Graph Optimization
Lab assignment

(Due June 15, 2020, at 22)

Problem

Consider a set of N requests for web services that must be served by a data center. Each request i is characterized by an amount of traffic w_i, requires a computing capacity cpu_i and occupies an amount of memory m_i. A set of M virtual machines can be instantiated in the data center to serve the requests. Each request must be assigned to one and only one virtual machine. If it is instantiated, a virtual machine can receive a maximum amount of traffic B_c, has an overall computing capacity B_{cpu} and a total memory B_m. Instantiating a virtual machine is expensive, therefore the goal is to minimize the number of used virtual machines.

1. Formulate the problem as an Integer Linear Programming model, using variables that describe the assignment of a single request. Write the model in AMPL syntax (file .mod).
2. Formulate the problem using variables associated with the assignment of subsets of requests to machine. Develop a column generation solution scheme for the continuous relaxation and implement it in a AMPL script. Describe the dual constraints, the pricing problem and the choice of the initial subset of variables.
3. Develop a surrogate relaxation for the problem and implement it in a AMPL script. Describe a relaxation of the problem and discuss the choice and update of the parameters.
4. Derive cover-like inequalities for the problem. Implement in AMPL a procedure to generate the violated cover inequalities.
5. Develop a heuristic approach (constructive and improving) and implement it in a AMPL script.
6. Describe all the models, the pricing and separation problems, the surrogate relaxation, the heuristics and all the procedures required in points 1 - 5 on a pdf (possibly handwritten).
7. Download the instances from the Beep directory `Lab Exams` and apply all the approaches develop to them. The parameter definition is described in the file `parameterDefiniton.mod`. Fill-in the tables underneath and compare the obtained lower and upper bounds, discussing the impact of parameters.

8. Upload the pdf file and the .mod and .run files as a single zip file on the Beep directory `Lab Exam/submission`. Rename all the files as your last name (in case of groups, use the last name of the person who sent the e-mail with the group composition).

instance	model			column generation		
	cont. relax.	optimum	time	obj. function	time	# columns

Table 1: Relaxation comparison - part 1

instance	surrogate relaxation			cover			
	value LB/UB	time	#iterations	initial obj function	final obj. function	time	# covers

Table 2: Relaxation comparison - part 2

instance	constructive			improving			
	obj.function	gap	time	obj. function	gap	time	# iterations

Table 3: Heuristic comparison