PhD Proposal:

Distributed Optimal Planning for Large Distributed Systems

Location : Main location: IRISA, Rennes (35), DistribCom team
Secondary location : NICTA & the Australian National University, Canberra, DPO group

Topic : A new generation of large distributed systems is being developed which covers a wide variety of devices or softwares obtained by assembling large numbers of components. These include systems on chips, telecom and computer networks, energy distribution systems, grid and web services, to name but a few. The success of this new generation of systems will be largely determined by the existence of adequate supervision tools, that enable self-monitoring, diagnosis, control, and reconfiguration to achieve optimal system performance. Due to their size and complexity, one cannot hope to supervise such systems in a centralized manner. The right paradigm to deal with them is to work at the scale of a component, and to coordinate the work of the local supervisors. This distributed supervision approach takes advantage of the sparse interactions between components, is easy to upgrade and scales up well when the system evolves.

The thesis will focus on planning for such systems, which is the problem of optimally choosing and organising tasks to reach a control or reconfiguration objective. Scaling up planning to large distributed systems is an important challenge, and industry is eager of a breakthrough in that field.

The thesis topic aims at the cross-fertilisation between two disciplines, namely formal methods in computer science and artificial intelligence, with a view to a substantial advance in adressing this challenge. Specifically, the DistribCom team at IRISA has developed an algebraic approach to distributed monitoring. It is based on the notion of unfolding, which represents all runs of a dynamic system in a compact manner and exploits the concurrency of events in the system. A key result is the factorization property of unfoldings, that allows to process systems by parts. Following initial work by the DPO group at ANU on combining unfolding with heuristic search for planning, the thesis will explore the use of unfoldings, and their factorization properties, in order to design planning systems that operate by parts and assemble their local results, just like distributed monitoring algorithms.

This thesis will be hosted by the DistribCom team in Rennes, but will be performed in collaboration with NICTA and the Australian National University in Canberra, which will assume several stays there.

Ideal profile : Master in computer science or mathematics, with good programming skills. Backgrounds in distributed algorithms, optimization, constraint solvers will be appreciated.

Contacts :

- Eric Fabre, Eric.Fabre@irisa.fr, +33 (0)2 99 84 73 26
  http://www.irisa.fr/distribcom/Personal_Pages/fabre/fabre.html
- Sylvie Thiébaux, Sylvie.Thiebaux@anu.edu.au, +61 2 6125 8678
  http://users.rsise.anu.edu.au/∼thiebaux/

Bibliography :

- A. Benveniste, E. Fabre, S. Haar, C. Jard, **Diagnosis of asynchronous discrete event systems, a net unfolding approach,** IEEE Trans. on Automatic Control, vol. 48, no. 5, pp. 714-727, May 2003.
- E. Fabre, **Distributed diagnosis based on trellis processes,** in proceedings of Conf. on Decision and Control, Sevilla, Dec. 2005, pp. 6329-6334.
- E. Fabre, A. Benveniste, S. Haar, C. Jard, **Distributed Monitoring of Concurrent and Asynchronous Systems**, Journal of Discrete Event Systems, special issue, vol. 15 no. 1, pp. 33-84, March 2005.
- S. Hickmott, J. Rintanen, S. Thibaux, L. White. **Planning via Petri Net Unfolding,** 20th International Joint Conference on Artificial Intelligence (IJCAI-07).
- I. Little, S. Thibaux. **Concurrent Probabilistic Planning in the Graphplan Framework,** 16th International Conference on Automated Planning and Scheduling (ICAPS-06), AAAI Press, Cumbria (UK), June 2006.