

- ▶ **Title** : Sustainability and explainability through learning on large knowledge graphs
- ▶ **Supervisors** : Antoine Zimmermann (Prof), Victor Charpenay (MC)
- ▶ **Summary** : **Large Language Models** (LLMs), characterized by a large number of parameters and/or a large number of symbols in their training corpus, have become a reference in the development of AI systems. Yet, their use implies a **significant energy consumption**, both during training and inference, and a **lack of transparency** about decisions made by the system. The goal of the thesis will be to show that Knowledge Graphs (KGs), such as **DBpedia, BabelNet or ConceptNet** can be a solution to both problems. They have already been used e.g. for question answering tasks—like LLMs—but KGs are known to be incomplete, especially on “naive physics” (which includes spatial-temporal reasoning). Incompleteness of large KGs can however be compensated by learning **vector embeddings of the main concept of a KG** (its foundational ontology), whose geometric properties can be semantically interpreted. The thesis will consist in characterizing the relationship between performances of a KG embedding model and its computational cost—empirical laws do exist for LLMs—and in analyzing the correspondance between its geometric properties and the semantic properties of the KG.

Expected Results

- ▶ **Field of research** : Knowledge representation and reasoning
- ▶ **Keywords** : Knowledge graph, embedding, foundational ontology, neuro-symbolic integration
- ▶ **Expected results and outcomes** : Low-computational-cost method to learn vector embeddings of concepts (evaluated on the GLUE benchmark); pre-trained model for querying against a foundational ontology derived from DBpedia (or similar KGs); refinement of the model in a spatial-temporal reasoning task on a KG describing a Cyber-Physical System (connected building, automated manufacturing line or transportation network).
- ▶ **Sustainable development goals** : 12 – Responsible consumption and production, 8 – Decent work and economic growth.

