Problem Set 4
ECON31749/PPHA48403

February 5, 2019

Due Date : Tuesday, Feb 19

Part I

Exercises from Bertsimas and Tsitsiklis (1997):
1. Do 3.18 a,b,c, with d and e as optional exercises.
2. Do 4.4, 4.26, with 4.10 4.19, 4.20, 4.38, 4.39, 4.40, 4.48 as optional exercises.

Part II

1. Code the *revised* simplex algorithm. Design a simulation study and investigate speed gains obtained from "revising" the primal simplex, i.e., from maintaining the inverse using the "elementary row operations trick" from the last segment of Lecture 2, Section 1.2.3, instead of recomputing a new inverse from scratch at each iteration of the simplex.

2. Show equivalence of the two dual formulations of the quantile regression problem,

$$\max_d Y^T d$$

subject to

$$X^T d = 0$$
$$(\tau - 1)\mathbf{1}_n \leq d \leq \tau \mathbf{1}_n, \tag{1}$$

and

$$\max_a Y^T a$$

subject to

$$X^T a = (1 - \tau) X^T \mathbf{1}_n \tag{2}$$

$$a \in [0,1]^n.$$

3. Provide clearly annotated pseudocode for a primal simplex –i.e., with "wide" linear equality constraint matrix– for box constrained variables, $a \in [0,1]^n$. Specifically, write a simplex that mimics that described in subsection 3.3 of Bertsimas and Tsitsiklis (1997), but is adapted to solve problem (2).

4. Code the algorithm from Barrodale and Roberts (1973) and study its behavior. Implement the quantile regression linear program in Gurobi. Design and implement a simulation study to compare the performance of your implementation of the Barrodale and Roberts algorithm to that of the Gurobi implementation and that of the primal simplex you coded in question 1 applied to the primal standard form representation of the quantile regression problem.

Discuss the simulation results.