

SICSA DVF Dr Leïla Kloul, University of Versailles, France

Dr Juliana Bowles, University of St Andrews

Dr Leïla Kloul visited the School of Computer Science, University of St Andrews as a SICSA distinguished visiting fellow from Wednesday 14th October 2009 to Friday 13th November 2009 and again from Wednesday 2nd December to Friday 11th December 2009.

The general purpose of the visit, and more concretely for St Andrews, was to investigate reliable techniques for performance engineering of distributed systems focusing specifically on distributed mobile applications. We wanted to strengthen an existing collaboration by Bowles and Kloul (demonstrated by ACSD 2006 and WOSP 2010 papers) to investigate how the structure of high-level formalisms used for performance evaluation (e.g., PEPA nets) can be exploited to enhance verification and scalability when the intention is to prove performance related properties over large-scale distributed models. This research included at the first instance the development of a stochastic logic rich enough to capture mobility, location awareness and local behaviour. This logic could then be used to formulate properties over high-level formalisms such as PEPA nets (but not only). Starting points for such a logic were the distributed logics developed by Bowles (St Andrews) and more recent stochastic approaches such as MOSL+, a temporal mobile stochastic logic developed by researchers in Germany and Italy. Apart from MOSL there are no existing logics that combine both stochastic and mobile behaviour which highlights the timeliness of the research. The approach taken by Bowles and Kloul is different from the approach behind MOSL, as we want to preserve the structure also in the underlying Continuous Time Markov Chain and use that in future work to exploit a more scalable approach for verification through model checking. The logic developed by Bowles and Kloul as part of this visit is a two-level stochastic logic interpreted over state and action-labelled Markov Chains. The higher level *net logic* captures the net properties including mobility and location awareness. The lower level *place logic* is used to describe individual properties of the places in the net. Various stochastic but non-mobile logics have been influential the most relevant being asCSL. Bowles and Kloul are currently writing a paper on the logic to be submitted to a conference in January/February 2010.

The topic of the visit was centrally positioned within SICSA's Modelling and Abstraction theme. No specific ModAbs events were held during the time period of Kloul's visit. There are also relationships with the Complex System Engineering theme, and contacts within this theme were established with Professor Bhatti as described below.

One of the main purposes of this visit was to encourage further and new research collaborations between Scotland and the University of Versailles. Three main new collaborations were established:

1. with the University of Stirling (Dr C. Shankland and Mr S. Benkirane). Three mutual visits led to consider a new domain in Epidemiology and use:
 - functional rates (work developed by Kloul and others) in PEPA to improve the PEPA model of the behaviour of prairie dogs in a single burrow (a case study currently under study in Stirling), and how bubonic plague is transmitted (either by direct contact with infected animals, indirect contact via dead bodies or faeces, or carried by infected fleas).
 - high-level performance formalisms that take into account spatial information as a way to better describe the behaviour of spatially distributed colonies of prairie dogs and be able to formulate properties over such a case study using Bowles and Kloul's stochastic mobile logic. Properties can include the most likely cause of transmission

of the disease amongst prairie dogs from one infected burrow to another, the time it takes to spread, and so on.

Due to the success of this newly established collaboration, there are now plans for Stirling researchers to visit Kloul at the University of Versailles in early 2010.

2. with the University of Edinburgh (Dr K. Etessami). Two mutual visits looked into analysing how different notions of *state lumpability* on a continuous time Markov chain (derived for example from a PEPA net) could be potentially beneficial for improving the efficiency of algorithms for formal verification of stochastic properties over such models. As this is a very challenging problem it is less clear at present how and whether this can be achieved, and will more likely be a topic for further future research and visits.
3. with the University of St Andrews (Professor S. Bhatti, leader of the SICSA CSE theme). Two meetings were held which addressed issues such as:
 - (a) how techniques used by Prof. Bhatti in order to analyse Self-Reported Social Networks (SRSN) and Detected Social Networks (DSN), in terms of role equivalence, structure equivalence or between centrality, can be used in order to profile mobile wireless network customers given their past mobility traces. Such a profiling allows us to classify mobile users' behaviours and thus build robust and reliable mobility prediction algorithms for mobile wireless networks. Predicting the next move of a mobile user allows for better resource management of a mobile wireless network.
 - (b) how formal techniques such as the stochastic process algebra PEPA used by Kloul can be used in a new context in order to formally analyse and compare the performances of previous topologies (SRSN and DSN) such as transmission delays of a message to a targeted node of the network. The benefits of using performance analysis approaches such as PEPA lie in the formality of the approach, the reliability of the performance results obtained, as well as the time gained since these approaches are not time consuming, unlike the measurement techniques used in St Andrews.

After initial discussions, Kloul and Bhatti are planning to start more concrete work in January 2010 whilst Bhatti is on research leave.

Beyond the visits and interactions described above, one of the intentions of Kloul's visit was to enable additional interactions with Professor Hillston and Dr Gilmore from Edinburgh. Contacts in September by email, however, made it clear that Professor Hillston had little time between October and Christmas and other priorities than PEPA nets. No formal work meetings were therefore arranged.

Kloul gave a three hour lecture on stochastic modelling and performance evaluation techniques open to all SICSA PhD students and MSc Advance Computer Science students in St Andrews on the 29th October 2009.

Kloul presented her research at a seminar open to all SICSA partners on Friday 11th December 2009. Due to unexpected circumstances Kloul had to leave for France for approximately two weeks during her visit, and hence had to cancel a talk that was planned in the PEPA club in Edinburgh at the end of November.

Finally, a meeting with Professor Lane from the French Embassy in St Andrews on the 4th November 2009 led to an interesting prospect of raising funds and hence making it feasible to have a shared PhD student between St Andrews (supervised by Bowles) and Versailles (supervised by Kloul).