# Activity Report 2022

## Team LOGICA

LOgic, Games, Information, Coordination, and Applications

D4 – Language and Software Engineering

# 1   Team composition

**Researchers and faculty**
>   Sophie Pinchinat, PR University of Rennes 1
>   François Bodin, PR University of Rennes 1
>   François Schwarzentruber, MCF ENS Rennes

**Research engineers, technical staff**
>   Laurent Morin, Engineer, UR1 (100%)
>   Olivier Martineau, Engineer, CDD (100%)
>   Didier Vojtisek, Engineer, INRIA (20%)

**PhD students** Dylan Bellier (CDSN)
>   Pierre Le Scornet (UR1)
>   Alexandre Terefenko (UR1/UMONS)

**Administrative assistant**
>   Sophie Maupilé

# 2   Overall objectives

## 2.1   Overview

The LOGICA team studies theoretical and practical aspects of *multi-agent systems* (MAS). The notion of MAS is finding a wide range of applications: multi-robot systems (e.g. drones), web services, distributed systems, decentralized control, cyber-physical systems, games, etc. Therefore, an agent could be either a physical entity, a computer program, or a human being. Its behaviour can be cooperative, adversarial, or malicious. In a more abstract view, MAS are systems composed of agents that are autonomous entities deciding by themselves which actions to perform in order to meet their objectives.

Noticeably, in a MAS, agent may not have perfect information about their environment. As a consequence, agent decisions are taken on the basis of the available information, that changes dynamically due to events occurring over time.

Reasoning about MAS requires their formal modeling and the development of theories. Such theories should support their deployment in practice, by providing guarantees and certification of their proper functioning. This can be achieved by various means: verification (model-checking), automated generation (synthesis), and coordination mechanisms between agents (control/orchestration/choreography/communication). The LOGICA group contributes to the foundations of MAS by developing innovative ideas in these lines. A particular research interest concerns the use of logical approaches where both the models for MAS and the languages for the specification of their properties lead to effective methods.

Additionally to contributing to the foundations of MAS, the LOGICA team investigates several application domains: IoT, data Logistics and risk analysis in MAS (with attack tree specifications).

## 2.2   Application domains

- Development of a platform for IoT that allows experiments with data logistics.

- Vulnerability analysis of virtualized networks.

- Information systems risk analysis via attack generation and attack tree design.

## 2.3   Scientific foundations

The team activities are spread in theoretical aspects of computer science as well as applied ones.

Most of its members work on developing a wide spectrum of ideas and results, in particular in logic, for the analysis of automated reasoning methods in multi-agents systems (MAS): epistemic reasoning, strategic reasoning, dependencies between strategies, synthesis of correct behavior. In most cases, a careful study of the computational complexity of the exhibited problems is conducted. Main research topics are reasoning under

uncertainty in MAS, planning problems, strategic reasoning, foundations of attack trees in risk analysis, and automata techniques for system verification and synthesis.

Other researchers are involved in collaborative research and technological design and developments with the territorial authorities to conduct research in IoT and data Logistics.

### 2.3.1 Strategic reasoning: strategy dependencies

Sophie Pinchinat and François Schwarzentruber supervise Dylan Bellier to explore logic-based mathematical settings to specify and handle dependencies of agent strategies in decision making systems.

### 2.3.2 Theoretical aspects of security

Members of the team involved in this research line are Sophie Pinchinat, Didier Vojtisek, Alexandre Terefenko and Pierre Le Scornet.

- Sophie Pinchinat and Didier Vojtisek maintain their tight collaboration (contract Ouest Valorisation number 2020 00161) with the start-up SYA Digital to tune a well-thought Domain Specific Language dedicated to the specification of asset-based systems. This collaboration aims at enlarging the ATSyRA platform (`http://atsyra2.irisa.fr/`) to the risk analysis of information systems, on top of previous analysis tools for physical systems.

  Sophie Pinchinat dedicates 10% of her time for this collaboration, and Didier Vojtisek 20%.

- Sophie Pinchinat and Pierre Le Scornet (PhD started in September 2021 and aborted in August 2022 because Pierre Le Scornet got a position as a computer science teacher in Classes Préparatoires) have worked on the problem of synthezising an attack in virtualized network systems. They took inspiration from the approach of Pernelle Mensah[Men19a] who's work outlines an operational model for such systems. Significant decidability results have been established in a report, but the results have not been published. Sophie Pinchinat will continue this line of research.

- Sophie Pinchinat and Alexandre Terefenko collaborate with Prof. Thomas Brihaye from University of Mons, Belgium, to design a strategy-based semantics of attack trees that will allow to reason on systems that involve several agents, attackers and/or defenders, in order to generalize the correctness criteria of attack trees for single-agent systems as developed in the thesis of Maxime Audinot[?], former PhD student of the team.

[Men19a]    P. MENSAH, *Generation and Dynamic Update of Attack Graphs in Cloud Providers Infrastructures*, Theses, CentraleSupélec, June 2019, `https://hal.inria.fr/tel-02416305`.

### 2.3.3   Automata techniques for system verification and synthesis

Sophie Pinchinat and François Schwarzentruber keep on with the problem of synthesizing a logical specification given a model, that allows to exhibit a proerty (if any) among a possibly infinite set. The set is seen as a finite-word language described by a grammar, and the properties are given in thos languages, e.g. as modal logic formulas.

This problem generalizes the classic model checking problem in verification and becomes a matter of increasing concern within the formsal methods community.

### 2.3.4   Smart-city and IoT

The smart-city activities of LOGICA keeps on with two projects : the continuation of the RUDI (`https://rudi.datarennes.fr`) project "RUDI-producer nodes: governance principles, conception, development, operation (2020-2023)" and the project"Breizh Mobilité Décarbonée (2022-2023)".

## 3   Scientific achievements

### 3.1   Dependency Matrices for Multiplayer Strategic Dependencies

**Participants**:   Dylan Bellier, Sophie Pinchinat, François Schwarzentruber.

In multi-player games, players take their decisions on the basis of their knowledge about what other players have done, or currently do, or even, in some cases, will do. An ability to reason in games with temporal dependencies between players' decisions is a challenging topic, in particular because it involves imperfect information. In this work, we propose a theoretical framework based on dependency matrices that includes many instances of strategic dependencies in multi-player imperfect information games. For our framework to be well-defined, we get inspiration from quantified linear-time logic where each player has to label the timeline with truth values of the propositional variable she owns. We study the problem of the existence of a winning strategy for a coalition of players, show it is undecidable in general, and exhibit an interesting subclass of dependency matrices that makes the problem decidable: the class of perfect-information dependency matrices.

This achievement has been published at the 42nd IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (see [3]).

### 3.2   Good-for-games Quantified Propositional Time Logic

**Participants**:   Dylan Bellier.

*Joint work with Fabio Mogavero and Massimo Benerecetti and Dario Della Monica of the Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione of Università degli Studi di Napoli Federico II.*

We define two semantics: one that is formal and compositional and one game-theoretic. By showing them equivalent, we give two points of view on this logic, which allowed us to develop verification algorithms (for model-checking and satisfiability). In multi-player games, players take their decisions on the basis of their knowledge about what other players have done, or currently do, or even, in some cases, will do. An ability to reason in games with temporal dependencies between players' decisions is a challenging topic, in particular because it involves imperfect information. In this work, we propose a theoretical framework based on dependency matrices that includes many instances of strategic dependencies in multi-player imperfect information games. For our framework to be well-defined, we get inspiration from quantified linear-time logic where each player has to label the timeline with truth values of the propositional variable she owns. We study the problem of the existence of a winning strategy for a coalition of players, show it is undecidable in general, and exhibit an interesting subclass of dependency matrices that makes the problem decidable: the class of perfect-information dependency matrices.

These results have been published as an article in the ACM Journal Transactions On Computational Logic (see [2]).

## 3.3   Formula synthesis in propositional dynamic logic with shuffle.

**Participants**:   Sophie Pinchinat, François Schwarzentruber.

*Joint work with Prof. Sasha Rubin Senior Lecturer Leader of the Computational Logic for Artificial Intelligence (LOGIC-AI) group School of Computer Science from University of Sydney, Australia.*

We introduce the formula-synthesis problem for Propositional Dynamic Logic with Shuffle (PDLS). This problem, which generalises the model-checking problem againts PDLS is the following: given a finite transition system and a regular term-grammar that generates (possibly infinitely many) PDLS formulas, find a formula generated by the grammar that is true in the structure (or return that there is none). We prove that the problem is undecidable in general, but add certain restrictions on the input structure or on the input grammar to yield decidability. In particular, we prove that (1) if the grammar only generates formulas in PDL (without shuffle), then the problem is EXPTIME-complete, and a further restriction to linear grammars is PSPACE-complete, and a further restriction to non-recursive grammars is NP-complete, and (2) if one restricts the input structure to have only simple paths then the problem is in 2-EXPTIME. This work is motivated by and opens up connections to other forms of synthesis from hierarchical descriptions, including HTN problems in Planning and Attack-tree Synthesis problems in Security.

This work has been published at AAAI-2023, the 36th Conference on Artificial Intelligence, Vancouver, BC, Canada, February 22 - March 1, 2022 (see [7]).

## 3.4   Theoretical aspects of security

### 3.4.1   Attack Synthesis in Virtualized Networks

**Participants**:   Pierre Le Scornet Sophie Pinchinat.

Virtualization is a new development of Cloud technologies. It refers to creating a virtual version of an actual piece of hardware, for example, a real computer with an operating system, and is controlled by a hypervisor running on a host machine. It is often designed to respect some security properties, especially the separation between the virtualized environment and the underlying system. Cloud providers use this technology to build complex virtual services, from virtual infrastructures rented to back customer services to *Software-as-a-Service* solutions where virtual networks are used to host software and services. In this context, Cloud providers manage highly dynamic virtual networks containing various types of virtual machines (VM). However, those structures become more and more critical to businesses and individuals, and their security weakens as infrastructures grow in size, complexity and dynamicity. Furthermore, their economic value has increased, prompting organizations and individuals to attack them. With virtualization comes new kinds of security breaches (see the survey [SAD+12]). For example, Virtualized Environment Neglected Operations Manipulation (VENOM) is a vulnerability in Quick EMUlator (QEMU) allowing an attacker located in a VM to access colocated VMs (run by the same hypervisor) and execute arbitrary code [org15]. For administrators of these complex systems, it is essential to assess risks on their infrastructure to be able to apply appropriate countermeasures.

To do so, one needs to know two core pieces of information. On the one hand, one needs a list of vulnerabilities that may be exploited in the virtual network. Each vulnerability comes with pre-conditions such as the attacker's location, his privilege level, some local pieces of information about the network, and with effects on the attacker's penetration and on the network.[1] On the other hand, one needs a view of the virtual network, i.e., an up-to-date list of the VMs in the network and their characteristics. Building such views is an area of research by itself (see [EBN08,MRW15] for example). In the context of virtual network analysis, one also needs a way to dynamically update this model under the influence of events, such as VM creations, deletions, migrations, modifications, etc. [MDK+17]. A commonly accepted approach is *attack graph analysis*,

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[1]There exist vulnerability databases, like CVE (`https://cve.mitre.org`), but they may have to be refined with more information about their pre- and post-conditions [Men19b].

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[SAD+12]   I. STUDNIA, E. ALATA, Y. DESWARTE, M. KAÂNICHE, V. NICOMETTE, "Survey of Security Problems in Cloud Computing Virtual Machines", *in: Computer and Electronics Security Applications Rendez-vous (C&ESAR 2012). Cloud and security:threat or opportunity*, p. p. 61–74, Rennes, France, November 2012, `https://hal.archives-ouvertes.fr/hal-00761206`.

[org15]   M. ORGANIZATION, "VENOM CVE entry", `https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2015-3456`, 2015.

[EBN08]   B. ERIKSSON, P. BARFORD, R. NOWAK, "Network Discovery from Passive Measurements", *SIGCOMM Comput. Commun. Rev. 38*, 4, August 2008, p. 291–302.

[MRW15]   R. MOTAMEDI, R. REJAIE, W. WILLINGER, "A Survey of Techniques for Internet Topology Discovery", *IEEE Communications Surveys Tutorials 17*, 2, 2015, p. 1044–1065.

[MDK+17]   P. MENSAH, S. DUBUS, W. KANOUN, C. MORIN, G. PIOLLE, E. TOTEL, "Connectivity

modeling an attacker's penetration into a network, but the attack graph model can vary. The first model of attack graph is called *state-based* as each node of its graph is a state of the system and each edge is a vulnerability [SHJ+02]. A parallel approach relies on the *vulnerability-based* attack graphs [AWK02], where nodes are attributes of the network, such as VM status, software version, etc., and edges are labeled with vulnerabilities. The unavoidable exponential blowup in the number of states in [SHJ+02] led to a second type of attack graph, named *host-based* [APRS05,Men19b], where each node is a specific device with the attacker's level of access, and each edge is a vulnerability an attacker may exploit.

Each of those three types of attack graph models may come with some algorithms to generate them, dynamically update them or analyze them from network management tools. While these models are essentially designed for security analysis in a static network, the host-based model introduced in [Men19b] allows to capture the dynamics of virtualized networks. The approach provides efficient graph transformation algorithms to keep the attack graph model up-to-date in an always-evolving network, thus allowing to perform *monitoring*. However, it is not clear whether the proposed dynamic model, intrinsically infinite, is amenable to perform *verification* such as deciding if an attacker elevating to certain privilege on some VM is reachable in a dynamic network.

Our contribution aims at answering this question.

- We formalize the dynamic host-based attack graph model from [Men19b] as an infinite (state-)transition system, called *Snapshot Transition System (STS)*. In an STS, each state represents a snapshot of the network and the attacker's privilege in it, and state-transitions represent the network and attacker's dynamics, i.e., events altering the virtual network configuration. We choose to represent network snapshots as first-order structures where the domain is the set of all VM at a given time, and each VM holds information about its hypervisor, its internal configuration and the attacker's privilege in it. Then, we define transitions between those states according to the different types of events (creations, deletions, migrations, modifications of VM, and attacker's actions). Each event requires a precondition to hold in order to trigger the event.

- We use STSs to define a decision problem, called the *Reachability Problem* (Reach), security properties verification in virtual networks: namely, we want

graph reconstruction for networking cloud infrastructures", *in: 2017 IEEE 16th International Symposium on Network Computing and Applications (NCA)*, p. 1–9, 2017.

[SHJ+02]  O. SHEYNER, J. HAINES, S. JHA, R. LIPPMANN, J. M. WING, "Automated generation and analysis of attack graphs", *in: Proceedings 2002 IEEE Symposium on Security and Privacy*, p. 273–284, 2002.

[AWK02]   P. AMMANN, D. WIJESEKERA, S. KAUSHIK, "Scalable, Graph-Based Network Vulnerability Analysis", *in: Proceedings of the 9th ACM Conference on Computer and Communications Security, CCS '02*, Association for Computing Machinery, p. 217–224, NY, USA, 2002, `https://doi.org/10.1145/586110.586140`.

[APRS05]  P. AMMANN, J. PAMULA, R. RITCHEY, J. STREET, "A host-based approach to network attack chaining analysis", *in: 21st Annual Computer Security Applications Conference (ACSAC'05)*, p. 10 pp.–84, 2005.

[Men19b]  P. MENSAH, *Generation and Dynamic Update of Attack Graphs in Cloud Providers Infrastructures*, PdD Thesis, CentraleSupélec, June 2019, `https://hal.inria.fr/tel-02416305`.

to decide if there exists a reachable STS that satisfies a given first-order formula describing a security breach in the virtual network. Even if the set of all reachable network snapshots is potentially infinite, we establish the decidability of Reach, and classify the complexity of this problem according to restrictions made on the initial configuration of the network and on the expressiveness of the dynamics in terms of the logical expressiveness of the event preconditions.

Two unpublished reports exist.

### 3.4.2   Adversarial Formal Semantics of Attack Trees and Related Problems.

**Participants**:  Sophie Pinchinat, Alexandre Terefenko.

*Joint work with Prof. Thomas Brihaye, head of the "Service de Mathématiques Effectives", Département de Mathématique, from University of Mons, Belgium.*

Security is a subject of increasing attention in our actual society in order to protect critical resources from information disclosure, theft or damage. The informal model of attack trees introduced by Schneier, and widespread in the industry, is advocated in the 2008 NATO report to govern the evaluation of the threat in risk analysis. Attack-defense trees have since been the subject of many theoretical works addressing different formal approaches.

In 2017, M. Audinot et al. introduced a path semantics over a transition system for attack trees. Inspired by the latter, we propose a two-player interpretation of the attack-tree formalism. To do so, we replace transition systems by concurrent game arenas and our associated semantics consist of strategies. We then show that the emptiness problem, known to be NP-complete for the path semantics, is now PSPACE-complete. Additionally, we show that the membership problem is coNP-complete for our two-player interpretation while it collapses to PTIME in the path semantics.

The work has been published at the 13th International Symposium on Games, Automata, Logics and Formal Verification, GandALF 2022, Madrid, Spain, September 21-23, 2022 (see [4]).

## 4   Software development

### 4.1   Risk analysis in information systems: ATSyRA platform

**Participants**:  Sophie Pinchinat, Didier Vojtisek.

*Joint work with Maxime Audinot, Laurent Collet (head), William Ragot of the SYA Digital company from Rennes.*

We keep on with the ATSyRA platform development (`http://atsyra2.irisa.fr/`) to address the risk analysis of information systems, on top of previous analysis tools for physical systems.

Most of our research code is being made available through `http://atsyra2.irisa.fr/`. The software functionalities are essentially the specification of an information

system, reachability analysis with scenario synthesis, and an attack tree design assistant tool with correctness criteria checking of the specified attack trees via model checking techniques.

This year, the software development is performed in the context of an industrial collaboration with the start-up SYA Digital from Rennes.

# 5    Contracts and collaborations

## 5.1    National Initiatives

### 5.1.1    RUDI-producer nodes: governance principles, conception, development, operation (2020-2023)

**Participants**:   François Bodin, Laurent Morin, Olivier Martineau.

RUDI European project aims at making as easy as possible for Rennes metropolis public service actors to share their data to citizens and companies.

Through direct collaboration with Rennes Métropole and other territorial public data actors, the University of Rennes 1/IRISA has contributed to the elaboration of the governance principles, the conception and development of the RUDI data exchange platform. Different challenges were identified:

- The data content and formats are highly heterogenous: they can cover various domains such as social-economics, environment, geography, mobility, energy networks, education...

- The data producers are themselves heterogenous by nature: the municipalities, the metropolis, the associations and the local or national industrial actors allocate to the publication of their data different levels of effort, and their point of view or even awareness to data publication is of course bound to their own use.

- Data producers need a constant control on the publication, update or deletion of the data as well as the metadata that document them. Data Sovereignty is crucial, as much as the ease to publish them or the need to check the status of the data.

- Sharing data on the internet comes with an immediate exposure to hacking threats: cybersecurity needs an effort at every level.
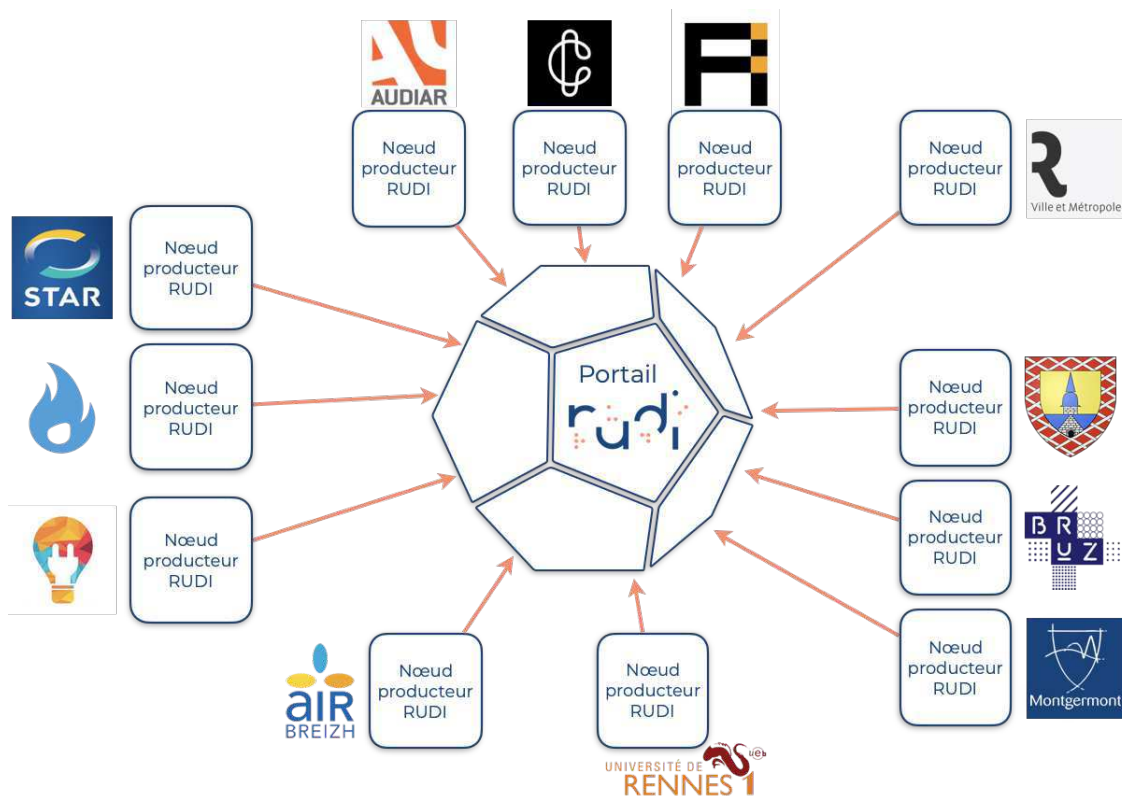
A decentralized platform such as the federation of RUDI producer nodes (cf. Fig. A) is an interesting way to tackle such challenges: a producer node offers a data producer both a technical object that can be hosted by the data producer themselves, and a software solution that answers the need for control/supervision, making it easy to add, modify or delete data sets and associated metadata in RUDI ecosystem. The metadata created in the RUDI producer node references the data hosted on it, or on the producer portal, and only such metadata are shared (through an API that respects INSPIRE principles) to a central portal that offers the end-user a way to search the data.

For this project, the IRISA/UR1 contributed on the governance principles and the conception of the RUDI producer node federation, supporting the largest part if not all the efforts on the conception, the development of the producer node (API, UI, media hosting) but also the securing and the hosting (mostly with the help of the CEA through the Fenix project) of 20 dedicated operational nodes. A large number of "harvesters" were also developed to periodically scan the published data on a producer's existing portal and replicating the metadata on the RUDI producer node, or digesting incoming data and transmitting it to the producer node, establishing by that very fact an ad-hoc link between the producer's information system and their RUDI node.

### 5.1.2   Breizh Mobilité Décarbonée (2022-2023)

**Participants**:   François Bodin, Laurent Morin, Olivier Martineau.

The BMDec (Breizh Mobilité Décarbonée) project aims to design a decision support

tool for multimodal mobility to meet the challenges of decarbonization of peri-urban "home to work" mobility at the scale of the Brittany region, with experimentations at Rennes and at Brest metropolis.

The BMDec project consortium is composed of four partners: SETUR (Digital solutions), RatpDev (Transportation operator) and two research laboratories from the University of Rennes 1: CREM (Behavioral economics) and IRISA (Computer science).

The contribution of the university of Rennes 1 is twofold:

1. Design a set of software services for implementing user panel survey

2. Study the impact of nudges on mobility decision

The project main innovation is to implement a daily survey over a 3-month periods to understand how mobility decisions are made and how decarbonated mean should be promoted. Irisa is in charge of collecting and protecting users' data.

This multidisciplinary project is funded by the Region Bretagne.

## 5.2   Collaborations

### 5.2.1   Software Development for Information System Security

**Participants**:   Sophie Pinchinat, Didier Vojtisek.

The IRISA team LOGICA and the start-up SYA Digital had a research collaboration.

The project aims at developing a assistant tool for reasoning about Information System Security in terms of its design and its potential vulnerabilities. The ATSyRA software plateform of the LOGICA team is the basis of the project.

The IRISA team LOGICA and the start-up SYA Digital haad a contract supervised by the university service Ouest-Valorisation.

### 5.2.2   Academia with Italy on "Multi-agent Strategic Reasoning"

**Participants**:   Dylan Bellier, Sophie Pinchinat.

*Joint work with Fabio Mogavero and Massimo Benerecetti of the Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione of Università degli Studi di Napoli Federico II.*

We have a tight collaboration with Fabio Mogavero and Massimo Benerecetti on Multi-agent Strategic Reasoning.

The collaborative project aims developping innovative approaches in logic for strategic reasoning. The main focus is to question the notion of feasible strategies, a notion that magnetizes a lot of attention from the community since it allows to describe problems emerging from today's technology. Additionally, and beyond sustaining a fruitful academic interaction, we have the ambition of building a recognized research network at the international level.

Sophie Pinchinat and Fabio Mogavero were the scientific and origanization chairs of the International Workshop on Logical Aspects in Multi-Agent Systems and Strategic Reasoning August 25-26, 2022, Rennes, France Co-located with AiML 2022.

The collaboration has been supported by a grant from DRI of University of Rennes 1.

This year, Dylan Bellier and Sophie Pinchinat visited the Italian lab twice (June 2022 and January 2023), and the Italian collaborators Fabio Mogavero and Massimo Benerecetti visited IRISA once (August 2022).

### 5.2.3 Academia with Italy on "Quantitative Strategic Logics"

**Participants**:  Sophie Pinchinat.

*Joint work with Nicolas Markey (PI), CNRS IRISA, and Aniello Murano (PI) head of the Astrea team, U. Naples, Italy*

Strategic reasoning is a powerful approach to the verification and synthesis of reliable computer systems, for which several logics have recently been defined. Our aim in this project is to further develop this line of research by incorporating quantitative aspects, e.g. modelling timing aspects, energy consumption or stochastic behaviours. A long-term goal is to develop notions of quality of strategies, with the aim of optimising these measures. Our workplan can be presented along three axes (which all involve the whole team but where we identified a leader for each axis):

1. measuring the quality of strategies,

2. measuring the efficiency of strategies,

3. measuring the needed knowledge of strategies.

The collaboration is supported by an Inria Associated Team funding. Sophie Pinchinat and Nicolas Markey visited Naples once.

## 6   Dissemination

### 6.1   Promoting scientific activities

#### 6.1.1   Scientific Events Organisation

**General Chair, Scientific Chair**

- Sophie Pinchinat was the Scientific co-Chair of the International Workshop on Logical Aspects in Multi-Agent Systems and Strategic Reasoning August 25-26, 2022, Rennes, France.

**Member of the Organizing Committees**

- Sophie Pinchinat was the Organization Chair of the internation conference on Advances in Modal Logic 2022 Rennes, August 22-25.

- Sophie Pinchinat was the Organization Chair of the International Workshop on Logical Aspects in Multi-Agent Systems and Strategic Reasoning August 25-26, 2022, Rennes, France. Co-located with AiML 2022.

### 6.1.2 Scientific Events Selection

**Chair of Conference Program Committees**

- Sophie Pinchinat was the scientific co-chair of the International Workshop on Logical Aspects in Multi-Agent Systems and Strategic Reasoning August 25-26, 2022, Rennes, France

**Member of Conference Program Committees**

- François Schwarzentruber contributed as: SPC at AAAIs, PC at AAMAS, PC at IJCAI, PC at IJCAI@demo, PC at PRIMA.

- Sophie Pinchinat contributed as: PC at AAAI, Board-PC at IJCAI, PC at LAMAS&SR, PC at AiML, PC at JIAF-JFPDA.

**Reviewer**

- François Schwarzentruber reviewed for AAAI, AMAAS, IJCAI, PRIMA.

- Sophie Pinchinat reviewed for AAAI, IJCAI, LAMAS&SR, AiML, JIAF.

### 6.1.3 Journal

**Reviewer - Reviewing Activities**

- François Schwarzentruber reviewed for Journal of Artificial Intelligence Research, Annals of Pure and Applied Logic, Artificial Intelligence Journal.

- Sophie Pinchinat reviewed for IEEE Transactions on Dependable and Secure Computing.

- Dylan Bellier reviewed for ACM Transactions on Computational Logic.

- Alexandre Terefenko reviewed for IEEE Transactions on Dependable and Secure Computing.

### 6.1.4   Invited Talks

- François Bodin was invited twice:

    - "Vers un calcul de haute performance frugal", NRC22 France, Senlis, France, November, 23-24 2022.
    - 49ième Forum ORAP : Le PEPR Numpex "Numérique pour l'Exascale", Exa-AToW Architectures and Tools for Large-Scale Workflows, Saclay, France, November 29, 2022.

- Sophie Pinchinat was invited twice:

    - (virtual talk) "Model checking over infinite structures: Automatic Structures and Regular Automatic Trees" at the Fourteenth Latin American Workshop on New Methods of Reasoning 2022 held online on June 16th and 17th, 2022 in Mexico City, Mexico.
    - "Formula synthesis in propositional dynamic logic with shuffle" at the Conférence Nationale en Intelligence Artificielle. 27 Juin - 29 juin 2022, Saint-Étienne, France. Co-located with PFIA 2022.

- François Schwarzentruber was invited twice:

    - "Connected multi-agent path finding" Séminaire LMF ENS Paris-Saclay, March 29, 2022.
    - "Connaissances, annonces et actions", Journées Plénières du GDR IA 2022, Arras, France, October 12-14, 2022

### 6.1.5   Scientific Expertise

Sophie Pinchinat was a member of an ANR selection committee.

## 6.2   Teaching, supervision

### 6.2.1   Teaching

- Licence:  François Bodin, Découverte Informatique, L1, ISTIC, Université de Rennes 1, France.
- Licence:  Laurent Morin, Découverte Informatique, L1, ISTIC, Université de Rennes 1, France.
- Licence:  Dylan Bellier, Fondements et Outils Mathématiques, 30h, L1, ISTIC, Université de Rennes 1, France.
- Licence: Dylan Bellier, Principes des systèmes informatiques, 30h of lab sessions, L1, ISTIC, Université de Rennes 1, France.
- Licence:  Sophie Pinchinat, Introduction à l'Informatique et à Java, 6h of lab sessions, L1, ISTIC, Université de Rennes 1, France.
- Licence: Sophie Pinchinat, Fondements et Outils Mathématiques, 30h, L1, ISTIC, Université de Rennes 1, France.

- Licence: Dylan Bellier, Calculabilité, 24h of lab sessions, L2, ISTIC, Université de Rennes 1, France.
- Licence: Dylan Bellier, Genie logiciel, 20h of lab sessions, L2, ISTIC, Université de Rennes 1, France.
- Licence: Sophie Pinchinat, Logique, 10h, L3 Informatique, ISTIC, Université de Rennes 1, France.
- Licence: Sophie Pinchinat, Méthodes algorithmiques, 24h, L3 Informatique, IS-TIC, Université de Rennes 1, France.
- Licence: François Schwarzentruber, Introduction to algorithms, 22h, L3 SIF (Science Informatique), ISTIC, Université de Rennes 1/ENS Rennes, France.
- Licence: François Schwarzentruber, Advanced algorithms, 22h, L3 SIF (Science Informatique), ISTIC, Université de Rennes 1/ENS Rennes, France.
- Master: François Schwarzentruber, Algorithmique, 8h, M1 MEEF (préparation au CAPES), ISTIC, Université de Rennes 1, France.
- Master: François Schwarzentruber, Complexity theory, 12h, M1 SIF (Science Informatique), ISTIC, Université de Rennes 1/ENS Rennes, France.
- Master: François Schwarzentruber, Méthodes et Vérification Formelle par Automates, 24h, M1 SIF (Science Informatique), ISTIC, Université de Rennes 1/ENS Rennes, France.
- Master: Sophie Pinchinat, Advance Algorithmics, 10h, M1 informatique
- Master: François Schwarzentruber, Algorithmique, 8h, M2 MEEF (préparation au CAPES), ISTIC, Université de Rennes 1, France.
- Préparation à l'agrégation d'informatique: François Schwarzentruber, Practice in Logic, 4h, ISTIC, Université de Rennes 1/ENS Rennes, France.
- Préparation à l'agrégation d'informatique: François Schwarzentruber, Practice in Logic, 4h, ISTIC, Université de Rennes 1/ENS Rennes, France.
- Préparation à l'agrégation d'informatique: François Schwarzentruber, Lessons, 2h, ISTIC, Université de Rennes 1/ENS Rennes, France.
- Préparation à l'agrégation de mécatronique: François Schwarzentruber, Algorithmique, 12h, ENS Rennes, France.

### 6.2.2 Supervision

- PhD in progress:

  - Sophie Pinchinat and François Schwarzentruber supervise Dylan Bellier to explore logic-based mathematical settings to specify and handle dependencies of agent strategies in decision making systems.

  - Sophie Pinchinat co-supervises Alexandre Terefenko with Thomas Brihaye (Université de Mons, Belgium). This PhD is in "co-tutelle" between University of Rennes 1 and University of Mons.

### 6.2.3 Juries

- Sophie Pinchinat was an examinor in the PhD committee of Sébastien GAMBLIN at Université de Caen Normandie (defended on December 12, 2022).

- François Schwarzentruber was an examinor in the PhD committee of Munyque MITTELMANN at IRIT, Université de Toulouse 1 (defended on Septembre 1, 2022).

- François Schwarzentruber was a committee member of the jury of two sessions on Lesson preparation at Préparation à l'agrégation d'informatique, ENS Rennes.

## 6.3   Popularization

### 6.3.1   University/Lycée Mediation

**Participants**:   François Bodin Laurent Morin.

The Logica team organises every year a one-day immersion of Lycée (secondary school) school pupils at the University. This experience, mutually organized with the Lycée "René Cassin" (situated in Montfort-sur-Meu a small town at 30km), proposes to around 30 teenagers in 1ere and Terminale to live the typical day as a student in Computer-Science at the University. The objective is to provide an overview of three main aspects of the University reality: its concrete life in the campus, its studies with a real-life experience of a courses, and its perspectives with a presentation of what is Scientific Research and what is the job of a Researcher.

The agenda of the day is tightly planned with a teacher in Mathematics (main contact: Jean-Baptiste Faure). This year, the main topic was the asymmetric cryptography, and two different interactive courses were setup for the each level of pupils. It was the following:

- Welcome in a set of two real computer lab rooms.

- Presentation of the Campus and of the agenda.

- Introduction to cryptography challenges and encryption/decryption programming exercises on real lab computers from the University (ISTIC).

- A meal (offered by the team) in the student's university restaurant (called RU)

- A presentation by a teaching researcher of its jobs and of its research topics. This year, Marc Christie Assistant Professor at the University of Rennes and Member of the INRIA Mimetic team presented its research in the creation of complex 3D contents for the Movie industry.

- A small Course in symmetric and asymmetric cryptography fundamentals.

## 7   Bibliography

### Books and Monographs

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## Articles in referred journals and book chapters

[2]  D. Bellier, M. Benerecetti, D. D. Monica, F. Mogavero, "Good-for-Game QPTL: An Alternating Hodges Semantics", p. ?:1–55.


## Publications in Conferences and Workshops

[3]  D. Bellier, S. Pinchinat, F. Schwarzentruber, "Dependency Matrices for Multiplayer Strategic Dependencies", *in: 42nd IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science, FSTTCS 2022, December 18-20, 2022, IIT Madras, Chennai, India*, A. Dawar, V. Guruswami (editors), *LIPIcs*, *250*, Schloss Dagstuhl - Leibniz-Zentrum für Informatik, p. 31:1–31:21, 2022, `https://doi.org/10.4230/LIPIcs.FSTTCS.2022.31`.

[4]  T. Brihaye, S. Pinchinat, A. Terefenko, "Adversarial Formal Semantics of Attack Trees and Related Problems", *in: Proceedings of the 13th International Symposium on Games, Automata, Logics and Formal Verification, GandALF 2022, Madrid, Spain, September 21-23, 2022*, P. Ganty, D. D. Monica (editors), *EPTCS*, *370*, p. 162–177, 2022, `https://doi.org/10.4204/EPTCS.370.11`.

[5]  S. Chakraborty, A. Ghosh, S. Ghosh, F. Schwarzentruber, "On Verifying Expectations and Observations of Intelligent Agents", *in: Proceedings of the Thirty-First International Joint Conference on Artificial Intelligence, IJCAI 2022, Vienna, Austria, 23-29 July 2022*, L. D. Raedt (editor), ijcai.org, p. 2568–2574, 2022, `https://doi.org/10.24963/ijcai.2022/356`.

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[7]  S. Pinchinat, S. Rubin, F. Schwarzentruber, "Formula Synthesis in Propositional Dynamic Logic with Shuffle", *in: Thirty-Sixth AAAI Conference on Artificial Intelligence, AAAI 2022, Thirty-Fourth Conference on Innovative Applications of Artificial Intelligence, IAAI 2022, The Twelveth Symposium on Educational Advances in Artificial Intelligence, EAAI 2022 Virtual Event, February 22 - March 1, 2022*, AAAI Press, p. 9902–9909, 2022, `https://ojs.aaai.org/index.php/AAAI/article/view/21227`.