Internship subjects

Title: **Mathematical and computational analysis of genetic regulatory networks**
Contact: Gouze Jean-Luc, COMORE
Subject Description:
The aim is to develop mathematical and computational methods, supported by computer tools, for analyzing the dynamics of genetic regulatory networks.
The role of the intern will be to study the dynamic behavior of piecewise-linear (PL) systems used for modeling genetic regulatory networks. He or she continues the work previously done by characterizing the equilibrium points and limit cycles of PL systems as well as their stability. Based on these mathematical results, computational methods for the analysis of genetic regulatory networks will be developed. The methods will be implemented and applied in the study of the networks underlying the global regulation of transcription in the bacteria Escherichia coli and Synechocystis. We will also use methods of hybrid systems theory, and control theory.
see http://www.inrialpes.fr/helix/people/dejong/projects/aci03/bacattract-eng.html
Prerequisites :
applied mathematician with some background in computer algorithms and familiar with the analysis of dynamical systems. In addition, we expect a strong motivation to work on applications in genomics.

Title: Overlay formation games
Contact: Giovanni Neglia - MAESTRO
Subject description :
Network formation games [Jackson04] are a new branch of game theory, which investigates players having economic interactions with their neighbours in a network, as for example human beings interacting with their friends or their collegues.
In such games players usually have some discretion to connect each other; hence the network structure both influences the result of the economic interactions and is shaped by the decisions of the players.
The recent research tries to address the following questions:
1) how is the network structure important in determining the outcome of economic interaction?
2) Is it possible to predict which networks are likely to form when individuals have the discretion to choose their connections?
3) How efficient are the networks that form, i.e. how is the global payoff of such networks in comparison to that of some socially optimal network (if any)?
While the game theory community mainly focuses on economic interactions among men or companies, the framework seems to be promising to investigate some important issues in computer networks. In particular there is a strong trend in computer networks to provide services through overlays -virtual networks of nodes and logical links built on top of the existing network communication infrastructure.
Overlays often relies on a peer-to-peer paradigm: the nodes constituting the network at the same time use the service and contribute to provide the service. An example is the Resilient Overlay Network [Andersen01] which is an architecture that allows distributed Internet applications to detect and recover from path outages and periods of degraded performance.
It is reasonable to assume that nodes can have interest to act selfishly, for example trying to exploit the service provided by the overlay without contributing to it (this phenomenon is commonly referred to as free-riding).

We have already obtained some results about the interactions of peers in BitTorrent filesharing system [Zhang07].
The purpose of the internship is to extend this research, but at the same time to consider the case where the underlying network topology limits the possible
interactions among players, as it happens in the case of a wireless network, where the set of neighbours of each node is constrained by its transmission range,
and hence by its available power.
>From the methodological point of view the research will try to investigate the problem both by analysis and by simulations. For this reason the candidate is
required to have good mathematical and programming skills.
References
[Andersen01] "Resilient Overlay Networks",
David Andersen, Hari Balakrishnan, Frans Kaashoek, and Robert Morris - In Proc. 18th ACM Symposium on Operating Systems Principles (SOSP), (Banff, Canada), Oct. 2001, pp. 131-145.
[Jackson04] "A survey of models of network formation: Stability and efficiency," Matthew O. Jackson, in Group Formation in Economics: Networks, Clubs and Coalitions, New York Cambridge University Press, 2004
[Zhang07] "On Unstructured File Sharing Networks", H. Zhang, G. Neglia, D. Towsley, G. Lo Presti, in Proc. 26th Annual IEEE Conference on Computer Communications (INFOCOM) 2007, May 2007, Anchorage, Alaska, USA IEEE

Title: **A Reconfiguration Language for Distributed Components**
Contact : Ludovic HENRIO - Marcela RIVERA - OASIS
Subject description:
General context
The OASIS team is highly involved in the design of a Grid Component Model (GCM), which consists in a Grid-oriented extension of the Fractal component model.
The OASIS team is developing a distributed implementation of Fractal (over ProActive -- a Java library for distributed computing), together with model checking tools adapted to those components
systems. ProActive/Fractal implementation merges the notions of active objects and Fractal components, yielding to a distributed component framework having a single thread for each component.
In general for component programming, but even more specifically in distributed and Grid environments, components need to be highly adaptive, a great part of adaptativeness relies on dynamic reconfiguration of component systems.
Fractal predefines basic controllers that should be present in most of Fractal components. We are interested here in binding, life-cycle, and content controllers (they allow to bind/unbind components, start/stop components, add/remove components inside another one). The primitives
proposed in Fractal are expressive enough for encoding any reconfiguration, but they are situated at a rather low-level. Reconfigurations and all other aspects defined by component controllers are called non-functional.
Objectives
This internship consists in designing a set of high-level reconfiguration primitives (at least higher level than in Fractal) allowing to achieve complex operations, but also to trigger such operations on specific events. This aspects consists in designing a set of such primitives (e.g., replace, add and bind, unbind and remove, duplicate, recursively add, ...) for reconfiguration ensuring more correctness properties than the Fractal ones,

and more autonomicity. By providing higher level of primitives, we want to help the programmer to design safe scenario. For example a replacement primitive seems safer and easier to verify than the equivalent sequence (stop+unbind+remove+add+bind+start) that would implements it in Fractal. The possible sub-objectives envisioned are the following:
* implement controllers for these primitives;
* verify/prove the correct behavior of the effect of these primitives to a system;
* apply model checking techniques to prove the correctness of the behavior of a given example, using the new reconfiguration primitives, and perhaps the synchronization features.

Title: An Eclipse editor for the Java Distributed Component Description Language
Contact: Antonio Cansado, Eric Madelaine, OASIS team
Subject description:
General context:
The Oasis team is working on:
* the design of programming paradigms, languages, and middlewares for distributed systems. The strong trends in these research areas are currently on component systems. Specifically, in the Grid area, we contribute to the development of the Grid Component Model (GCM), in the context of the CoreGrid European network of excellence, and it's implementation with the ProActive middleware.
* The specification of distributed component systems in term of a high-level specification language, expressing both the structural description of components and their behavior, expressed as protocols between their exposed services.
* A toolset named Vercors, for the specification and analysis of distributed component systems.
This platform includes tools for extracting the models of components from their specification or from their code, a graphical editor for UML-based specifications, and connections with state-of-the art model-checkers. This allows us to verify temporal properties of distributed components. Those properties are essentially about messages exchanged between active objects (requests and replies), including to some extend the identity of objects (but not their location) and the data values carried by the messages. Building behavioral models is also the basis for reasoning about the correction of assembly of components, about substitutability, and about correctness of reconfigurations.
Subject of the proposed work:
The goal of this internship is to develop a plugin for Eclipse to support a high-level specification language for distributed components. The language extends Java with architectural aspects of components, and constrains Java w.r.t. allowed communications with other components and allowed parallelism. The idea is to extend Eclipse's JDT so that the plugin inherits common Eclipse's features such as code highlighting, refactoring, and on-the-fly syntax verification. Depending on the advancement of the project, the student will then implement the model-generation functions required for the integration of the plugin within the Vercors platform.
The internship should attract students willing to experiment with Eclipse and with state-of-the-art programming models.
Planned duration: 5 months.

Title: Grid and Parallel SAT Solving Around the World
Contact: Denis Caromel, Eric Madelaine, OASIS team

Subject description:

General context

The OASIS team at INRIA Sophia Antipolis, together with ETSI (European Telecommunications Standards Institute) is organizing since 2004 the Grid Plugtests. See the 2007 IV GRID Plugtests page at http://www.etsi.org/plugtests/Upcoming/GRID2007/GRID2007.htm and the 2006 III GRID PLUGTESTS Report at http://www-sop.inria.fr/oasis/ProActive/userfiles/file/reports/III-GRID-Plugtests-Report-2006.pdf

The main goal of the Grid Plugtests is to gather many machines around the world, and to test interoperability on a very large scale deployment (over 4100 CPUs in the last event in 2007). Moreover, the test itself takes the form of a contest, where many teams are competing to execute a given program (e.g. NQueen, Flowshop). The Grid Plugtests uses the ProActive middleware for the sake of interoperability and large scale deployment (http://www-sop.inria.fr/oasis/ProActive/).

The propositional satisfiability problem (SAT: http://en.wikipedia.org/wiki/Boolean_satisfiability_problem) is becoming a prominent problem in both theoretical and applied computer science. SAT lies at the heart of the most important open problem in complexity theory and underlies many applications in, among other examples, artificial intelligence, operations research, electronic design engineering, as well as hardware and software property verification (model-checking). A full series of conferences are being specifically dedicated to the SAT problem (http://www.satisfiability.org/), and a journal (http://www.isa.ewi.tudelft.nl/Jsat/), but also, since 2002, a performance competition between the major academic and industrial SAT engine (http://www.satcompetition.org/).

Naturally, given the complexity (in both time and space) of the problem, it could be very interesting to change the classical mono-machine / sequential architecture used bu most of those engines, and to try novel approaches, using multi threaded or distributed framework and programming models to try to handle very large case-studies.

Indeed, in the recent years, some concurrent engines have appeared, e.g. Miraxt (http://www.satcompetition.org/2007/miraxt.pdf), or SAT4J (http://www.sat4j.org/) that now has a prototype (partial) implementation based on ProActive.

Subject of the proposed work:

In this context the student would have to take an active part in this event by developing a new use case in ProActive, namely a parallel and distributed ProActive SAT using the Sat4J library.

The overview of the work will be the following:

- Understand the setting of the Grid Plugtests
- Understand the ProActive distributed object library
- Study the Sat4J library
- Determine an appropriate Industrial SAT problem to be used as a benchmark
- Propose an architecture for parallelizing
- Write the ProActive Distributed SAT4J solver
- Execute benchmarks on machines located around the world (machines and accounts provided by the OASIS team)

A technical paper can be written and submitted to a conference at the end of the internship.

Following this internship, the student will have the possibility to participate to the next issues of Grid Plugtests (2008 in the French Riviera).