

Part B

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MARIE SKŁODOWSKA–CURIE ACTIONS

Individual Fellowships (IF)
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PART B

“LoGICInMAS”

“Logics and Games for Imperfect Information in Multi-Agent Systems”

This proposal is to be evaluated as:

[Standard EF]

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List of Participants

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1 Excellence

1.1 Quality, innovative aspects and credibility of the research (including inter / multidisciplinary aspects)

- Introduction, state-of-the-art, objectives and overview of the action

Multi-agent systems (MAS) are systems composed of several autonomous entities that can interact with each other and aim at achieving private and/or common objectives. MAS typically include distributed and embedded systems, more and more present in our everyday lives. As an example, the concept of autonomous vehicles involves several layers of multi-agent systems. A single vehicle contains a number of sensors and computing units that can be seen as autonomous agents, composing a multi-agent system whose task is to maintain the vehicle safe and, if possible, take it to its destination. On the higher scale of smart cities, agents are vehicles themselves, that communicate with each other in order to remain aware of their respective positions and better avoid accidents, traffic jams, pollution and so on. Another example concerns natural or nuclear disasters, where human rescue teams are not sufficient or cannot be sent due to excessive hazards, and where teams containing robots with communication and strategizing abilities could be sent instead.

Multi-agent systems thus have a skyrocketing importance in our society, in particular in critical applications such as autonomous vehicles or rescue teams, where any possibility of failure should be discarded. Therefore, [the study of MAS through formal methods has recently thrived](#). Proof of this is the organisation in the recent years of high-quality international events aiming at bringing together the communities of formal methods and multi-agent systems. One example is the new international workshop Strategic Reasoning (SR), whose three first editions attracted acclaimed researchers from both communities, such as Moshe Vardi (who co-organised the two first editions), Thomas Henzinger, Wolfgang Thomas, Michael Wooldridge, Joe Halpern and Johan van Benthem. Another example is the Dagstuhl seminar VaToMAS (Verification and Testing of MAS), held in 2013 and organised by Alessio R. Lomuscio, Sophie Pinchinat and Holger Schlingloff. During this event, that gathered many influential researchers of both communities, was drawn a comprehensive picture of the current fundamental challenges for the formal analysis of MAS.

One of the outcomes of this seminar was that [we still lack a satisfying logical framework to model, specify and analyse MAS](#). One of the proposals most studied so far is Alternating-time Temporal Logic (ATL)¹, in which one can specify what objectives coalitions of agents can achieve. Several extensions were introduced (ATL*, game logics...), but all of these logics fail to model non-cooperative situations where agents follow individual objectives. As an example, consider a number of autonomous vehicles having to choose a path to reach their destination through a road network, each vehicle aiming at minimising its travel time. It is well known that [studying this kind of situation requires solution concepts from game theory, such as Nash equilibria](#)², that cannot be expressed in ATL or its extensions.

To address this shortcoming, Chatterjee, Henzinger and Piterman recently introduced Strategy Logic (SL)³. This logic subsumes all extensions of ATL, and because it considers strategies as first-order citizens in the language, it can express fundamental game-theoretic concepts such as Nash Equilibria or dominated strategies. SL has recently been extended and intensively studied by Murano (the supervisor of the action), Mogavero, Perelli, Sauro (who all worked with the supervisor in the host institution) and Vardi⁴⁵⁶. Relevant

¹R. Alur, T. A. Henzinger, and O. Kupferman, “Alternating-time temporal logic,” *J. ACM*, vol. 49, no. 5, pp. 672–713, 2002.

²J. Nash, “Non-cooperative games,” *Annals of mathematics*, pp. 286–295, 1951.

³K. Chatterjee, T. A. Henzinger, and N. Piterman, “Strategy Logic,” *Inf. Comput.*, vol. 208, no. 6, pp. 677–693, 2010.

⁴F. Mogavero, A. Murano, G. Perelli, and M. Y. Vardi, “Reasoning about strategies: on the model-checking problem,” *ACM Trans. Comput. Log.*, vol. 15, no. 4, 34:1–34:47, 2014.

⁵F. Mogavero, A. Murano, G. Perelli, and M. Y. Vardi, “What makes ATL* decidable? a decidable fragment of Strategy Logic,” in *CONCUR*, M. Koutny and I. Ulidowski, Eds., ser. LNCS, vol. 7454, Springer, 2012, pp. 193–208.

⁶F. Mogavero, A. Murano, and L. Sauro, “On the boundary of behavioral strategies,” in *LICS*, IEEE Computer Society, 2013, pp. 263–272.

fragments enjoying nice computational characteristics have been identified. In particular, the syntactic fragment SL[1G] (One-Goal Strategy Logic) is strictly more expressive than ATL* but not computationally more expensive⁷. [SL\[1G\] is therefore very likely to replace ATL and its extensions.](#)

However, despite its great expressiveness, [there is one fundamental feature of most real-life situations that SL lacks, which is imperfect information.](#) An agent has imperfect information if she does not know the exact state of the system at every moment, but only has access to an approximation of it. This situation arises, e.g. when some variables of a system are private, or when autonomous vehicles or robots have imperfect or damaged sensors. Considering [imperfect information in MAS raises two main theoretical issues.](#) The first one concerns strategizing under imperfect information. Indeed, in this context an agent’s strategy must prescribe the same choice in all situations that are indistinguishable to the agent. Such strategies are called *uniform strategies*, and it is well known since Reif’s seminal work⁸ that [this requirement makes computing winning strategies intrinsically much harder.](#) The second main theoretical challenge relates to uncertainty, deeply intertwined with imperfect information, and it consists in [representing and reasoning about agents’ knowledge and beliefs.](#) This is a vast domain in which various formalisms have been studied to represent knowledge and beliefs, their update or revision with new information, how to aggregate them or reason about them, etc⁹. However, in the formal methods community, people have for the moment mostly focused on knowledge, representing it with indistinguishability relations and the classic possible world semantics, first in static settings¹⁰ and later adding dynamics^{11,12}. All these logics have in common a *knowledge operator*, usually denoted K , with which one can express properties such as “Alice knows that the light is red”. In this project, we also intend to focus on knowledge, leaving the topic of beliefs for further research.

Versions of ATL with imperfect information and knowledge operators have been studied in the past few years. However, SL being on the brink of replacing ATL, [it is imperative to extend Strategy Logic in order to encompass imperfect information scenarios.](#) This is the ambitious purpose of this project. This endeavour has already started, with a few very recent works. One¹³ studies an extension of SL with knowledge operators, but it does not require the agents to strategize consistently with their knowledge. Another one¹⁴ considers an extension of SL with knowledge operators and uniform strategies, but where agents are assumed to have zero memory, which is an over-simplification of most realistic systems. We propose to:

1. extend Strategy Logic with knowledge operators and the notion of uniform strategies,
 2. methodically study the obtained logics for all observational and memory abilities considered in the literature (no memory, bounded memory, synchronous/asynchronous perfect recall. . .), and
 3. identify fragments that enjoy both good complexity and satisfying expressive power.
- Research methodology and approach

The first step will be to [formally define an extension of SL with all the features desired to realistically model strategizing under imperfect information and reasoning about knowledge](#) (Sophia Knight and I recently made a preliminary proposal¹⁵). We may define several different logics, due to subtleties in the semantics of the strategy operators and the knowledge operators. For instance, I have identified during my PhD that for the knowledge operator K , two different semantics can be found in the literature, even though the distinction is never made explicit. Informally, one semantics restricts what an agent considers possible

⁷Mogavero, Murano, Perelli, and Vardi, “What Makes ATL* Decidable? A Decidable Fragment of Strategy Logic,” see n. 5.

⁸J. H. Reif, “The complexity of two-player games of incomplete information,” *Journal of computer and system sciences*, vol. 29, no. 2, pp. 274–301, 1984.

⁹J. Y. Halpern, *Reasoning about uncertainty*. MIT press Cambridge, 2003, vol. 21.

¹⁰R. Fagin, J. Y. Halpern, Y. Moses, and M. Y. Vardi, *Reasoning about knowledge*. MIT press Cambridge, 1995, vol. 4.

¹¹J. Y. Halpern, R. van der Meyden, and M. Y. Vardi, “Complete Axiomatizations for Reasoning about Knowledge and Time,” *SIAM J. Comput.*, vol. 33, no. 3, pp. 674–703, 2004.

¹²J. van Benthem, *Logical dynamics of information and interaction*. Cambridge University Press, 2011.

¹³F. Belardinelli, “Reasoning about knowledge and strategies: epistemic strategy logic,” in *SR*, F. Mogavero, A. Murano, and M. Y. Vardi, Eds., ser. EPTCS, vol. 146, 2014, pp. 27–33.

¹⁴P. Cermák, A. Lomuscio, F. Mogavero, and A. Murano, “MCMAS-SLK: a model checker for the verification of Strategy Logic specifications,” in *CAV*, A. Biere and R. Bloem, Eds., ser. LNCS, vol. 8559, Springer, 2014, pp. 525–532.

¹⁵S. Knight and B. Maubert, “Dealing with imperfect information in strategy logic,” in *SR 2015*, 2015.

to situations consistent with what she knows of agents’ strategies, while the other does not. I proved that choosing one or the other semantics in a logic heavily impacts its complexity.

We will then start, for the obtained logics, [the study of the classic problems when designing new logics, which are the model checking problem and the satisfiability problem](#). Both will be undecidable for the most general setting, as the model checking problem for ATL with imperfect information (ATLii) and agents with perfect-recall is already undecidable, and so is the satisfiability problem for SL with perfect information. However, considering agents with bounded memory or hierarchical observations yields a decidable model-checking problem for ATLii, and the syntactic fragment SL[1G] has a decidable satisfiability problem. In a similar fashion, we will have to [identify syntactic fragments and/or reasonable assumptions on the agents’ observational and memory abilities for which our logics behave well](#). In these cases, we will have to study their expressivity, determine their exact computational complexity and devise optimal decision procedures.

- Originality and innovative aspects of the research programme

Because SL can express Nash equilibria, adding imperfect information will allow us to study Nash equilibria under imperfect information in a logical framework, [which has never been done as far as we know and may lead to new insights on their nature](#). Also, in my PhD, the existence of strategies was considered only at the level of decision problems: there was no strategy quantifier in the logic we considered. Therefore, the above-mentioned two semantics for the knowledge operator were essentially studied in the framework of a simple temporal epistemic logic. It will thus be [the first study on the differences between these semantics in a logic of strategies and knowledge](#). For instance, I believe that expressing within such a logic whether a strategy is uniform or not can be achieved with one of these semantics, but not the other one.

The third originality relates to Janin and Walukiewicz’ classic result on the expressive completeness of the μ -calculus with regards to the bisimulation invariant fragment of Monadic Second Order Logic (MSO), which is the yardstick of logics of programs on transition systems¹⁶. This result established the μ -calculus as the unifying logic of programs. But if we add imperfect information, Catalin Dima, Sophie Pinchinat and I very recently proved that when we consider agents with perfect recall, this result no longer holds: indeed, we showed that the existence of winning strategies in games with imperfect information, though expressible in the bisimulation invariant fragment of MSO, cannot be expressed in the epistemic μ -calculus¹⁷. This negative result [calls for the identification of a new unifying logic in the setting of imperfect information](#). Such a logic should encompass both the epistemic μ -calculus and the existence of winning strategies in games with imperfect information, and [our investigations on epistemic and imperfect-information extensions of Strategy Logic may allow us to discover such a new unifying logic](#).

Finally, because unlike ATL and its variants, SL treats strategies as first-order citizens in the language, introducing imperfect information and knowledge may give rise to new intricate phenomena. Therefore, many techniques used in the ATL setting will not transfer straightforwardly to SL, and [new theoretical tools and proof methods will be required](#). In this regard, the *Jumping Tree Automata* that I introduced during my PhD may be very helpful, as detailed in Section 1.4.

1.2 Clarity and quality of transfer of knowledge/training for the development of the researcher in light of the research objectives

- Knowledge transferred from the host institution to me

During this project I will: (1) reinforce my background in some areas of theoretical computer science; (2) become expert in Strategy Logic; (3) complement my pedagogical skills by supervising a PhD student; (4) learn how to conceive and write a project proposal, as well as implement the project itself and help monitor its progression, thus gaining in autonomy and maturity; (5) acquire hands-on experience in the

¹⁶D. Janin and I. Walukiewicz, “On the expressive completeness of the propositional μ -calculus with respect to monadic second order logic,” in *CONCUR’96: Concurrency Theory*, Springer, 1996, pp. 263–277.

¹⁷C. Dima, B. Maubert, and S. Pinchinat, “Relating paths in transition systems: the fall of the modal μ -calculus,” in *MFCS 2015: 40th International Symposium on Mathematical Foundations of Computer Science*, G. F. Italiano, G. Pighizzini, and D. Sannella, Eds., ser. Lecture Notes in Computer Science, vol. 9234, Springer, 2015, pp. 179–191.

organisation of scientific events, both for scientific audiences and for the general public, and (6) learn how to speak Italian fluently, which will strengthen my CV and facilitate collaborations with Italian researchers.

Concerning point (1), Università di Napoli proposes each year advanced classes for PhD students and postdoctoral fellows on topics such as complexity, logics, game theory, automata theory, graph theory or advanced mathematics, providing [ample choice for me to reinforce my knowledge](#) in some of these matters highly relevant in theoretical computer science. For Point (2), the supervisor will be happy to teach me all he knows on Strategy Logic, through both private and team meetings; then expertise will be reached through both [individual and team research activity](#). Point (3) will be achieved by [helping supervise Vadim Malvone](#), who just started his PhD with the supervisor of this project on extensions of Strategy Logic with graded modalities. Concerning Point (4), the very writing of this proposal is an excellent exercise, and the outcome of the application together with the comments of the evaluators will be very beneficial to improve my skills in this task. But more importantly, if the project is funded, it would be my [first experience as a researcher in working on a project that I have essentially designed myself](#), and I will monitor myself the progress we make on the project, with the help of the supervisor when necessary. For Point (5), I will [help organise future editions of conferences such as SR or HIGHLIGHTS](#), some of which will take place in Napoli, as well as [scientific events for the communication with the public at large](#) (see p.10). Finally, [I will follow the first year weakly Italian lessons organised for foreign students and researchers by the University](#). Given that I speak French and Spanish, that I studied Latin for several years and that I enjoy learning new languages, I do not doubt that Point (6) will be fulfilled.

- Knowledge transferred from me to the host institution

During my pre- and postdoctoral research activities, [I became expert on imperfect information in logics, games and automata](#). The supervisor and other members of his team, who have attended some of my talks, are [very interested in automata techniques that I have developed](#) (see Section 1.4). Having acquired good pedagogical and communication skills through my teaching activities and participation in workshops and conferences, [the supervisor is confident that the team will benefit from this expertise](#).

1.3 Quality of the supervision and the hosting arrangements

- Qualifications and experience of the supervisor

Aniello Murano (<http://people.na.infn.it/~murano/>) is an associate professor in computer science at the Università degli Studi di Napoli Federico II (Università di Napoli for short) since November 2010, where [he leads a group on formal methods for the automatic verification of systems](#). He counts amongst the [world leading researchers on interactions between logic, games and automata](#). In this area, he has co-authored nearly a hundred articles in top-rated journals and conferences. In particular, he has highly participated, together with Moshe Y. Vardi and Fabio Mogavero, in the development of Strategy Logic as a promising framework for reasoning about multi-agent systems. He also is in the steering committee of Highlights of Logic, Games and Automata, he serves regularly in the PC of several A+ conferences such as AAAI or AAMAS, and he is on the editorial board of Information and Computation.

The supervisor also has vast experience leading, managing and participating in projects of various sizes, and he [can serve as an experienced guide to me on managerial matters](#): He currently is involved in the European FP7 project SHERPA (Smart collaboration between Humans and ground-aerial Robots for improving rescuing activities in Alpine environments), and in the recent years [he has been the principal investigator in the national project “Extended Strategy Logic”, and “Project FARO: Specification, modelling and verification of robotic systems”](#), funded by the Compagnia San Paolo di Torino. He has also been involved in the national project “Logics in Computer Science” and in the European research project ESF Research Networking Programme “Games for Design and Verification (GAMES)”. In addition, between 2008 and 2010 he was on the administrative board of Università di Napoli, in charge of over 20,000,000 Euro per year. Finally, since 2005 he supervised several master students and five PhD students, including Fabio Mogavero, recipient of [“The best Italian PhD thesis in theoretical computer science”](#), awarded by EATCS in 2012.

The supervisor has [deep ties with Moshe Vardi](#) (Rice University, Texas) and [Orna Kupferman](#) (Hebrew University, Jerusalem), who are amongst the [world’s most acclaimed researchers in automata theory and logics for computer science](#). One month a year since 2005 he visits Orna Kupferman and her formal methods group, and in 2010 [they were awarded together the Vigevani Research Prize by the Hebrew University of Jerusalem](#). Other notable collaborators include Angelo Montanari (Università di Udine), Giuseppe De Giacomo (Università La Sapienza di Roma), Alessio Lomuscio (Imperial College, UK), Michael Wooldridge (University of Oxford, UK), Wojtek Jamroga (University of Luxemburg), and Carsten Lutz (Universität Bremen, Germany), and the supervisor frequently invites researchers from abroad to give talks in Napoli.

- Quality of the hosting arrangements

The project will be hosted in the Department of Electrical Engineering and Information Technology at Università di Napoli, in which [the supervisor leads an active group on formal methods for the automatic verification of systems](#), which currently includes two postdoctoral fellows (Sasha Rubin and Loredana Sorrentino), one PhD student (Vadim Malvone) and several MSc students, [all working on Strategy Logic, game theory and/or automata theory](#). In addition, Dario Della Monica, currently a postdoctoral fellow in Helsinki at the Icelandic Centre of Excellence in Theoretical Computer Science and [expert on temporal and strategic logics](#), should start a position in the host team by early 2016. Also, Fabio Mogavero and Giuseppe Perelli (former PhD student of the supervisor), [both experts on Strategy Logic](#), are currently research assistants at the University of Oxford, but they both keep collaborating closely with the group and plan on returning to Napoli within one year. I already know Aniello Murano, Sasha Rubin, Dario Della Monica, Fabio Mogavero and Giuseppe Perelli from various conferences and workshops, so that [I am already virtually integrated in this working environment](#). Importantly, only I have a strong background in uncertainty aspects of logics, games and automata, so that [I perfectly complement the skills of my future collaborators for this project](#). My integration will be complemented by meeting with the supervisor and the team several times a week, as well as my participation in the supervision of Vadim Malvone. This project should also [help me develop my network in several ways](#). First, I will [visit Fabio Mogavero and Giuseppe Perelli while they are in Oxford](#), as they are privileged interlocutors on the topic of Strategy Logic. This will allow me to [reinforce existing connections and create new ones with renowned researchers with whom they collaborate there, such as Michael Wooldridge or Alessio Lomuscio](#), who I already met at SR and at the Dagstuhl Seminar VaToMAS. Second, young researchers of the department [frequently organise one-day workshops](#), and the supervisor is willing to introduce me to his many frequent collaborators in the department, so that I should [rapidly create new connections in other groups](#). For instance, the department counts [another verification group](#) that includes full professor Adriano Peron and assistant professors Marco Faella and Luigi Sauro (whom I already know from SR 2014), whose interests include formal verification of distributed systems, and Massimo Benerecetti (associate professor), who has developed the EUREKA tool for software model checking.

1.4 Capacity of the researcher to reach and re-enforce a position of professional maturity in research

After following the demanding “preparatory classes for entrance to Grandes Ecoles” in mathematics, I was accepted at the Brittany extension of the prestigious *Ecole Normale Supérieure de Cachan*. After obtaining my master’s degree, I asked the school a one-year leave to go on a six-months journey in South America. For the six-months period before the trip, [the research team where I had done my master’s thesis hired me as a temporary agent](#), with the mission of implementing a verification tool based on modal specifications.

When I came back to France I started my PhD with Sophie Pinchinat, who had supervised my master’s thesis, and with Guillaume Aucher, on the topic “Logical foundations of games with imperfect information”. During my PhD I discovered the topic of Dynamic Epistemic Logic (DEL), and I contributed to establish some decidability and complexity results in this field¹⁸. Helping organising the GIPSy workshop (Rennes, 2011) and participating in workshops, conferences and schools, I had the occasion to meet several leading

¹⁸G. Aucher, B. Maubert, and F. Schwarzentruber, “Generalized DEL-Sequents,” in *JELIA*, L. F. del Cerro, A. Herzig, and J. Mengin, Eds., ser. LNCS, vol. 7519, Springer, 2012, pp. 54–66.

researchers in the areas of game theory, temporal and epistemic logics, automata theory and formal verification. Among them are Moshe Vardi, Alexandru Baltag, Hans van Ditmarsch, Valentin Goranko, Dietmar Berwanger, Andreas Herzig and Ram Ramanujam, whom I visited at IMSc (Chennai, India) in 2012 during one month. When I came back I proposed a new approach in temporal epistemic logics, which is to see agents' perceptions as binary relations represented by finite state automata. Through the introduction of *information-set automata*, this view allowed me to establish powerful decidability results and provide a unified proof for previously known results¹⁹. Afterwards I introduced *Jumping Tree Automata*, an extension of classic alternating tree automata that proved very useful in the study of logics of knowledge and time. In the context of strategizing with epistemic temporal objectives, these automata allowed me to prove a decidability result for a vast class of indistinguishability relations²⁰. I defended my PhD in January 2014, in front of a prestigious jury presided by Joseph Y. Halpern (Cornell University).

I had then already been accepted for a CNRS postdoctoral position in Hans van Ditmarsch's team at LORIA (Nancy, France), to work on his ERC starting grant Epistemic Protocol Synthesis. But because I had the project of sailing across the Atlantic, I chose to postpone the start of this position. Also, because I aimed at going abroad, both for career strategy and personal taste, we had agreed on a short six-months contract, and a two months visit in Cordoba (Argentina) in the team of Carlos Areces, whom I had met at the Dagstuhl Seminar VaToMAS. During this position I kept collaborating with various researchers such as Laura Bozzelli and Sophie Pinchinat: we established that the recently introduced temporal logics for hyperproperties are incomparable with the Epistemic Temporal Logic, before introducing a unifying logic²¹. I also started to work with Catalin Dima, jury member at my PhD defence, who was very interested in my notion of Jumping Tree Automata. Thanks to these, we proved together with Sophie Pinchinat an important expressive incompleteness result concerning the μ -calculus and MSO in the context of imperfect information²². I am also currently finishing an article with Carlos Areces and others to expose the results that I helped establishing during my visit in Cordoba.

Concerning my future research projects, I am convinced that there is a boulevard in bringing together the communities of games and automata on the one hand, and logics for uncertainty on the other hand. The latter has developed over the past decades involved logical frameworks that allow very precise descriptions of agents' perceptions and beliefs, and the evolution thereof through the occurrence of informative events. The former disposes of a rich toolbox of powerful and well understood automata techniques, that provide efficient decision procedures to verify and synthesize systems from specifications expressing complex temporal behaviours. Bringing them together would certainly increase immensely the richness of the properties that we can handle for automatic verification and synthesis of multi-agent systems. In fact, the last main result of my PhD constitutes a first promising step in that direction²³.

My career plan is to apply for a tenured CNRS position, which in France is the best option to achieve maximal independence and impact as a full-time researcher, on the project of merging the power of games and automata techniques with the expressiveness of logics of uncertainty. I will apply in the laboratory IRIT, in Toulouse, which hosts both a research team on verification of embedded and distributed systems (ACADIE), and a research team that excels in logics for belief representation and decision making under uncertainty (LILaC). Andreas Herzig, a senior CNRS researcher who leads the theme "Reasoning and Decision" at IRIT, is willing to support my application to a CNRS position. On the longer term, I believe that theoretical computer science can, and must, play a role in addressing one of the most ominous challenges that our civilisation faces, which is the ecological crisis. I would like to try and apply formal methods to Green IT. The recent years witnessed some attempts in that direction: energy complexity²⁴ aims at measuring programs not with respect to their execution time or memory usage, but rather their

¹⁹B. Maubert, S. Pinchinat, and L. Bozzelli, "The complexity of synthesizing uniform strategies," in *SR*, 2013, pp. 115–122.

²⁰maubertFSTTCS2013court.

²¹L. Bozzelli, B. Maubert, and S. Pinchinat, "Unifying hyper and epistemic temporal logics," in *FoSSaCS, 18th International Conference on Foundations of Software Science and Computation Structures.*, 2015, pp. 167–182.

²²Dima, Maubert, and Pinchinat, "Relating Paths in Transition Systems: The Fall of the Modal μ -Calculus," see n. 17.

²³G. Aucher, B. Maubert, and S. Pinchinat, "Automata techniques for epistemic protocol synthesis," in *SR*, F. Mogavero, A. Murano, and M. Y. Vardi, Eds., ser. EPTCS, vol. 146, 2014, pp. 97–103.

²⁴DBLP:conf/wenc/JainMR05.

energy consumption, and energy games²⁵ provide techniques to synthesise energy-efficient systems. But **I am convinced that much more could be done**, notably concerning the analysis of systems’ life cycles, central in the optimisation of energy and resources consumption.

2 Impact

2.1 Enhancing research- and innovation-related human resources, skills, and working conditions to realise the potential of individuals and to provide new career perspectives

This fellowship will, first, **allow me to spend two years abroad**, thus fulfilling the informal criterion for CNRS candidates to have worked at least one year abroad. More importantly, collaborating on this project with excellent researchers such as Aniello Murano, Fabio Mogavero and Moshe Vardi will **broaden and deepen my knowledge and skills at the intersection of formal methods and reasoning under uncertainty**, which is precisely where my project for the CNRS application lies. In particular, I will **become expert on the thriving topic of Strategy Logic** by working closely with the world leaders on the matter, and **I will assert my unique expertise on automata techniques for logics of knowledge and time or strategies**. In addition, this project will allow me to **create and tighten bounds** with the above mentioned researchers and more (see Section 1.3), **making my network worldwide with a strong heart in Europe** and branches in Asia, North and South America as well as Oceania, **with members from formal methods and from the reasoning under uncertainty community**. Therefore, I do not doubt that at the end of this project my track record, strengthened by the obtention of a Marie Curie fellowship and my network, will **maximise my chances of obtaining a position of independent and influential researcher within the European Union**.

Also, the host department counts many researchers working on Green IT – incidentally, the supervisor is involved in a project on smart cities (ORCHESTRA). The frequent one-day workshops organised in the department will thus give me the opportunity to **create valuable contacts for my long-term project on Green IT**. Regarding the latter, the training in organising scientific events, in supervising students and in managing projects, as detailed in Section 1.2, will be **great assets to gather researchers around the thematic of formal methods for Green IT** and, maybe, ultimately successfully manage a research team on the topic.

2.2 Effectiveness of the proposed measures for communication and results dissemination

- Communication and public engagement strategy of the action

Fondazione Idis is a non-profit organisation that fosters the active involvement of citizens in the major decisions of our civilisation. The dissemination of scientific knowledge is a crucial part of their activity, and in 1989 it created Città della Scienza in Napoli, whose mission is precisely to **promote scientific culture**. The centre is very successful as it counts about **500,000 visitors each year**. In addition, Fondazione Idis participates in ECSITE, the European network of science centres, and has been awarded the Descartes Prize by the European Commission. All of this qualifies Città della Scienza as an **outstanding means to effectively reach a broad audience**, reason why **the supervisor’s team regularly organises events there**. **At the end of each year**, we will present there the project to the public. We will informally explain the aim (design robots that can strategize to attain their respective objectives), the main challenges to address (modelling and strategizing under imperfect information, and reasoning about knowledge), and **possible applications understandable to a non-expert audience**, such as autonomous vehicles or robotic rescue teams. If possible, we will also try to explain informally our main achievements.

Every year, the supervisor’s team also **receives high school students to advertise their research** and their Bachelor’s programmes, through small seminars on maths, algorithms and game theory or robot experiments. This is a perfect occasion to communicate on this project, with a **good chance of reaching local newspapers**.

²⁵DBLP:conf/emsoft/ChakrabartiAHS03.

- Dissemination of the research results

We plan on [submitting advances of the project in the best workshops and conferences of the domain](#): SR, FSTTCS, MFCS, LICS, CLS, STACS, ICALP on the formal methods side, and AAAI, AAMAS, IJCAI, JELIA and ECAI on the artificial intelligence side. Presenting our work there will ensure an efficient diffusion of our results amongst our communities, a good advertising for Marie Skłodowska-Curie actions and an increased influence of European research. Of course, we will also [submit to the top journals of our area](#), such as Journal of the ACM, ACM Transactions on Computational Logic, Annals of Mathematics and Artificial Intelligence, Logic Journal of the IGPL, Journal of Logic and Computation or Information and Computation, where the supervisor and his team regularly publish. We will also [participate in HIGHLIGHTS, which is the perfect occasion to present our work to the very active community of logic, games and automata](#): this year, this cheap, proceedings-free conference brought together more than a hundred researchers. Finally, [we will develop a web page](#) to present the project, advertise our main achievements and announce our public presentations, both for expert and non-expert audiences. [Open access to all our publication will be ensured](#) by self-archiving them, both on the project's web page and on www.arXiv.org.

- Exploitation of results and intellectual property

The host department organises regular informal meetings and workshops with industries to discuss their research projects. They are [in contact with over a hundred companies](#), such as Ansaldo STS (transportation company) and Telecom (main Italian telephone company). This project is essentially fundamental research, so that there is no guarantee to obtain results readily applicable in the industry. But all will be made to [interest industries in our project](#); in particular we will [reuse the presentations prepared for the broad audience to explain what Strategy Logic can achieve](#), and thus attract investors for further developments.

Again by nature of the project, [no intellectual property issue is to foresee](#). Concerning background IP, all scientific articles required for the investigation will be provided by the host institution, as specified in the partnership agreement. Concerning foreground IP, all articles published in conference proceedings or journals during the project will be submitted to standard copyrights depending on each publisher's policy.

3 Implementation

3.1 Overall coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources

- Work Packages description

[WP1: Define one or several extensions of SL for imperfect information with satisfying expressivity](#). Since preliminary works exist²⁶²⁷, we should quickly come up with interesting logics and start to look for ways to tame their expected high complexity (WP2). We may continue to look for alternative logics for a little while, but we should stop rather quickly and focus on the ones we will have defined at that point.

[WP2: Identify fragments that may lead to good complexity while retaining interesting expressivity](#). Again, because studies on related topics provide ideas of assumptions that may bring about better complexity (bounded memory agents, hierarchical knowledge, syntactic fragments of SL...), we should rather quickly be able to identify our first promising fragments and start studying them in detail (WP3). But from that point until the end of the project, we will probably go back and forth between WP2 and WP3, as the detailed study of fragments is very likely to give new insights on how to tame our logics.

[WP3: Study identified fragments in detail: exact complexity and expressivity](#). For identified fragments we should first verify whether they really are expressive enough and tractable, and try to establish their exact complexity and expressivity. This task also runs until the end of the project as it is its final objective.

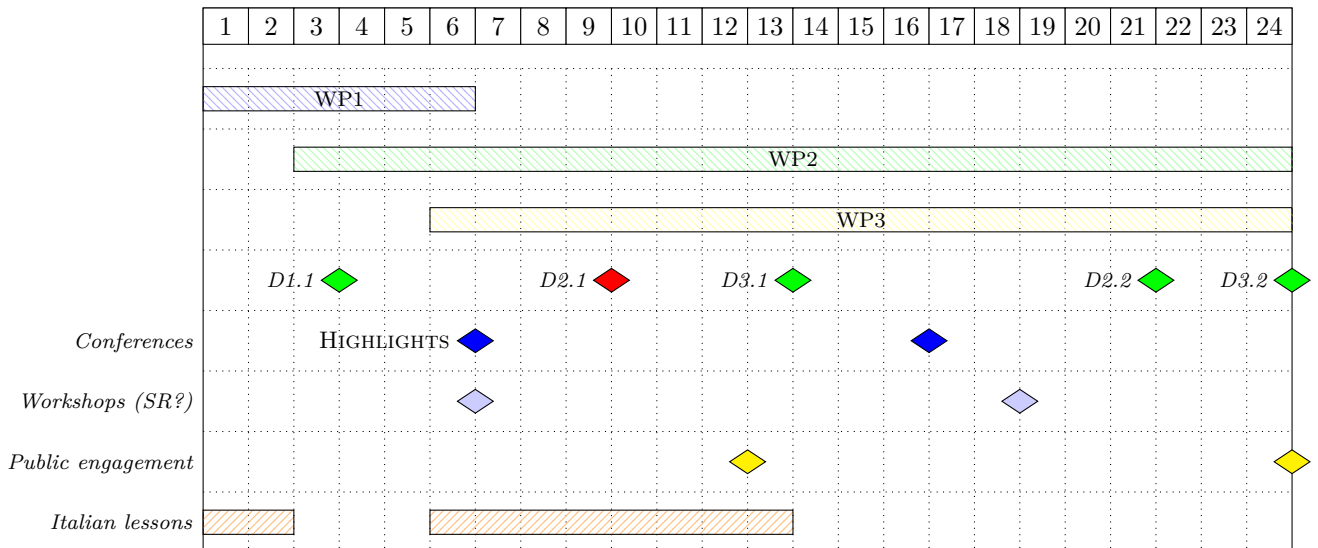
- List of major deliverables

²⁶Belardinelli, “Reasoning about Knowledge and Strategies: Epistemic Strategy Logic,” see n. 13.

²⁷Knight and Maubert, “Dealing with imperfect information in Strategy Logic,” see n. 15.

- D1.1 Workshop submission (probably SR) on our first extension(s) of SL
- D2.1 Conference submission on the first identified fragment(s)
- D3.1 Journal submission enriching D2.1 with new, precise expressivity/complexity results
- D2.2 Conference submission on newly identified fragment(s)
- D3.2 Journal submission enriching D2.2 with new, precise expressivity/complexity results

- Milestone: deliverable D2.1 is the only milestone.
- Gantt diagram (thought with respect to a starting date in April 2016).



3.2 Appropriateness of the management structure and procedures, including quality management and risk management

- Project organisation and management structure

As demonstrated by his track record, the supervisor has a strong experience in participating in and managing projects, both European and national. The supervisor pledged to see me at least twice of thrice a week, to work and monitor the progress of the project together; in addition, the supervisor already organises weekly team meetings, and has very frequent video conferences with Fabio Mogavero and Giuseppe Perelli. Concerning public engagement, our events at Città della Scienza will be prepared at least together with Aniello Murano, and maybe with other collaborators, such as Vadim Malvone or Dario Della Monica.

Of course, the host department commits to supporting me in reaching the project objectives. Università di Napoli has the overall responsibility for the financial management. At the beginning of the project the Centralised University Research and Innovation services will organise a kick-off meeting together with the supervisor, the host department's administration and myself to agree about the internal reporting and the EU rules. Financial reporting and administration are managed together by the different department's administrative offices (see Section 3.3) and the Centralised University Research and Innovation services. Università di Napoli has considerable experience with the administration of FP7 projects, as it is involved in a hundred of them (<http://irm.scienceonthenet.eu/>), and it keeps adequate records and other supporting documentation according to European Union's and its own rules.

- Risks that might endanger reaching project objectives

On the management side, the risk of a lack of integration and interaction with competent collaborators is very low, as justified above and in Section 1.3. Should something happen to the supervisor resulting in an impossibility to work with me, Fabio Mogavero could fill in his place the role of main interlocutor. No

financial risk at all is to foresee, as our project requires only basic furniture, equipment and infrastructures, and the financial support provided for Marie Skłodowska-Curie Individual Fellowships is amply sufficient to cover participation in workshops and conferences as well as several visits to researchers abroad.

On the scientific side, a first risk is [not to find any interesting fragment](#) of the logics that we will design. As justified in the description of WP2, this is [quite unlikely](#), but if it is the case when we reach our milestone (see Section 3.1), we will [go back to WP1 and design a new logic](#), learning from our failure to further diminish the odds that it could happen again. A second risk is [not to manage to establish the exact expressivity and/or complexity of some relevant fragment\(s\)](#). A first solution in that case would be to [ask the help of other collaborators](#), such as Laura Bozzelli, who is renowned for her skills in solving this kind of problems, and with whom I have published several papers. [If this does not work neither](#), we would leave these as open problems and explain the difficulties we have met. Since it is extremely unlikely that we stay stuck on all aspects of all fragments, [this should not diminish too much the quality of the project's outcome](#).

3.3 Appropriateness of the institutional environment (infrastructure)

The campus is recent, well connected to the city with metros and buses, and it counts a well stocked library as well as indoor and outdoor wireless internet, including in the cafeterias. [The host department disposes of all the necessary facilities for this project to be implemented in the best conditions](#): it has its own library specialised on the department's thematics, high-speed internet, [modern video-conference installations which will ensure good interactions with collaborators abroad](#), offices for postdoctoral fellows and meeting rooms equipped with projectors and digital blackboards. The department also provides each researcher with modern computers and the rest of standard equipment.

The department's "Contracts, Logistics and Personnel Office" will be in charge of, first, performing the final procedures for the grant agreement, preparing my contract, providing administrative support along the project, purchasing the necessary equipment, organising missions for attendance to workshops and conferences, and for visits to collaborators such as Fabio Mogavero and Giuseppe Perelli in Oxford or Moshe Vardi in Houston. The "Management of Research Projects and Activity on the Territory Office" is in charge of, among other things, supporting research projects proposals (which they did very competently with this one), management and reporting of research projects, and other activities related to research grants. The "Accounting Office" will be in charge of financial aspects, and finally, "International House Federico II" [will help me find a dwelling](#) at my arrival, and also [help with administrative issues](#), such as obtaining a residence permit, registering to the health-care system and opening a bank account.

3.4 Competences, experience and complementarity of the participating organisations and institutional commitment

To summarise, this project constitutes the [natural next challenge in the burning domain of formal methods, logics and games for multi-agent systems](#), and it has [applications of undeniable societal impact](#) such as smart cities or robotic rescue teams. The host department constitutes a highly stimulating and multi-disciplinary environment. I will be surrounded with over thirty interlocutors of quality, young and senior, who will contribute to the success of this project. I will have the opportunity to improve my skills as a researcher and a supervisor, to publish with outstanding researchers such as Moshe Y. Vardi and Orna Kupferman, as well as to meet researchers interested in Green IT aspects. All of this should [enable me to fulfil my career purposes, become an independent and influential researcher and hopefully initiate a trend of research on formal methods for Green IT](#). The scientific, pedagogical and managerial indubitable skills of the supervisor and his [leadership in worldwide research on Strategy Logic](#) show that [there is no better place to implement this project](#).

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4 CV of the Experienced Researcher

Bastien Maubert

Born February 26, 1987 in Nantes, France

<http://bastien-maubert.fr/>

Education

10/2010 - 01/2014	PhD in Computer Science, Université de Rennes 1 Title of the thesis: <i>Logical foundations of games with imperfect information: uniform strategies.</i> Cited once. Supervised by Sophie Pinchinat and Guillaume Aucher. Defended at Université de Rennes 1 on January 14, 2014. Jury composed of Joseph Y. Halpern (president), Christof Löding (referee), Ram Ramanujam (referee), Dietmar Berwanger, Thomas Bolander, Cătălin Dima, Sophie Pinchinat and Guillaume Aucher.
09/2007 - 06/2009	Master's degree in Computer Science, with honours <i>ENS Rennes</i>
09/2006 - 06/2007	Bachelor's degree in Computer Science, with high honours <i>ENS Rennes - Université de Rennes 1</i>
09/2004 - 06/2006	Preparatory classes for entrance to Grandes Ecoles <i>Lycée Chateaubriand, Rennes</i> Accepted at Ecole Normale Supérieure (ENS) de Rennes, formerly Brittany extension of ENS Cachan
06/2004	Scientific Baccalauréat, with high honours <i>Lycée Julliot de la Morandière, Granville</i>

Current position

04/2015 - today	After the end of my previous position in Nancy (see below), and after I came back in April from my visit in Carlos Areces' team in Cordoba, Argentina, I chose to stay a few months in Rennes, where my partner lives, even though I had no position there. I did not look for one since I had the plan of moving to Napoli for this project. I therefore currently continue my research activities while being officially unemployed.
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Past position

09/2014 - 02/2015	CNRS PostDoc position in the ERC funded project Epistemic Protocol Synthesis, lead by Hans van Ditmarsch in LORIA, Nancy.
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Note that after my PhD defence, I stayed at Université de Rennes 1 until the end of my doctoral contract, in August 2014.

Miscellaneous / gaps

01/2014 - 02/2014	Transatlantic on a sailing boat 21 days, from Canary islands to Guadeloupe
03/2010 - 09/2010	Six months journey in South America Brasil, Argentina, Chile, Bolivia, Peru, Paraguay
09/2009 - 02/2010	Temporary agent at IRISA, Rennes (Team S4) Implementation of a verification tool based on modal specifications, <i>supervised by Benoît Caillaud</i>

Teaching

2011/2012, 2012/2013	Tutorials – Program Design and Verification ENS Rennes, postgraduate
2011/2012, 2012/2013	Tutorials – Logic and Calculability ENS Rennes, undergraduate
2012/2013	Tutorials – Introduction to LaTeX ENS Rennes, undergraduate
2010/2011, 2011/2012	Lectures and tutorials – Introduction to Compilation Université de Rennes 1, undergraduate
2010/2011	Tutorials – Data Structures INSA de Rennes, undergraduate
2009/2010	Tutorials – Functional Programming INSA de Rennes, undergraduate

Other academic activities

Paper reviews:

Conferences: GandALF 2013, AAMAS 2013, WoLLIC 2013, CLIMA 2014, GandALF 2014, ICLA 2015, TACAS 2015, LICS 2015, TARK 2015, LORI 2015, RV 2015

Journals: Journal of Logic and Computation, Information and Computation, ACM Transactions on Computational Logic.

Collector for a Dagstuhl report:

VaToMAS Dagstuhl seminar 13181, 2013, Schloss Dagstuhl (Germany)

Local organisation:

GIPSy workshop, October 25-27, 2011, IRISA (Rennes, France)

Scholarships and grants

2015	MEALS travelling grant to visit Carlos Areces in Cordoba, Argentina (5320€)
2012	One year of so called “teaching mission” by Université de Rennes 1.
2011	Three-year PhD scholarship from Ecole Normale Supérieure de Cachan.
2011	One year of so called “teaching mission” by Université de Rennes 1.
2011	Travelling grant to visit Ram Ramanujam in Chennai, India (800€).
2006	Four-year scholarship by Ecole Normale Supérieure de Cachan (formally, hired as a probationary official).

Publications

In international journals:

2015	Uniform strategies, rational relations and jumping automata L. Bozzelli, B. Maubert and S. Pinchinat <i>Information and Computation</i> , vol. 242. Special issue for SR 2013.	
2014	A general notion of uniform strategies B. Maubert and S. Pinchinat <i>International Game Theory Review</i> , vol. 16(01). Special issue for LOFT 2012.	cited once

In international conferences with program committee:

- 2015 Games with Communication: from Belief to Preference Change**
 G. Aucher, B. Maubert, S. Pinchinat and F. Schwarzenruber
 PRIMA, 18th Conference on Principles and Practice of Multi-Agent Systems
- Relating paths in transition systems: the fall of the modal mu-calculus**
 C. Dima, B. Maubert and S. Pinchinat
 MFCS, 40th International Symposium on Mathematical Foundations of Computer Science
- Asynchronous announcements in a public channel**
 S. Knight, B. Maubert and F. Schwarzenruber
 ICTAC, 12th International Colloquium on Theoretical Aspects of Computing
- Unifying Hyper Logic and Epistemic Temporal Logic**
 L. Bozzelli, B. Maubert and S. Pinchinat
 FoSSaCS, 18th International Conference on Foundations of Software Science and Computation Structures
- 2013 Jumping automata for uniform strategies**
 B. Maubert and S. Pinchinat
 FSTTCS, 33rd IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science
- 2012 Generalized DEL-sequents** cited four times
 G. Aucher, B. Maubert and F. Schwarzenruber
 JELIA, 13th European Conference on Logics in Artificial Intelligence
- Uniform strategies**
 B. Maubert and S. Pinchinat
 LOFT, 10th Conference on Logic and the Foundations of Game and Decision Theory (no published proceedings)

In international workshops with program committee:

- 2015 Games with Communication: from Belief to Preference Change**
 G. Aucher, B. Maubert, S. Pinchinat and F. Schwarzenruber
 SR, 3rd International Workshop on Strategic Reasoning (no published proceedings)
- Dealing with imperfect information in Strategy Logic**
 S. Knight and B. Maubert
 SR, 3rd International Workshop on Strategic Reasoning (no published proceedings)
- 2014 Automata techniques for epistemic protocol synthesis**
 G. Aucher, B. Maubert and S. Pinchinat
 SR, 2nd International Workshop on Strategic Reasoning
- 2013 The complexity of synthesizing uniform strategies**
 B. Maubert, S. Pinchinat and L. Bozzelli
 SR, 1st International Workshop on Strategic Reasoning
- 2011 Tableau method and NEXPTIME-completeness of DEL-sequents** cited once
 G. Aucher, B. Maubert and F. Schwarzenruber
 M4M, 7th Methods for Modalities workshop
- Opacity issues in games with imperfect information** cited thrice
 B. Maubert, S. Pinchinat and L. Bozzelli
 GandALF, 2nd International Symposium on Games, Automata, Logics and Formal Verification
- 2009 Games with opacity condition**
 B. Maubert and S. Pinchinat
 RP, LIX Colloquium / 3rd Workshop on Reachability Problems

Other publications:**2012 Uniform strategies**

cited once

B. Maubert and S. Pinchinat

INRIA research report N° 8144, <http://arxiv.org/abs/1212.0526>**Generalized DEL-sequents**

G. Aucher, B. Maubert and F. Schwarzentruher

INRIA research report N° 8012, <http://hal.inria.fr/hal-00716074/en>Internships and visits

22/06 - 02/07/2015	Visit at LORIA (Nancy, France) Work with Sophia Knight
20/01 - 05/04/2015	Visit at FAMAF (Cordoba, Argentina) Work with Carlos Areces, Raul Fervari and Guillaume Hoffman
02 - 03/07/2014	Visit at LORIA (Nancy, France) Work with Carlos Areces and Raul Fervari
19 - 21/05/2014	Visit at LORIA (Nancy, France) Work with Hans van Ditmarsch and Sophia Knight
03 - 04/03/2014	Visit at LACL (Paris, France) Work with Cătălin Dima
01 - 11/12/2013	Visit at IMSc (Chennai, India) Work with Ram Ramanujam
24 - 27/11/2012	Visit at UPM (Madrid, Spain) Work with Laura Bozzelli
23/06 - 20/07/2012	Visit at IMSc (Chennai, India) Work with Ram Ramanujam
02 - 06/2009	Internship at IRISA (Rennes, France) Supervisor: Sophie Pinchinat Subject: <i>Synchronizing automata and applications to games with imperfect information</i>
05 - 07/2008	Internship at ITU (Copenhagen, Denmark) Supervisor: Lars Birkedal Subject: <i>Verification of design patterns in Hoare Type Theory</i>
05 - 06/2007	Internship at IRISA (Rennes, France) Supervisor: Jean-Pierre Talpin Subject: <i>Certification of SIGNAL programs</i>

Talks

22/09/2015	Games with Communication: from Belief to Preference Change SR 2015 (Oxford, England)
21/09/2015	Dealing with imperfect information in Strategy Logic SR 2015 (Oxford, England)
17/09/2015	Relating paths in transition systems: the fall of the modal mu-calculus Highlights of Logic, Games and Automata (Prague, Czech Republic)
28/08/2015	Relating paths in transition systems: the fall of the modal mu-calculus MFCS 2015 (Milano, Italy)
03/09/2014	Automata techniques for epistemic protocol synthesis in DEL Highlights of Logic, Games and Automata (Paris, France)

26/08/2014	Automata techniques for epistemic protocol synthesis Workshop Epistemic Protocol Synthesis (Rennes, France)
06/04/2014	Automata techniques for epistemic protocol synthesis SR 2014 (Grenoble, France)
17/01/2014	Logical foundations of games with imperfect information: uniform strategies PhD defence, IRISA (Rennes, France)
12/12/2013	Jumping automata for uniform strategies FSTTCS 2013 (Guwahati, India)
07/12/2013	Uniform strategies, rational relations and jumping automata GImInAL, IMSc (Chennai, India)
04/07/2013	Uniform strategies with rational relations GT FORWAL, Université Paris 6 (Paris, France)
18/06/2013	Uniform strategies with rational relations GT Vérif, ENS Cachan (Paris, France)
29/04/2013	Uniform strategies VaToMAS Dagstuhl seminar 13181, Schloss Dagstuhl (Germany)
17/03/2013	The complexity of synthesizing uniform strategies SR 2013 (Roma, Italy)
21/11/2012	Uniform strategies IRIT (Toulouse, France)
20/09/2012	Towards a notion of uniform strategies GT Jeux 2012, ENS Cachan (Paris, France)
20/07/2012	Introduction to Dependence Logic Formal methods update meeting, CMI (Chennai, India)
11/07/2012	Towards a notion of uniform strategies TCS Colloquium, IMSc (Chennai, India)
18/06/2012	Uniform Strategies LOFT 2012 (Sevilla, Spain)
11/11/2011	Tableau method and NEXPTIME-completeness of DEL-sequents M4M 7 (Osuna, Spain)
26/10/2011	Uniform strategies GIPSy workshop, IRISA (Rennes, France)
15/06/2011	Opacity issues in games with imperfect information GandALF 2011 (Minori, Italy)
24/09/2009	Games with opacity condition RP 2009, Ecole Polytechnique (Palaiseau, France)
16/09/2009	Games with opacity condition 68NQRT seminar, IRISA (Rennes, France)

Languages

French	Mother-tongue
English	Fluent
Spanish	Fluent

5 Capacities of the Participating Organisations

Beneficiary	
General Description	Università degli Studi di Napoli Federico II
Role and Commitment of key persons (supervisor)	Aniello Murano, associate professor of computer science at Dipartimento di Ingegneria Elettrica e Tecnologie dell'Informazione. Commits to spend 15% of his working time on this project (6-8 hours a week).
Key Research Facilities, Infrastructure and Equipment	The host department possesses recent and modern facilities, a well stocked specialised library, and is fully equipped for all the standard needs of fundamental research (professional computers, laptops, high-speed internet, wi-fi, video-conference installations, meeting rooms with projectors and digital blackboards. . .). The service “International House Federico II” helps foreign researchers find a dwelling at their arrival, and it also helps them with administrative issues, such as obtaining a residence permit, registering to the health-care system and opening a bank account.
Independent research premises?	Not Applicable
Previous Involvement in Research and Training Programmes	<p>Selection of research projects in which Aniello Murano has been involved:</p> <ul style="list-style-type: none"> • National project “Extended Strategy Logic” (principal investigator) • National project “Logics in Computer Science” • European project ESF Research Networking Programme “Games for Design and Verification (GAMES)” • National project “Automatic Verification of Internet Security Protocols” <p>He has also been involved in the National Science Foundation project “Educational Innovation – Integrating Logic in the Computer Science Curriculum”</p>
Current involvement in Research and Training Programmes	<p>Aniello Murano is involved in the following European FP7 projects:</p> <ul style="list-style-type: none"> • SHERPA (Smart collaboration between Humans and ground-aerial Robots for imProving rescuing activities in Alpine environments) • RoDYMAN (RObotic DYnamic MANipulation) • EUroC (European Robotics Challenges) • CRYSTAL (Critical System Engineering Acceleration)
Relevant Publications and/or research/innovation products	<p>Fabio Mogavero, Aniello Murano, Giuseppe Perelli, Moshe Y. Vardi: Reasoning About Strategies: On the Model-Checking Problem. ACM Transactions on Computational Logic. 15:4. pp 1-42 (2014)</p> <p>Petr Cermák, Alessio Lomuscio, Fabio Mogavero, Aniello Murano: MCMAS-SLK: A Model Checker for the Verification of Strategy Logic Specifications. CAV 2014. pp. 525-532</p> <p>Benjamin Aminof, Axel Legay, Aniello Murano, Olivier Serre, Moshe Y. Vardi: Pushdown module checking with imperfect information. Inf. Comput. 223. pp. 1-17 (2013)</p> <p>Fabio Mogavero, Aniello Murano, Luigi Sauro: On the Boundary of Behavioral Strategies. LICS 2013. pp. 263-272</p> <p>Benjamin Aminof, Orna Kupferman, Aniello Murano: Improved model checking of hierarchical systems. Inf. Comput. 210. pp. 68-86 (2012)</p>

6 Ethical Aspects

Not Applicable.

7 Letters of Commitment of Partner Organisations

Not Applicable.

ENDPAGE

MARIE SKŁODOWSKA–CURIE ACTIONS

Individual Fellowships (IF)
Call: H2020-MSCA-IF-2015

PART B

“LoGICInMAS”

“Logics and Games for Imperfect Information in Multi-Agent Systems”

This proposal is to be evaluated as:

[Standard EF]