

Research work proposed for a PhD (China Scholarship Council)

Title : Deep Learning Holonic mechanism for decentralized learning

Supervisor's name : HILAIRE Vincent, full professor
Laboratoire Connaissance et Intelligence Artificielle Distribuées
Université de Technologie de Belfort Montbéliard
13, rue Thierry Mieg - FR-90010 Belfort Tél. : +33(0) 3 84 58 30 09
vincent.hilaire@utbm.fr
<http://www.ciad-lab.fr/author-10835/>

Context and thesis topic :

Machine Learning (ML) is a well-known branch of Artificial Intelligence that has got recently remarkable results and that is increasingly becoming relevant for a wide range of applications in every day life such as smart grids, smart homes, autonomous navigation, medicine, etc. This recent growth has been led by the explosion of data, applications, new services and challenges. Among ML mechanisms Deep Learning seems to be one of the most promising in terms of results and efficiency.

However, for many problems the decentralized structure underlying the problem asks for a change in ML traditional mechanism, even the Deep Learning technique. Decentralized deep learning is a possible solution for this kind of problems. The goal of this PhD is to study the use of holarchies which are a paradigm for defining the architecture of decentralized and dynamic complex systems.

Holarchies are a kind of hierarchical structure composed of holons. An holon is a self-similar structure composed of holons. Using holarchies one can represent technical or organizational systems at different levels that are existing simultaneously and can follow the achievement of different goals at different timescales. Holarchies have already been used to define a self-organizing technique for software systems.

The main goal of the PhD thesis is to study and deploy a Deep Learning technique using holarchies in order for decomposing the learning process in order to gain efficiency and better adaptation to specific situations such as self-organizing systems and individual profiling. Candidate deployment for such a technique could be: management of smart homes with heterogeneous users or individual users profiling.

Publications related to the subject :

Pournaras, E., Yadhunathan, S. & Diaconescu, A. Holarchic structures for decentralized deep learning: a performance analysis. *Cluster Comput* **23**, 219–240 (2020). <https://doi-org.ezproxy.utbm.fr/10.1007/s10586-019-02906-4>

Esmaeili, Ahmad & Gallagher, John & Springer, John & Matson, Eric. (2020). HAMLET: A Hierarchical Agent-based Machine Learning Platform.

Gillian Basso, Massimo Cossentino, Vincent Hilaire, Fabrice Lauri, Sebastian Rodriguez, Valeria Seidita: Engineering multi-agent systems using feedback loops and holarchies. *Eng. Appl. Artif. Intell.* 55: 14-25 (2016)

Massimo Cossentino, Vincent Hilaire, Nicolas Gaud, Stéphane Galland, Abderrafiaa Koukam: The ASPECS Process. *Handbook on Agent-Oriented Design Processes 2014*: 65-114

Vincent Hilaire, Abderrafiaa Koukam and Sebastian Rodriguez. An Adaptative Agent Architecture for Holonic Multi-Agent Systems. In *ACM Transactions on Autonomous and Adaptive Systems*, vol. 3, pp. 1-24, 2008.