Activity Report 2018

Team LOGICA

Logic and Applications

D4 – Language and Software Engineering

1 Team composition

Researchers and faculty

Sophie Pinchinat, PR University of Rennes 1
François Schwarzentruber, MCF ENS Rennes

Associate members

none

Research engineers, techical staff

Didier Vojtisek, Engineer, INRIA (20%)

PhD students

Sébastien Lê Cong
Arthur Queffelec
Florence Wacheux

Administrative assistant

Tifenn Donguy and Fanny Banor

2 Overall objectives

2.1 Overview

Many of our activities which were in the past performed in the physical world and in interaction with other humans, are nowadays carried out in a digital world in interaction with both human and non-human 'agents': classic examples are e-commerce, e-voting, e-banking, e-government, etc. This transposition of some of our activities into the digital world already plays an important role in our everyday life. This transposition is expected to develop in the future, which is certainly desirable in order to harmonize the rate at which our society evolves. This large picture exhibits an urgent need for both taming already existing e-activities and assisting the birth of new ones.

Existing e-activities, such as e-voting, e-commerce, e-banking, e-government etc. rely on a combination of numerous technologies either at the physical/hardware level or at the digital/software one. The nature of interaction between different services that form the whole application is very complex and leads to critical issues regarding its quality that the research community together with industry try to resolve.

Among the main issues, we can mention privacy, legal process, correction of the functionalities. Also, the growing development of applications to support e-activities urges the designers to elaborate methodologies that would allow them to exploit adaptability or re-usability of existing services. Whichever issue can be picked, rigorous settings are required in order to make evidence of the correctness, the quality, the robustness, etc. of the existing products. Moreover, some sectors of activity are currently far from being computerized or even computer-assisted: typically, legal processes, abilities to remote control some domestic processes such as closing roller blinds when a storm is forecast, and so on.

All in all, not only existing e-activities need to be coupled with meticulous development methodologies, but also accurate approaches need being set up to design new e-activities that support underdeveloped domains currently operated by hand. To that end, important efforts are required to bring out the capabilities to rigorously analyze or design the functionalities[1] of services in e-activities.

The LogicA project aims at contributing to this will, by focusing on interaction issues in e-activities with a logical-based perspective. The project will develop foundations, transfer to practical applications, and convey the tight coupling between research and education.

One of the most challenging feature in e-activities analysis is the ability to "predict/control" the interaction between the numerous involved entities. These entities can be artificial (software agents, distributed systems components) or human (users). As a first step, the project will focus on artificial entities, which are, ideally, designed to act *autonomously* on the behalf of users, e.g. for negotiating in an e-commerce activity. These entities are called *software agents*, and they gather into *multi-agent system (MAS)*.

[1] in terms of what an application offers to its users

Since MAS are central objects, they need to be preliminary well understood at a mathematical level. The theories that will support their use in practical applications should give rise to different techniques, ranging from the ability to guarantee and certify before their deployment that they will behave properly (verification) to the ability of automatically generating skeletons of MAS (synthesis) or of coordination mechanisms between MAS (control/orchestration/choregraphy/communication).

Whereas successful logic-based techniques in computer science already exist for verification, synthesis and control, it is not clear yet how to transfer this know-how to the paradigm of MAS where interaction is central. Investigations to formally *reason about* and *infer properties of* interacting agents is currently a very active topic in computer science, which actually originates with, e.g. artificial intelligence and game theory. The LogicA project aims at cross-fertilizing logic-based techniques from verification in computer science, synthesis in discrete-event control theory, agency in artificial intelligence, concepts and solution concepts in game theory, and interaction concepts in philosophy. In particular, what typically differentiates the MAS framework from its pairs is the inherent information change/exchange in its dynamics, which gives evidence of, e.g. epistemic, strategic and normative features to be taken into account.

2.2 Scientific foundations

The LogicA project follows three main research lines.

Epistemic logics and logics of information change When agent interaction issues are concerned, ability to reason about knowledge is central. To this aim, epistemic logic has been extensively studied [FHMV95], and recent extensions that take dynamics into account draw the attention of a growing community of logicians and computer scientists (see for instance the very much cited book [vvK08] and the recent ERC grant on epistemic protocols coordinated by Hans van Ditmarsch (DR CNRS, LORIA). The LogicA project explores variants of epistemic logic that can easily mix with time, in order to reason about information change along time. As mixing knowledge and time easily yields to high complexity and even undecidability [HV89], the challenge is to identify settings where the formalism would enjoy good computational features while being expressive enough to capture useful properties.

Strategic reasoning and automata-theoretic approaches Modeling strategic abilities is central for reasoning about MAS. We plan to carry on with logical formalism that were already proved or are currently foreseen as powerful approaches in many exciting domains, including software tools for information system security, robot teams with sophisticated adaptive strategies, and automatic players capable of beating expert human adversary, just to cite a few. All these examples share the challenge of developing novel theories and tools for agent-based reasoning that take into account the likely behavior of "adversaries".

[FHMV95] R. Fagin, J. Halpern, Y. Moses, M. Vardi, *Reasoning about knowledge*, MIT Press, 1995.

[vvK08] H. van Ditmarsch, W. van der Hoek, B. Kooi, *Dynamic Epistemic Logic*, Springer, Dordecht, 2008.

[HV89] J. Y. Halpern, M. Y. Vardi, "The complexity of reasoning about knowledge and time. 1. Lower bounds", *Journal of Computer and System Sciences 38*, 1, 1989, p. 195–237.

The natural setting for strategic reasoning is not surprisingly the one of multi-player games with imperfect information. Although discouraging results from the literature shows that three-player games with safety objectives are undecidable [PRA01], there are however promising results which show that some classes may be manageable. Basically, undecidability comes from the ability for some players to form a coalition: the resulting binary indistinguishability relation of the coalition would correspond to the intersection of the relations of its respective members. Now, it is well-known that intersection of binary relations yields more complex relations that may exit decidable classes (e.g. for membership or emptiness), like e.g., rational relations. Note that such phenomenon cannot arise in two-player games where safety objectives can be solved by a simple (although costly) power-set construction [Rei84]. Also, undecidability becomes even "stronger" when dealing with more realistic objectives for epistemic properties, such as seeking a strategy of agent A such eventuallty "agent B does know Property P until agent C knows it".

The LogicA group contributes in the development of logics that make a trade-off between expressiveness and decidability/tractability.

Formal approaches for the design of attack trees Whether it is physical security, environmental security, or information technology environments, ensuring security requires preliminary investigations to identify and evaluate risks that threaten the system under consideration. This is what the *risk analysis* [ISO05,ISO13,Sch07] discipline is about.

While many approaches to risk assessment and analysis exist, and the methodologies differ from country to country, from industry to academia, and from organization to organization, some security modelling approaches applied in risk analysis are being adopted across these boundaries. For example, the 2008 NATO Improving Common Security Risk Analysis report [RR08] and the 2013 OWASP CISO Application Security Guide [OWA13] recommend the use of *attack trees* to handle the threat assessment task. DARPA has applied attack trees in their Information Assurance live experiments [Lev03,

[PRA01] G. Peterson, J. Reif, S. Azhar, "Lower bounds for multiplayer noncooperative games of incomplete information", *Computers & Mathematics with Applications 41*, 7, 2001, p. 957–992.

[Rei84] J. H. Reif, "The complexity of two-player games of incomplete information", *Journal of computer and system sciences 29*, 2, 1984, p. 274–301.

[ISO05] ISO, Geneva, Switzerland, *Norm ISO/IEC 27002 - Information Technology - Security Techniques - Code of Practice for Information Security Management*, edition ISO/IEC 27002:2005, 2005, Section 9.

[ISO13] ISO, Geneva, Switzerland, *Norm ISO/IEC 27002 2013 - Information Technology - Security Techniques - Code of Practice for Information Security Management*, edition ISO/IEC 27002:2013, 2013, Section 11 "Physical Security Management".

[Sch07] E. E. Schultz, "Risks due to the Convergence of Physical Security and Information Technology Environments", *Inf. Secur. Tech. Rep. 12*, 2007, p. 80–84.

[RR08] N. Research, T. O. (RTO), "Improving Common Security Risk Analysis", *research report number AC/323(ISP-049)TP/193*, North Atlantic Treaty Organisation, University of California, Berkeley, 2008.

[OWA13] OWASP, "CISO AppSec Guide: Criteria for Managing Application Security Risks", 2013.

[Lev03] D. Levin, "Lessons Learned in Using Live Red Teams in IA Experiments", *in : 3rd DARPA Information Survivability Conference and Exposition (DISCEX-III 2003)*, p. 110–119, 2003.

[KB01]. Recently, an excellent state-of-art survey by Kordy et al. [KPCS14] has shown that attack trees have been extensively studied by the scientific community and are widely accepted within the industry.

Indeed, attack trees [Sch99] provide a systematic way of describing the vulnerability of a system, taking various types of attacks into account. Strengths of attack trees combine two aspects: first, an *intuitive representation of possible attacks* and second, *formal mathematical frameworks for analyzing them* in a qualitative or a quantitative manner [MO06,KMRS14].

This research line contributes to the development of mathematical foundations for attack trees and of a tool to assist security experts in their design.

2.3 Application domains

2.3.1 Security: assisted design of attack trees

Participants: Maxime Audinot, Sophie Pinchinat, Sébastien Lê Cong, Florence Wacheux, Didier Vojtsek and Barbara Kordy.

Risk Analysis is a discipline consisting in identifying and evaluating risks that threaten a given system in order to reduce or annihilate them by defining actions to engage (risk management). Such analysis is central when the aim is to ensure the security of an information system means guaranteeing data availability, integrity and confidentiality.

Current methods follow mostly a common methodology: one decomposes the system to analyze into subsystems and produces a model, then one draws up a list of feared events, and finally determines the potential reasons of their emergence.

For the particular case of risk analysis in physical security, these steps are mostly processed by hand, based on knowledge and experiences of analysts and technicians. In order to match the standards of experts in risk analysis, the whole process is conducted in two steps:

Step 1 One produces an *attack/defense tree*, that is a tree-like structure where one easily reads the attacker's abilities to achieve her attack and the weaknesses of the defender's capabilities to counter them. The attack/defense tree levels describe

[KB01] D. L. Kewley, J. F. Bouchard, "DARPA Information Assurance Program dynamic defense experiment summary", *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on 31*, 4, 2001, p. 331–336.

[KPCS14] B. Kordy, L. Piètre-Cambacédès, P. Schweitzer, "DAG-Based Attack and Defense Modeling: Don't Miss the Forest for the Attack Trees", *Computer Science Review*, 2014, DOI: 10.1016/j.cosrev.2014.07.001.

[Sch99] B. Schneier, "Attack Trees", *Dr. Dobb's Journal of Software Tools 24*, 12, 1999, p. 21–29, `http://www.ddj.com/security/184414879`.

[MO06] S. Mauw, M. Oostdijk, "Foundations of Attack Trees", *in : ICISC'05*, D. Won, S. Kim (editors), *LNCS*, *3935*, Springer, p. 186–198, 2006, `http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.97.1056`.

[KMRS14] B. Kordy, S. Mauw, S. Radomirović, P. Schweitzer, "Attack–Defense Trees", *Journal of Logic and Computation 24*, 1, 2014, p. 55–87.

successful attacks at different level of abstraction. The attack/defense tree is meant to describe all successful attacks, independently of their realism due to intrinsic cost of their application.

Step 2 The attack/defense tree obtained in Step 1 is reworked to incorporate cost features on actions and then exploited to reveal the more realistic scenarios.

We develop an entire tool-supported methodology to help security experts in prototyping secure sites on the basis of attack/defense trees.

2.3.2 Drones

Participants: François Schwarzentruber, Ocan Sankur and Arthur Queffelec.

A number of use cases of planning rose in information-gathering missions from the development of unmanned autonomous vehicles (UAVs). For instance, in search and rescue missions, a fleet of drones can cover a lot of ground in a short amount of time and report any finding to a mission supervisor to narrow the search for the rescue team. Other examples are the analysis of terrain for smart farms and in hazardous locations. For this kind of missions, the information gathered is used for decision making at a supervising station. Thus, the drones need to be constantly in communication with the station to report the gathered information during the mission. The use of multiple UAVs to cover an area not only reduces the time required to complete the mission but can also enable reaching locations which would not be reachable with a single drone due to connection constraints.

3 Scientific achievements

3.1 Attack trees for Risk Analysis

3.1.1 Guided design of attack trees: a system-based approach

Participants: Maxime Audinot, Sophie Pinchinat and Barbara Kordy.

Presented at CSF 2018.

Attack trees are a well-recognized formalism for security modeling and analysis, but in this work we tackle a problem that has not yet been addressed by the security or formal methods community – namely guided design of attack trees. The objective of the framework presented in this paper is to support a security expert in the process of designing a pertinent attack tree for a given system. In contrast to most of existing approaches for attack trees, our framework contains an explicit model of the real system to be analyzed, formalized as a transition system that may contain quantitative information. The leaves of our attack trees are labeled with reachability goals in the transition system and the attack tree semantics is expressed in terms of traces of the system. The main novelty of the proposed framework is that we start with an attack tree which is not fully refined and by exhibiting paths in the system that are optimal with

respect to the quantitative information, we are able to suggest to the security expert which parts of the tree contribute to optimal attacks and should therefore be developed further. Such useful parts of the tree are determined by solving a satisfiability problem in propositional logic.

3.1.2 Deciding the Non-Emptiness of Attack Trees

Participants: Maxime Audinot, Sophie Pinchinat, François Schwarzentruber and Florence Wacheux.

Presented at GraMSec 2018.

We define and study the decision problem of the non-emptiness of an attack tree. This decision problem reflects the natural question of knowing whether some attack scenario described by the tree can be realized in (a given model of) the system to defend. We establish accurate complexity bounds, rang- ing from NP-completeness for arbitrary trees down to NLOGSPACE-completeness for trees with no occurrence of the AND operator. Additionally, if the input sys- tem to defend has a succinct description, the non-emptiness problem becomes PSPACE-complete.

3.2 Epistemic planning

3.2.1 Chain-Monadic Second Order Logic over Regular Automatic Trees and Epistemic Planning Synthesis

Participants: Gaëtan Douëneau-Tabot, Sophie Pinchinat and François Schwarzentruber.

Presented at AiML 2018.

We consider infinite relational structures that have a finite presentation by means of a finite tuple of finite-state automata, and already known as automatic structures. While it is well established that model checking against first-order logic is decidable over automatic structures, we show how this seminal result can be adapted for a restricted class of automatic structures called regular automatic trees and an extension of the logic based on chain-MSO , and written cMSO (where MSO stands for monadic second-order logic). The logic cMSO , as chain-MSO, is interpreted over trees, and its second-order quantifiers range over subsets of branches. In the setting of regular automatic trees, we relate cMSO and logics of knowledge and time, among which the branching epistemic linear-time mu-calculus $BL_{\mu}^{lin}K$. We finally apply our results to dynamic epistemic logic and its related epistemic planning problem: when restricting to event models with propositional preconditions and postconditions, the relational structures arising from epistemic planning problems turn out to be regular automatic trees. This already established latter central property allows us to derive the (already known) decidability of the epistemic planning problem as a mere corollary, but also to enlarge the class of decidable epistemic planning problems to goals expressed in , with an effective way of computing the set of all successful (possibly infinite) plans.

3.2.2 Small undecidable problems in epistemic planning

Participants: Sophie Pinchinat, François Schwarzentruber and Sébastien Lê Cong.

Presented at IJCAI 2018.

Epistemic planning extends classical planning with knowledge and is based on dynamic epistemic logic (DEL). The epistemic planning problem is unde- cidable in general. We exhibit a small undecid- able subclass of epistemic planning over 2-agent S5 models with a fixed repertoire of one action, 6 propositions and a fixed goal. We furthermore con- sider a variant of the epistemic planning problem where the initial knowledge state is an automatic structure, hence possibly infinite. In that case, we show the epistemic planning problem with 1 public action and 2 propositions to be undecidable, while it is known to be decidable with public actions over finite models. Our results are obtained by reducing the reachability problem over small universal cel- lular automata. While our reductions yield a goal formula that displays the common knowledge op- erator, we show, for each of our considered epis- temic problems, a reduction into an epistemic plan- ning problem for a common-knowledge-operator- free goal formula by using 2 additional actions.

3.3 Reasoning about knowledge

3.3.1 Knowledge-Based Policies for Qualitative Decentralized POMDPs

Participants: Abdallah Saffidine, François Schwarzentruber and Bruno Zanuttini.

Presented at AAAI 2018.

Qualitative Decentralized Partially Observable Markov Decision Problems (QDec-POMDPs) constitute a very general class of decision problems. They involve multiple agents, decentralized execution, sequential decision, partial observability, and uncertainty. Typically, joint policies, which prescribe to each agent an action to take depending on its full history of (local) actions and observations, are huge, which makes it difficult to store them onboard, at execution time, and also hampers the computation of joint plans. We propose and investigate a new representation for joint policies in QDec-POMDPs, which we call Multi-Agent Knowledge-Based Programs (MAKBPs), and which uses epistemic logic for compactly representing conditions on histories. Contrary to standard representations, executing an MAKBP requires reasoning at execution time, but we show that MAKBPs can be exponentially more succinct than any reactive representation.

3.4 Logics for multi-agent systems

3.4.1 Relating paths in transition systems: the fall of the modal mu-calculus

Participants: Bastien Maubert, Sophie Pinchinat and Catalin Dima.

Published in ACM Transactions on Computational Logic 19(3): 23:1-23:33 (2018)

We revisit Janin and Walukiewicz's classic result on the expressive completeness of the modal mu-calculus with respect to Monadic Second Order Logic (MSO), which is where the mu-calculus corresponds precisely to the fragment of MSO that is invariant under bisimulation. We show that adding binary relations over finite paths in the picture may alter the situation. We consider a general setting where finite paths of transition systems are linked by means of a fixed binary relation. This setting gives rise to natural extensions of MSO and the mu-calculus, that we call the MSO with paths relation and the jumping mu-calculus, the expressivities of which we aim at comparing. We first show that "bounded-memory" binary relations bring about no additional expressivity to either of the two logics, and thus preserve expressive completeness. In contrast, we show that for a natural, classic "infinite-memory" binary relation stemming from games with imperfect information, the existence of a winning strategy in such games, though expressible in the bisimulation-invariant fragment of MSO with paths relation, cannot be expressed in the jumping mu-calculus. Expressive completeness thus fails for this relation. These results crucially rely on our observation that the jumping mu-calculus has a tree automata counterpart: the jumping tree automata, hence the name of the jumping mu-calculus. We also prove that for observable winning conditions, the existence of winning strategies in games with imperfect information is expressible in the jumping mu-calculus. Finally, we derive from our main theorem that jumping automata cannot be projected, and ATL with imperfect information does not admit expansion laws.

3.5 Demonstration of tools

3.5.1 Generating Plans for Cooperative Connected UAVs

Participants: François Bodin, Tristan Charrier, Arthur Queffelec, François Schwarzentruber.

Presented at IJCAI-ECAI2018.

We present a tool for graph coverage with a fleet of UAVs. The UAVs must achieve the coverage of an area under the constraint of staying connected with the base, where the mission supervisor starts the plan. With an OpenStreetMap interface, the user is able to choose a specific location on which the mission needs to be generated and observes the resulting plan being executed.

3.5.2 Hintikka's World: Agents with Higher-order Knowledge

Participants: François Schwarzentruber.

Presented at IJCAI-ECAI2018.

We present a pedagogical tool called Hintikka's world for showing how artificial agents can reason about higher-order knowledge (an agent knows that another agent knows that...). The system provides famous AI examples such as Muddy children and Russian

cards. The system also allows to implement user's own examples via the description of a Kripke model or via its generation by the generic tableau method prover MetTeL2.

4 Software development

4.1 ATSyRA

Participants: Maxime Audinot, Sophie Pinchinat and Didier Vojtisek.

ATSyRA, or Attack Tree Synthesis for Risk Analysis, is a software that provides tools for security risk analysis of buildings. The software allows to define buildings, in order to look for potential flaws leading to feasible attacks. ATSyRA also provides tools to design and analyze attack trees that help understand the possible threats. See `http://atsyra2.irisa.fr/` for more details and for downloading the plateform.

4.2 Hintikka's world

Participants: François Schwarzentruber.

Hintikka's world shows intelligent artificial agents reasoning about higher-order knowledge (a knows that b knows that...). It enables to explore mental states of the agents by clicking on them. It contains many classical AI examples. It is a tribute to Jaakko Hintikka. This tool can be used for:

- learning modal logic, model checking and satisfiability problem;
- learning models of dynamic epistemic logic;
- having fun with epistemic puzzles.

See `http://hintikkasworld.irisa.fr` for more details.

5 Contracts and collaborations

5.1 International Initiatives

Retina

Participants: François Bodin, Sophie Pinchinat, Arthur Queffelec Ocan Sankur, François Schwarzentruber.

- Project type: EIT Digital project
- Dates: 2018–2022
- PI institution: Université Rennes 1, IRISA
- Other partners: Bright Cape, Foundation Bruno Kessler, JCP Connect

The UAV-Retina platform aims at creating a startup that will commercialize an automatic drone platform to help search and rescue team such as fire-fighters, avalanche S&R as well as military force for Improvised Explosive Device (EID). The work performed in 2018 has been focused on setting up all necessary background to ensure a good start for the startup. The main tasks carried out during the period are the following:

1. The hardware/software of the architecture has been specified;
2. The needed hardware technology has been acquired;
3. The technical team has been hired as well as the startup creator;
4. The co-design process with the firemen has been initiated;
5. A first analysis of the avalanche business case has been initiated.
6. The subcontracting has been successfully completed.

5.2 Bilateral industry grants

Sophie Pinchinat collaborates with the DGA (French Defense Ministry) on Physical Security, supervising the PhD students Maxime Audinot and Florence Wacheux, with Pôle d'Excellence Cyber grant fundings. In this context, she collaborates with:

- Yann Thierry-Mieg, LIP6 laboratory in Paris, as a partner in the development of the ATSyRA plate-form (see the section on software), and
- Lionel van Aertryck, DGA Maîtrise de l'inforation, Bruz.

5.3 Collaborations

Non-contractual collaborations

Sophie Pinchinat:

- Yann Thierry-Mieg, LIP6 laboratory in Paris, as a partner in the development of the ATSyRA plate-form.

François Schwarzentruber:

- Abdallah Saffidine, University of New South Wales, Sydney, Australia. Collaboration on knowledge-based programs and QdecPOMDP.
- Bruno Zanuttini, Normandie Univ. UNICAEN, ENSICAEN, CNRS, GREYC. Collaboration on knowledge-based programs and QdecPOMDP.

Visiting scientists

- Christophe Chareton (visiting 30 january - 18 february), postdoctoral research at LORIA CNRS. Collaboration on logics for multi-agent systems.
- Yann Thierry-Mieg, MCF LIP6 Paris. Collaboration on the development of the model checker used in the ATSyRA plate-form and co-supervision of the PhD student Florence Wacheuxon the extention of ATSyRA to Cyber Security.
- Sasha Rubin (visiting 23 July-3 August), Postdoctoral researcher in computer science ASTREA laboratory (automated strategic reasoning) University of Naples "Federico II". Collaboration on startegic reasoning.

6 Dissemination

6.1 Promoting scientific activities

6.1.1 Scientific Events Selection

Chair of Conference Program Committees

- François Schwarzentruber: RJCIA

Member of Conference Program Committees

- Sophie Pinchinat: AAMAS, GraMSec, IJCAI, WODES, Wollic.
- François Schwarzentruber: AAMAS, AAAI, IJCAI, KR, PRIMA, Dare

Reviewer

- Sophie Pinchinat: AiML, KR
- François Schwarzentruber: KR, SR, IJCAI, AAMAS, Wollic, AAAI, GandALF

6.1.2 Journal

Member of the Editorial Boards

- Sophie Pinchinat: Discrete Event Dynamical Systems.

Reviewer - Reviewing Activities

- François Schwarzentruber: Artificial Intelligence Journal, Fondamentae informatica

6.1.3 Books

Reviewer - Reviewing Activities

- Sophie Pinchinat: review of "Temporal Logics in Computer Science - Finite-State Systems" by S. Demri, V. Goranko, M. Lange (800 pages) for Cambridge University Press.

6.1.4 Invited Talks

- Sophie Pinchinat: "Dynamics of knowledge" at Dynamics of MultiAgent Systems, Lorentz Center, Leiden, NL. See `https://www.lorentzcenter.nl/lc/web/2018/1056/info.php3?wsid=1056&venue=Oort`
- François Schwarzentruber: "Dynamics of knowledge" at Dynamics of MultiAgent Systems, Lorentz Center, Leiden, NL. *Automatic structures for Multi-agent systems*

6.1.5 Scientific Expertise

- Sophie Pinchinat has reviewed a project submitted to the FWF Austrian Science Fund (323k euros).
- Sophie Pinchinat is the scientific consultant for the IRISA international affairs.

6.1.6 Research Administration

- Sophie Pinchinat: 3 "Comités de Suivi Individuel du Doctorant" for the Doctoral School Mathstic at University of Rennes 1.
- Sophie Pinchinat: Appointed by the director of IRISA directeur as the PhD student mediator.
- François Schwarzentruber: Scientific council at ENS Rennes (2014-)

6.2 Teaching, supervision

6.2.1 Teaching

Sophie Pinchinat:

- Model Checking, 20h, M1, ISTIC Rennes, France
- Advanced Algorithmic, 30h, M1, ISTIC Rennes, France
- Mathematical writing, 30h, M1, ENS Rennes, France
- Summer School "Logic, Uncertainty and Games", 5h, PhD, Lake Como School of Advanced Studies, Italy.

François Schwarzentruber:

- Computability, complexity and logic (agregation) (24h)
- Algorithms and data structures (agregation SCIF) (6h)
- Complexity theory (M1) (24h)
- Epistemic reasoning in AI (tutorial at IJCAI-ECAI 2018) (2h)
- In charge of preparation of the computer science option of the agregation of mathematics
- In charge of the 'prelab' academic year in the computer science department at ENS Rennes

6.2.2 Supervision

- PhD: Tristan Charrier, *Theoretical complexity of reasoning in dynamic epistemic logic and study of a symbolic approach*, defended December 2018, Sophie Pinchinat and François Schwarzentruber.
- PhD: Maxime Audinot, *Assisted design and analysis of attack trees*, defended December 2018, Sophie Pinchinat and Barbara Kordy (EMSEC team, IRISA).
- PhD in progress: Sébastien Lê Cong, starting October 2017, Sophie Pinchinat and François Schwarzentruber.
- PhD in progress: Florence Wacheux, starting October 2018, Sophie Pinchinat and Yann Thierry-Mieg (LIP6).
- M2 Summer internship: Florence Wacheux, student at ISTIC Rennes. Quantitative analysis in security risk analysis,
  event vs. state-based approaches, supervised by Sophie Pinchinat
- M1 Summer internship: Anass Lalkha, master student at University Rennes 1. Generation of possible worlds from a symbolic representation.

6.2.3 Juries

- Sophie Pinchinat: 4 PhD juries (2 international), 1 HDR jury, 2 mock oral exams for "Agrégation de mathématiques".

- François Schwarzentruber: 2 mock oral exams for "Agrégation de mathématiques".

7 Bibliography

Major publications by the team in recent years

[1] M. Audinot, S. Pinchinat, B. Kordy, "Guided Design of Attack Trees: A System-Based Approach", *in : 31st IEEE Computer Security Foundations Symposium, CSF 2018, Oxford, United Kingdom, July 9-12, 2018*, p. 61–75, 2018, https://doi.org/10.1109/CSF.2018.00012.

[2] M. Audinot, S. Pinchinat, F. Schwarzentruber, F. Wacheux, "Deciding the Non-Emptiness of Attack trees", *in : Graphical Models for Security - 5th International Workshop on Graphical Models for Security, Oxford, UK - July 8, 2018*, p. 25–38, 2016, https://doi.org/10.1007/978-3-319-46263-9_2.

[3] F. Bodin, T. Charrier, A. Queffelec, F. Schwarzentruber, "Generating Plans for Cooperative Connected UAVs", *in : Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence, IJCAI 2018, July 13-19, 2018, Stockholm, Sweden.*, p. 5811–5813, 2018, https://doi.org/10.24963/ijcai.2018/846.

[4] T. Charrier, F. Schwarzentruber, "Complexity of Dynamic Epistemic Logic with Common Knowledge", *in : Advances in Modal Logic 7, papers from the 12th conference on "Advances in Modal Logic," held in Bern, Switzerland, 27-31 August 2018*, 2018.

[5] S. L. Cong, S. Pinchinat, F. Schwarzentruber, "Small Undecidable Problems in Epistemic Planning", *in : Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence, IJCAI 2018, July 13-19, 2018, Stockholm, Sweden.*, p. 4780–4786, 2018, https://doi.org/10.24963/ijcai.2018/664.

[6] C. Dima, B. Maubert, S. Pinchinat, "Relating Paths in Transition Systems: The Fall of the Modal Mu-Calculus", *ACM Trans. Comput. Log. 19*, 3, 2018, p. 23:1–23:33, http://doi.acm.org/10.1145/3231596.

[7] G. Douéneau-Tabot, S. Pinchinat, F. Schwarzentruber, "Chain-Monadic Second Order Logic over Regular Automatic Trees and Epistemic Planning Synthesis", *in : Advances in Modal Logic 7, papers from the 12th conference on "Advances in Modal Logic," held in Bern, Switzerland, 27-31 August 2018*, 2018.

[8] J. Euzenat, F. Schwarzentruber (editors), *Actes de la Conférence Nationale d'Intelligence Artificielle et Rencontres des Jeunes Chercheurs en Intelligence Artificielle (CNIA+RJCIA 2018), Nancy, France, 4-6 Juillet 2018*, *CEUR Workshop Proceedings*, *2133*, CEUR-WS.org, 2018, http://ceur-ws.org/Vol-2133.

[9] A. Saffidine, F. Schwarzentruber, B. Zanuttini, "Knowledge-Based Policies for Qualitative Decentralized POMDPs", *in : Proceedings of the Thirty-Second AAAI Conference on Artificial Intelligence, (AAAI-18), the 30th innovative Applications of Artificial Intelligence (IAAI-18), and the 8th AAAI Symposium on Educational Advances in Artificial Intelligence (EAAI-18), New Orleans, Louisiana, USA, February 2-7, 2018*, p. 6270–6277, 2018, https://www.aaai.org/ocs/index.php/AAAI/AAAI18/paper/view/17029.

[10] F. Schwarzentruber, "Hintikka's World: Agents with Higher-order Knowledge", *in : Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence, IJCAI 2018, July 13-19, 2018, Stockholm, Sweden.*, p. 5859–5861, 2018, https://doi.org/10.24963/ijcai.2018/862.