

ERCIM “Alain Bensoussan” Fellowship Scientific Report

Fellow: Anthony Harrington
Visited Location : PLERCIM University of Warsaw Poland
Duration of Visit: 1 Year
Scientific coordinator: Prof. Wojciech Niemiro

I - Scientific activity

During my Ercim fellowship at PLERCIM I worked under the supervision of Prof Wojciech Niemiro in the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw. I regularly attended three seminar groups :

Applied Statistics organised by Wojciech Niemiro and Przemyslaw Biecek.

BioInformatics organised by Jerzy Tiuryn.

Biomathematics and Game theory organised by Jacek Miekisz.

During the fellowship I worked in the area of planning and optimisation for pervasive computing environments. Pervasive computing environments are regions of the real world that have been augmented with sensor and actuator devices. The integration of computing devices and physical spaces provides an opportunity for intelligently managing activities in a range of areas from optimising transport systems to driving efficiencies in power grid management, and environmental monitoring, etc.

Previously my work has focused on integrating planning and optimisation algorithms into a model driven development process to be used to develop applications executing over a sensor and actuator infrastructure. This work was published at IEEE Percom in March 2011. Subsequently I investigated additional evaluation scenarios for the programming model and an extended version of this paper was published in the Elsevier Journal of Pervasive and Mobile Computing in December 2011.

In the past year I investigated techniques for managing the uncertainty in state observations inferred from sensor data. In particular I investigated Covariance Intersection algorithms to reduce the impact of redundant sensor data on state inference.

I also investigated optimisation algorithms in dynamic environments in the context of demand responsive public transport systems. This work is ongoing and I am preparing a publication for Spring 2012 in the area of Intelligent Transport Systems.

Finally I am trying to devise a heuristic to estimate the « hardness » of a pervasive computing optimisation problem in relation to the uncertainty and dynamism in state determination and transition. The heuristic should provide a domain expert with an estimate of the convergence properties of a learning algorithm in a pervasive computing environment. If a successful heuristic can be identified, it could be added to the model driven engineering tool chain I am developing to aid the process of automatically selecting an appropriate planning and optimisation algorithm for a pervasive computing application.

II- Publication(s) during your fellowship

"Model Driven Engineering of Planning and Optimisation Algorithms for Pervasive Computing Environments", Anthony Harrington and Vinny Cahill, In Proceedings of the 9th International Conference on Pervasive Computing and Communications (IEEE PerCom), March, 2011

Abstract—This paper presents a model-driven approach to developing pervasive computing applications that exploits design-time information to support the engineering of planning and

optimisation algorithms that reflect the presence of uncertainty, dynamism and complexity in the application domain. In particular the task of generating code to implement planning and optimisation algorithms in pervasive computing domains is addressed.

We present a layered domain model containing a set of object-oriented specifications for modelling physical and sensor/actuator infrastructure and state-space information. Our model-driven engineering approach is implemented in two transformation algorithms. The initial transformation parses the domain model and generates a planning model for the application being developed that encodes an application's states, actions and rewards. The second transformation parses the planning model and selects and seeds a planning or optimisation algorithm for use in the application.

We present an empirical evaluation of the impact of our approach on the development effort associated with a pervasive computing application from the Intelligent Transportation Systems (ITS) domain, and provide a quantitative evaluation of the performance of the algorithms generated by the transformations.

"Model Driven Engineering of Planning and Optimisation Algorithms for Pervasive Computing Environments", A. Harrington and V. Cahill, Elsevier Pervasive and Mobile Computing. Volume 7, Issue 6, Pages 641-760 (December 2011)

This is an extended version of the conference paper above that was submitted and accepted for the Elsevier Journal on Pervasive and Mobile Computing.

III -Attended Seminars, Workshops, and Conferences

Percom 2011 11th IEEE Conference on Pervasive Computing and Communications
March 21st -25th 2011, Seattle, USA

ACAI Summer School on Automated Planning and Scheduling
June 7th to June 10th 2011, Freiburg, Germany

ICAPS Workshops at the 21st International Conference on Automated Planning and Scheduling
June 12th -13th. Freiburg Germany

IV – Research Exchange Programme (12 month scheme)

INRIA Rocquencourt Paris France 6th -12th /11/11

I visited the ARLES research team on Software architectures and Distributed Systems led by Valérie Issarny. I presented a seminar on my work and there were a number of mutual areas of interest between my research and the work carried out by the ARLES team. During the week I had a series of meetings with team members relating to uncertainty handling, run-time adaptation in dynamic environments and evaluation metrics for model driven engineering programming models. I identified possible opportunities for future collaboration.

SINTEF ICT Oslo Norway 17th -25th /11/11

I visited the SINTEF ICT research lab and worked with Geir Horn, a senior scientist at SINTEF. We worked on a dynamic pervasive computing optimisation problem in the domain of Intelligent Transportation Systems. We also did some preliminary work on identifying a heuristic for the difficulty of a learning problem in a pervasive computing application. We have identified a number of possible publications for this work and are continuing to cooperate on this agenda.