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Master internship offer at L2S within the RTE Chair

Title :	Modelling and learning of behavior of large dynamical graphs
Place :	Laboratoire des Signaux et Systèmes (L2S), Gif-sur-Yvette (Paris suburbia)
Duration :	5 months to 7 months (in 2018)
Supervisor :	Antoine GIRARD - Collaboration with Michel KIEFFER and Samson LASAULCE.
Net salary :	920 E / month
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Description

The proposed project is sponsored by RTE which is the French transmission operator (TSO). The outcomes of the internship intend to be used as strong insights into the design of modern and smart electricity transmission networks.

The main tools that will be exploited are learning, dynamical systems, and graph theory. Technically, the proposed project aims at proposing a framework for modelling and learning the temporal behavior of large dynamical graphs from real data provided by RTE. We will model dynamical graphs as discrete dynamical systems where the set of states consists of all possible graph configurations and transitions between two states occur by adding or removing graph edges. We will consider the problem of learning a set of transition rules from data representing the evolution of the graph over a time period. Clearly, this can be seen as a problem of learning a discrete dynamical system from samples of its behavior [1].

The problem under consideration in the current study presents two challenging specificities:
1. We consider graphs with (tens of) thousands of edges. Thus, the set of graph configurations is huge. The standard learning algorithm for discrete dynamic system scales badly though several promising techniques have been proposed to tackle this issue (see e.g., [2,3]). Moreover, in our setting, the set of states has some underlying structure inherited from the underlying graphs. This structure can be exploited to split our learning problem into smaller problems of learning local transition rules, such as those expressed using graph grammars (see e.g. ,[4]).
2. The set of transition rules itself may evolve over a long-time period. Then, one must propose an adaptive (or online) learning scheme being able to update the learned model at runtime [5].

Finally, the proposed learning approach will be incorporated in a monitoring algorithm for detecting anomalous behaviours of the dynamic graph (see e.g. [6]).

List of references

[1] Biermann, Alan W., and Jerome A. Feldman. "On the synthesis of finite-state machines from samples of their behavior." IEEE Transactions on Computers 100.6 (1972): 592-597.

[2] Hungar, Hardi, Oliver Niese, and Bernhard Steffen. "Domain-specific optimization in automata learning." CAV. Vol. 3. 2003.

[3] Maler, Oded, and Irini-Eleftheria Mens. "Learning Regular Languages over Large Ordered Alphabets." Logical Methods in Computer Science 11 (2015).

[4] Doshi, S., Fang Huang, and Tim Oates. "Inferring the structure of graph grammars from data." Proceedings of the International Conference on Knowledge-Based Computer Systems. 2002.

[5] Maier, Alexander. "Online passive learning of timed automata for cyber-physical production systems." Industrial Informatics (INDIN), 2014 12th IEEE International Conference on. IEEE, 2014.

[6] Roth, Matthias, et al. "Fault detection and isolation in manufacturing systems with an identified discrete event model." International Journal of Systems Science 43.10 (2012): 1826-1841.