Statistical Learning Theory 2019 Homework

* Deadline: July 7
* Send a PDF file to sml2019homework@googlegroups.com
* The PDF file must include your answers to all of the questions in English as well as your name and student ID.

Q1. Consider a linear regression problem. We are given n training data instances $\{(\mathbf{x}_i, y_i)\}_{i=1,2,\ldots,n}$, where for each $i \in \{1,2,\ldots,n\}$, $\mathbf{x}_i \in \mathbb{R}^D, y_i \in \mathbb{R}$. We want to estimate a regression function $f(x) = \mathbf{w}^\top \mathbf{x}$ where $\mathbf{w} \in \mathbb{R}^D$ is the model parameter. Give the formulations and solutions for the least square regression, the ridge regression, and the lasso.

Q2. Give a multi-class logistic regression model and a method for maximum likelihood estimation of the model.

Q3. Explain a formulation of the recommendation problem and a solution using matrix factorization. Use the following notations: r_{ij} is the rating score of item i given by user j. $\mathcal{O}$ is the set of the indices of observed ratings, i.e. r_{ij} is observed if $(i,j) \in \mathcal{O}$.

Q4. Under the same setup of Q1, give the formulation of the elastic-net and define the augmented Lagrangian function of the elastic-net optimization problem (i.e., use the Alternating direction method of multipliers (ADMM) to optimize the elastic-net).

Q5. Derive the update formulas of the elastic-net optimization problem of Q4.

Q6. Explain the advantage of ADMM.

Q7. Explain the advantages of the elastic-net over the lasso and the ridge regression.