Homework 1

Deadline: May 03rd, 2019

Instruction: You may discuss these problems with classmates, but please complete the write-ups individually. Your answers must be **typewritten**, except for figures, which may be hand-drawn. Please submit your answers (pdf format only for non-programming assignments) on **Canvas**.

P1. Programming [50 points]

Undergrads: Implement the Multiple LPs to compute an SSE using Cplex.

Grads: Implement the MILP to compute an SSE using Cplex.

Instruction: The **input** of your program is two CSV (Comma Separated Values) file: *param.csv* and *payoff.csv*. The format of the param.csv file is *#targets,#resources* where *#targets* is the number of targets and *#resources* is the number of defender resources. In the payoff.csv file, each line consists of five numbers *target_id,def_payoff_cov,def_payoff_uncover,att_payoff_cov,att_payoff_uncover*. The **output** of your program is a CSV file, named *SSE.csv*. Each line of the output file is in the format of *target_id,def_coverage_probability*. A sample of the three files are provided.

Your submission must include: (i) source codes; (ii) documentary including description of your program and instruction to run it. Your program will be tested based on different games.

P2. Problem Solving [50 points]

Q1. [21 pts] Consider a security game with four targets. The payoffs are given in the following table. In each cell, the first number is the defender payoff and the second is the attacker payoff.

	t_1	t_2	t_3	t_4
Covered	(1,0)	(3,0)	(8,0)	(8,-1)
Uncovered	(-1,1)	(0,2)	(0,4)	(-4,4)

Find the SSE of the game using the ORIGAMI algorithm when the number of defender resources is (i) one; (ii) two; and (iii) three. You must provide the computation step by step.

Q2. [29 pts] Roger has invited Caleb to his party. Roger must choose whether or not to hire a clown. Simultaneously, Caleb must decide whether or not to go the party. Caleb likes Roger but he hates clowns. Caleb's payoff from going to the party is 4 if there is no clown, but 0 if there is a clown there. Caleb's payoff from not going to the party is 3 if there is no clown at the party, but 1 if there is a clown at the party. Roger likes clowns (he especially likes Caleb's reaction to them but does not like paying for them). Roger's payoff if Caleb comes to the party is 4 if there is no clown, but $8 - x$ if there is a clown (x is the cost of a clown). Roger's payoff if Caleb does not come to the party is 2 if there is no clown, but $3 - x$ if there is a clown there.

1. (5 pts) Write down the payoff matrix of this game.
2. (24 pts) Find any dominated strategies and the Nash equilibrium of the game (with explanation) when (i) $x = 0$; (ii) $x = 2$; (iii) $x = 3$; and (iv) $x = 5$.