RWTH AACHEN UNIVERSITY

E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Masters Thesis Proposal

Data and Ontology Model Definition in Energy Systems using Deep Reinforcement Learning

Background & Motivation:

Physics-based models and data-driven models are at a cross road as we head into the energy transition era. Power Systems are getting more complex with energy mix, and information & communication technology pushing into the frontiers of multi-domain systems making it pertinent to have a common knowledge base with knowledge representation for a holistic decision-making across divers Artificial Intelligence (AI) on demand applications. This will create an enabling environment for Digital Twins and Knowledge Representation and Reasoning (KRR) systems to thrive together and possibly for power and energy systems to pass the Turing Test.

This thesis topic considers a data interoperability problem for multi-domain systems with diverse vendor devices and diverse sets of information nomenclatures for asset naming, including their attributes, properties and relationship as well as symbolic and numerical measurements from IoT devices. Data and ontology model definition using Markov Decision Process (MDP) model to obtain an optimal data modeling policy is considered. We will first try to formulate a data modeling definition for multi-domain energy asset interoperability as a Markov Decision Problem (MDP) and then see how to parametrize the Quality function to obtain future rewards, as a greedy algorithm, while we try also to reduce the temporal difference error as the loss function the network is trying to minimize. Therefore, we will try to optimize the data and ontology model policy using the value based information. The work of [1] [2] and [3] opens up opportunity for such possibility.

Task:

- Literature review on semantic web with JSON, XML, RDF and OWL data formats
- Litertaure review on Optimization of multi-objective functions using Markov's Process
- Familiarization of modern optimization principles using Adaptive Dynamic Programming
- Review of existing validators for Data model and Ontology definition.
- Build Regex, DM and NLP Python scripts for Read/Write transactions with the DBMS
- Development of a reward function for the state space and action space policy iteration
- Familiarization with Fiware Orion Broker Core architecture and implementations
- Implementation of a service-based common data model component in the Data Layer

Prerequisite:

- Student of Electrical Engineering or Information Technology at RWTH Aachen University
- Disruptive mindset with passion and motivation for trying out new technologies (Beneficial)
- Excellent soft skills with ability to work with less supervision (Beneficial)
- Web development skills with Node.JS and/or Python
- Ability to work with SQL and NoSQL DBMS
- Fundamental knowledge of power and energy systems

Figure:

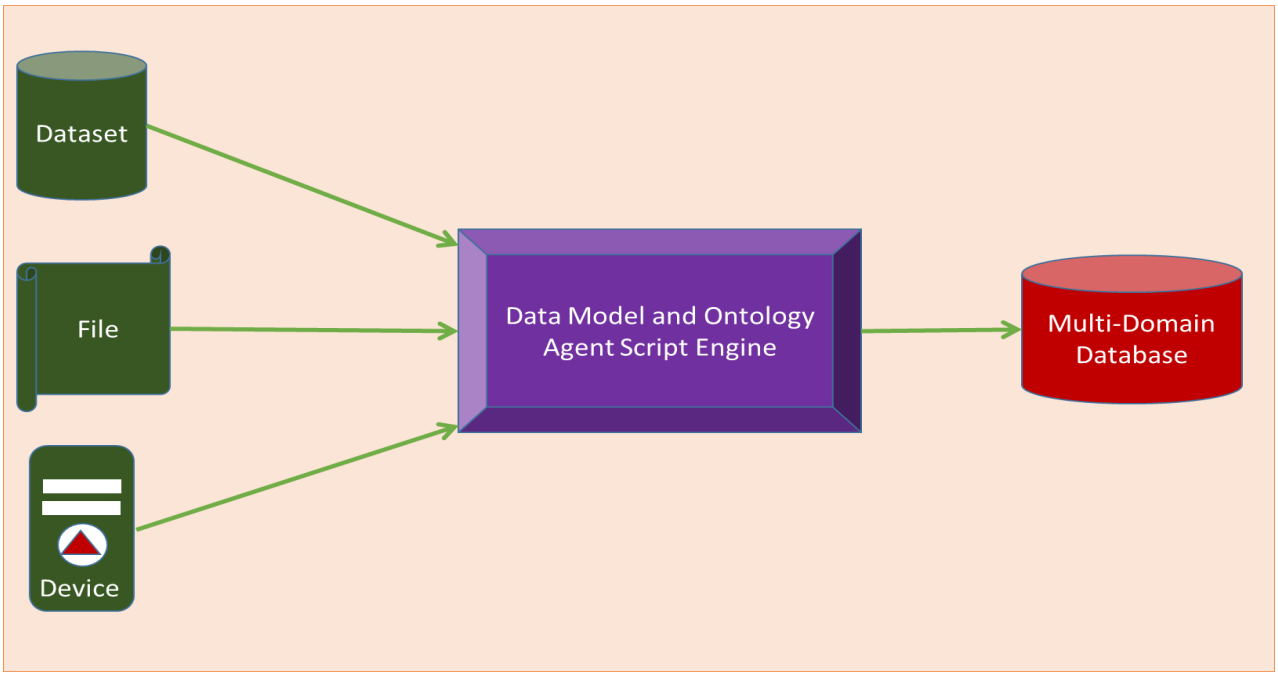

Figure 1: Conceptual Diagram of Common Data Model & Ontology Automation Architecture

Notes:

Supervision and Thesis will be done in English.

References:

[1] P. Marbach and J. N. Tsitsiklis, 'Simulation-based optimization of Markov reward processes', in *Proceedings of the 37th IEEE Conference on Decision and Control (Cat. No.98CH36171)*, Dec. 1998, vol. 3, pp. 2698–2703 vol.3. doi: 10.1109/CDC.1998.757861.

[2] G. D'Aniello, M. Gaeta, V. Loia, F. Orciuoli, and S. Tomasiello, 'A Dialogue-Based Approach Enhanced with Situation Awareness and Reinforcement Learning for Ubiquitous Access to Linked Data', in *2014 International Conference on Intelligent Networking and Collaborative Systems*, Sep. 2014, pp. 249–256. doi: 10.1109/INCoS.2014.73.

[3] A. Mooman, O. Basir, and A. Younes, 'An intelligent model to construct specialized domain ontologies', in *2010 3rd International Conference on Computer Science and Information Technology*, Jul. 2010, vol. 5, pp. 696–702. doi: 10.1109/ICCSIT.2010.5564016.

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