Ubiquitous Networking (Ubinet) Master Program

Machine Learning for Networks: Algorithms and Architecture

Responsable / *In charge of* : **Giroire Frédéric** (Frederic.GIROIRE@cnrs.fr)

Résumé / *Abstract* :
There is a growing trend in the networking community to use machine learning (ML) methods to solve classic networking problems. The course will show how to model network problems using ML and present several important applications, such as anomaly detection or network design and management.

Prérequis / *Prerequisite* :

Objectifs / *Objectives* :
The goal of the course is to explore how to use classic and advanced methods from machine learning in a networking context. We will present some of these methods among linear regression, Support Vector Machine, Reinforcement Learning, graph kernels, etc., and show how they can be applied to solve important networking problems such as the detection of anomalies in network traffic to show potential threats or discover the source of failures or the design of Internet of Things (IoT) and Unmanned Aerial Vehicles (UAV) networks.

Contenu / *Contents* :
The course will present machine learning methods used to study networks. It will start with a short presentation of classic ML algorithms.
Then, in the first part of the course, there will be a focus on methods to compare networks, in particular graph kernels. We will show how these techniques can be used to detect anomalies or attacks in telecommunication network traffic. This will be the topic of the course project.
The second part of the course will investigate Reinforcement Learning (RL) where the agent explore the environment to learn from it and maximize the rewards obtained from the actions taken.
We will present basic RL methods such as multi-armed bandit and Q-learning algorithm and investigate the applications of RL for the design of Internet of Things (IoT) and Unmanned Aerial Vehicles (UAV) networks.

Références / *References* :

Shortest-path kernels on graphs, K. M. Borgwardt and H.-P. Kriegel, ICDM, 2005.

Deep Graph Kernels, P. Yanardag, S.V.N. Vishwanathan, KDD, 2015.
Profiling the End Host, T. Karagiannis, K. Papagiannaki, N. Taft, and M. Faloutsos, PAM 2007.
Network Monitoring using Traffic Dispersion Graphs (TDGs), Iliofotou, M., Pappu, P., Faloutsos, M., Mitzenmacher, M., Singh, S., and Varghese, G., IMC, 2007.
GraphPrints: Towards a Graph Analytic Method for Network Anomaly Detection, Harshaw, C. R., Bridges, R. A., Iannacone, M. D., Reed, J. W., and Goodall, J. R., CIRSC 2016.
Richard S. Sutton and Andrew G. Barto. Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.
Csaba Szepesvári. Algorithms for reinforcement learning. 1st Edition, Morgan & Claypool Publishers, 2010.

Acquis / *Knowledge* :

Explain graph comparison methods
Use graph kernels to compare networks
Know the main network anomaly detection methods
Use reinforcement learning methods to solve networking problems

Evaluation / *Assessment* :

A serie of homeworks: 1/4 of the final note.
A project: 1/4 of the final note.

A final exam (without documents): 1/2 of the final note.
