# Scientific Report

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## I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During the first period of my 12+12 ERCIM "Alain Besnsoussan" fellowship I visited the Centrum Wiskunde & Informatica in Amsterdam (Netherlands). Here, I had the chance to start collaborating with Prof. Farhad Arbab on three main different research lines.

First, we studied the composition and orchestration of Web Services (WSs) by using the Reo Coordination language as a formal and practical framework where to interface all the considered services in a single composed outcome. This study involved the automatic generation of code, by considering the behaviour of the services (represented as constraint automata), and by describing the desired coordination among them with Reo. The result of this generation process is a piece of Java code that can be run in order to coordinate real WSs deployed on different machines. The ability for a service to be naturally and repeatedly composable is fundamental to attaining several of the strategic goals of service-oriented computing. Reo consists in an ideal tool where to specify this interaction protocol, because of its formal basis and automated verification environment.

Secondly, we investigated the similarity-based discovery of WSs by considering "imprecise" behavioural-matching. In this case, it is possible to retrieve from a database even those services whose behaviour is similar, but not identical, to the one required in a user's query. All the results are ranked according to their similarity score w.r.t. the query, and additional results can be used when the "perfect matches" cannot be used, e.g., temporary failures. The final goal will be to integrate this kind of search and the composition of WSs (previously introduced) in the same automated tool.

At last, we turned our attention to Risk Analysis of services: we used a simulation language (i.e., Modelica) in order to describe a finance industry scenario with different services and different coordination schemes among them, for instance, replication of business-process-flow braches, or not. In this way, we are able to evaluate the disadvantages of different kinds of coordination in terms of their risk-evaluation results. We have recently submitted a paper as a first report on this activity, and we think this study can be widely extended along different lines: for example, we plan to study how Control Theory can be used to sensitively switch from one scheme of coordination to another, according to the current workload and in order to reduce monetary losses.

# II – PUBLICATION(S) DURING YOUR FELLOWSHIP

*"A Semiring-Based Framework for the Deduction/Abduction Reasoning in Access Control with Weighted Credentials", Stefano Bistarelli, Fabio Martinelli and Francesco Santini, to appear in Computer & Mathematics with Applications, Elsevier (2012).*

(Abstract) We present a variant of the Datalog language (we call it $Datalog^W$ ), which is able to deal with weights on ground facts. The weights are chosen from a semiring algebraic structure. Our goal is to use this language as a semantic foundation for trust-management languages, in order to express trust relation- ships associated with a preference (e.g., a cost, an uncertainty, a trust or a fuzzy value). We apply $Datalog^W$ as the basis to give a uniform semantics to a weighted extension of the RT language family, called $RT^W$. Moreover, we show that we can model the deduction and abduction reasoning with semiring-based soft constraints: deduction can validate or not the access request, while abduction can be used to compute the missing credentials if the access is denied and the level of preference that would grant the access.

*"Automatic Code Generation for the Orchestration of Web Services with Reo", Sung-Shik T.Q. Jongmans, Francesco Santini, Mahdi Sargolzaei, Farhad Arbab and Hamideh Afsarmanesh. European Conference on Service-Oriented and Cloud Computing, ESSOC 2012.*

(Abstract) We present a compositional construction of Web Services, using Reo and Constraint Automata as the main "glue" ingredients. Reo is a graphical and exogenous coordination language based on channels. We propose a framework that, taking as input the behavioral description of services (as Constraint Automata), their WSDL interfaces, and the description of their interaction in Reo, generates all the necessary Java code to orchestrate the services in practice. For each Web Service, we automatically generate a proxy that manages the communication between this service and the Reo circuit. Although we focus on Web Services, we can compose different kinds of service-oriented and component technologies at the same time (e.g., CORBA, RPC, WCF), by generating different proxies and connecting them to the same coordinator.

*"Preference and Similarity-based Behavioral Discovery of Services", Farhad Arbab and Francesco Santini, Web Services and Formal Methods, WS-FM 2012.*

We extend Constraint Automata by replacing boolean constraints with semiring-based soft constraints. The obtained general for- mal tool can be used to represent preference-

based and similarity-based queries, which allow a user more freedom in choosing the behavior of the service to finally use, among all possible choices. A user states his preferences through a "soft" query, and obtains results that satisfy this query with different levels of preference. The soft requirements may involve a parameter data of the service operations, or the (names of the) operations themselves. Moreover, we introduce a first implementation of the search procedure by using declarative (soft) Constraint Programming.

*"Securely Accessing Shared Resources with Concurrent Constraint Programming", Stefano Bistarelli and Francesco Santini, International Conference on Software Engineering and Formal Methods, SEFM 2012.*

(Abstract) We present a fine-grained security model to enforce the access control on the shared constraint store in Concurrent Constraint Programming (CCP) languages. We show the model for a nonmonotonic version of Soft CCP (SCCP), that is an extension of CCP where the constraints have a preference level associated with them. Crisp constraints can be mod- eled in the same framework as well. In the considered nonmonotonic soft version (NmSCCP), it is also possible to remove constraints from the store. The language can be used for coordinating agents on a common store of information that represents the set of shared resources. In such scenarios, it is clearly important to enforce the integrity and confidentiality rights on the resources, in order, for instance, to hide part of the information to some agents, or to prevent an agent to consume too many resources.

*"Solving Fuzzy Distributed CSPs: An Approach with Naming Games" Stefano Bistarelli, Giorgio Gosti, and Francesco Santini, Declarative Agent Languages and Technologies, DALT 2012.*

(Abstract) Constraint Satisfaction Problems (CSPs) are the formalization of a large range of problems that emerge from computer science. The solving methodology described here is based on the Naming Game (NG). The NG was introduced to represent N agents that have to bootstrap an agreement on a name to give to an object (i.e. a word). In this paper we focus on solving Fuzzy NGs and Fuzzy Distributed CSPs (Fuzzy DCSPs) with an algorithm for NGs: each word on which the agents have to agree on is associated with a preference represented as a fuzzy score. The solution is the agreed word associated with the highest preference value. The two main features that distinguish this methodology from Fuzzy DCSPs methods are that the system can react to small instance changes and it does not require pre-agreed agent/variable ordering.

*"Towards a Similarity-based Web Service Discovery through Soft Constraint Satisfaction Problems", Stefano Bistarelli, Farhad Arbab and Francesco Santini, Workshop on Semantic Search over the Web, SSW 2012.*

(Abstract) We focus on the discovery process of Web Services (WSs) by basing the search on the similarities among the service requirements and candidate search results, in or- der to cope with over-constrained queries or to find satisfactory alternatives for user requirements. This discovery process needs to involve the so-called Soft Constraint Satisfaction Problems (SCSPs). First we represent both WSs and the search query of the user as Rooted Trees, i.e., a particular form of Conceptual Graphs. Then, we find a

homomorphism between these two trees as a solution of an SCSP. The main contribution of this paper is the enhanced expressiveness offered by this "softness": in over-constrained scenarios, when a user query cannot be satisfied, classical crisp constraints (i.e., CSP) are not expressive enough to find "close" solutions to meet the users' needs.

*"Semiring-based Constraint Models and Frameworks for Security-related Scenarios", Stefano Bistarelli and Francesco Santini, Tutorial at Conference on Risks and Security of Internet and Systems, Crisis 2012. (Tutorial).*

*"ConArg: Argumentation with Constraints", Stefano Bistarelli and Francesco Santini, International Conference on Agreement Technologies, AT 2012. (Extended Abstract).*

*"Modeling and Simulation of Operational Risks in Finance Industry", Christoph Brandt, Francesco Santini, Natallia Kokash and Farhad Arbab, Workshop on Models and Simulations for Emergency and Risk Management, European Simulation and Modelling Conference 2012. (**submitted**).*

(Abstract) International banks need to estimate their operational risk due to external regulations. Based on their estimations they need to provide private capital to cover potential losses caused by these risks. Therefore, operational risks need to be properly measured and managed in or- der to reduce the required private capital. In this paper we discuss operational risk related to a typical banking business process that is enabled by an IT landscape. We present how risks related to the operational behavior of the IT landscape can be simulated. The simulation results help to estimate risk measures like the expected loss, the value-at-risk and the expected shortfall. We further sketch how control theory could be used to actively manage the dynamic reconfiguration of a service landscape in order to minimize operational risks. First experimental simulation results illustrate our approach.

# III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- International Conference on Principles and Practice of Constraint Programming, 12th-16th September 2011. (Member of the Organization Committee).
- International Conference on Tool with Artificial Intelligence, 7th-9th November 2011, Florida, USA. (Talk + poster presentation).
- International Conference on Autonomous Agents and Multi-agent Systems, AAMAS 2012, 4th-8th June, Valencia, Spain. (Talk).
- Invited talk at INRIA-Rocquencourt, Paris, title: "Similarity-based Web Service Discovery through Soft Constraint Satisfaction Problems".