costs* 2, 4, 3, and 3 respectively, find the solution using the primal-dual algorithm discussed in class. Pick the y s in alphabetical order. Show all the steps in the algorithm.

4. (20 points) Formulate the following *Minimum Edge Dominating Set* problem as an integer linear program, and also give its relaxation. *Minimum Edge Dominating Set*: Given a graph $G = (V, E)$, find a subset of edges, E' , of smallest cardinality, such that if $e_1 \in E - E'$, then there is an $e_2 \in E'$ such that e_1 and e_2 are adjacent.

5. (20 points) The American Community Survey (ACS) provides data on a fairly detailed sample of American households and populations. You can obtain data for Florida (and other states) from:

http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_pums_csv_2010&prodType=document. Assume that you are a politician running for a statewide election in Florida. Use the year 2010 data from above to develop some strategy for your election campaign that optimizes some resource¹ using any approximation algorithm studied in class. Also compare with some reasonable heuristic. You can make reasonable assumptions so that you can formulate the problem as a combinatorial optimization problem. You should state your assumption in your answer and show the problem formulation. You should write codes for the approximation algorithm and your heuristic, and describe the heuristic in your answer. Compare the quality of the solutions from the heuristic and the approximation algorithm, and also their run times.

¹ For example, you may wish to minimize campaign expenses in targeting promising households, you may wish to minimize tax breaks, or minimize budget increases subject to winning the election.