

Foundations of Machine Learning

ECTS : 4

Volume horaire : 24

Description du contenu de l'enseignement :

The course will introduce the theoretical foundations of machine learning, review the most successful algorithms with their theoretical guarantees, and discuss their application in real-world problems. The covered topics are:

- **Part 1:** Supervised Learning Theory: the batch setting
 - Intro
 - Surrogate Losses
 - Uniform Convergence and PAC Learning
 - Empirical Risk Minimization and ill-posed problems
 - Concentration Inequalities
 - Universal consistency, PAC Learnability
 - VC Dimension
 - Rademacher complexity
 - Non Uniform Learning and Model Selection
 - Bias-variance Tradeoff
 - Structural Minimization Principle and Minimum Description Length Principle
 - Regularization
- **Part 2:** Supervised Learning Theory and Algorithms in the Online Setting
 - Foundations of Online Learning
 - Beyond the Perceptron Algorithm
- **Partie 3:** Ensemble Methods and Kernels Methods
 - SVMs, Kernels
 - Kernel Approximation Algorithms in the Primal
 - Ensemble Methods: Bagging, Boosting, Gradient Boosting, Random Forests
- **Partie 4:** Algorithms for Unsupervised Learning
 - Dimensionality Reduction: PCA, ICA, Kernel PCA, ISOMAP, LLE
 - Representation Learning
 - Expectation Maximization, Latent Models and Variational Methods

Compétence à acquérir :

The aim of this course is to provide the students with the fundamental concepts and tools for developing and analyzing machine learning algorithms.

Mode de contrôle des connaissances :

- Each student will have to have the role of scribe during one lecture, taking notes during the class and sending the notes to the teacher in pdf.
- Final exam

Bibliographie, lectures recommandées :

The most important book: - Shalev-Shwartz, S., & Ben-David, S. (2014). Understanding machine learning: From theory to algorithms. Cambridge University Press. Also: - Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2012). Foundations of machine learning. MIT press. - Vapnik, V. (2013). The nature of statistical learning theory. Springer science & business media. - Bishop Ch. (2006). Pattern recognition and machine learning. Springer - Friedman, J., Hastie, T., & Tibshirani, R. (2001). The elements of statistical learning (Vol. 1, No. 10). New York, NY, USA: Springer series in statistics. - James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112). New York: Springer.

