Multi-Agent Reinforcement Learning and Big Data for Supply Chain Optimization

1. Context

Supply chain management (SCM) is a systematic approach to managing the distribution of goods from producers of raw materials, through manufacturers and eventually down to end users. In recent years, the amount of data produced by the end-to-end supply chain has increased exponentially. Indeed, this huge data is a significant opportunity to collect rich information to optimize their activities. By analyzing all the hidden relationships among the hugely collected data, the Artificial Intelligence (AI) algorithms and the Big data techniques can result in an abundance of supply chain process improvement.

2. Objectives

This project aims at developing several AI algorithms to deal with some important problems in SCM. Specifically, we will focus on the following objectives:

Firstly, **supply chain monitoring** to identify and fix problems in real-time is an important problem in digitized supply chain management. The traditional methods like statistical process monitoring (SPM) are no longer suitable for real-time data are becoming more popular in a *digital supply chain* thanks to the Internet of Things (IoT) technologies. Instead, the advanced models to monitor the data in real-time is then required. We will use advanced deep learning algorithms such as long short-term memory (LSTM) and recurrent neural network (RNN), combined with anomaly detection methods to monitor the Supply Chain.

Secondly, **supply chain planning and scheduling** is the process of thinking about and organizing the activities to get the right product, on-time, in quality, to the right place, and to the lowest cost to satisfy the customer requirement. Real-time planning and scheduling in the SCM context are the process of organizing all activities around gathering data without time delays, analyzing it and taking fact-based real-time decisions. Therefore, in this context, we aim to propose a **new multi-agent reinforcement learning** (MARL) and leverage the power of **deep neural networks** approach for scheduling problems dealing with multiple objectives.

Finally, the traditional methods for **inventory management** are usually based on mathematical models with constant assumptions about customers' demand or lead time. For example, in the well-known economic order quantity method, demand for a product is assumed to be constant over the year and each new order is delivered in full when inventory reaches zero. These assumptions might not be true in practice as customers' demand often change over time and the lead time should depend on the supply ability of each company and market demand. This makes the classical models no longer efficient. In this context, we will propose a **new multi-agent reinforcement learning** (as discussed above) for application in the real-time inventory control system. This is the more advanced artificial intelligence approach that involves a model taking serious control of the inventory operations, with human checks and balances. We will also develop new methods for automated inventory monitoring using deep LSTM, kernel density estimation and exponentially weighted moving average (EWMA) control chart.

Data for this subject will be provided by a company in the field SCM in France and/or Belgium.

3. Location/Lab/Collaboration context

A France-Belgium joint PhD project (co-supervised) will be submitted to I-SITE ULNE. The candidate will be based mainly in Human Centered Design (HCD) team, the GEMTEX research laboratory belongs to ENSAIT, French Grande Ecole in Roubaix, France and be supervised by Prof. Kim Phuc TRAN. The candidate will be registered at both the French and the Belgium institutions as a PhD student, and must spend at least one year at the Ghent University in the UK during her/his PhD study. From the Belgium side the candidate will be supervised by Prof El-Houssaine Aghezzaf who is heading the Department of Industrial Systems Engineering and Product Design (ISyE-PD) and leading its research group Industrial Systems Optimization and Control (ISyOC).

4. Requirements

Applicants should hold a master's degree or equivalent (minimum of 5 years of post-secondary education) in Computer Science, Automation or a closely related area. Candidates should have an excellent background in computer science/engineering and the ability to work on inter-disciplinary research project. Acquaintance with machine learning as well as programming skills in Python will be considered as strong assets. The working language in the group is English. Applicants must have English language levels equivalent to IELTS 6.5 or higher to successfully apply the application requires. If you are interested please send CV, a one-page cover letter describing the applicant's relevant research skills, a copy of passport (if not a French citizen), a copy of all university degree certificates, a copy of transcript during at least the last 3 years of university studies, a description of the degree programme and courses taken for studies completed outside of France via e-mail under reference MARLBFSCO to kim-phuc.tran@ensait.fr and latest by 1 May 2019. The successful candidate is expected to start her/his study in October 2019.