Course 11	**SVMs and Regularized Learning**
Program	**1. Introduction:** • Classification and Margins. • Classical Unconstrained Optimization. • Hard Margin Linear SVMs: primal problem. • Lagrangian formulation and dual problem. • KKT conditions and optimal solution. • Linear SVMs for nonlinear problems • Support Vector Regression **2. SVM models:** • Kernelization and non-linear SVMs: ○ Non-linear classification in feature spaces. ○ Mercer's Theorem. Kernel trick. ○ Common kernel choices. ○ Parameter tuning. • Non-linear Support Vector Regression: ○ Primal and dual formulations, kernelization. • One-class Support Vector Machine: ○ Density estimation problems. ○ Primal and dual formulations, kernelization. ○ Kernels for non-vector data. • Other SVM-related models. **3. SVM learning algorithms:** • Brief introduction to convex optimization. • Non-linear SVM learning algorithms: ○ Chunking and decomposition methods. SVMlight. ○ Sequential Minimal Optimization. LIBSVM. • Linear SVM learning algorithms: ○ Primal solver: Pegasos. ○ Dual solver: LIBLINEAR. **4. Regularized Models and Convex optimization:** • Convex optimization problems. • Subgradients and subdifferential calculus. • Proximal optimization. • Proximal methods: Forward-backward Splitting, Douglas-Rachford, Dykstra, etc. • The ISTA and FISTA algorithms. • Application to regularized learning: lasso, elastic nets, group variants, fused lasso. • Application to image processing. • Application to projection problems. **5. Practical Sessions:** • Python with sklearn.
Bibliography	• ***Learning with Kernels: Support Vector Machines, Regularization, Optimization and Beyond***. B. Schölkopf and A. J. Smola. *MIT Press, 2002*. • ***A Tutorial on Support Vector Machines for Pattern Recognition***. C. J. C. Burges. *Data Mining and Knowledge Discovery, Volume 2, 2002*. • ***A Tutorial on Support Vector Regression***. A. J. Smola and B. Schölkopf. *Statistics and Computing, Volume 48, 2003*. • ***Proximal Splitting Methods in Signal Processing***. P. L. Combettes and J. C. Pesquet. *Recherche, Volume 49, 2009*. • ***A Fast Iterative Shrinkage–Thresholding Algorithm for Linear Inverse Problems***. A. Beck and M. Teboulle. *SIAM Journal on Imaging Sciences, Volume 2, 2009*. • ***Convex Optimization***. S. Boyd and L. Vandenberghe. *Cambridge University Press, 2004*.