RESEARCH CENTRE

Inria Centre at Université Grenoble Alpes

IN PARTNERSHIP WITH:

Université de Grenoble Alpes

2023

ACTIVITY REPORT

Project-Team MOEX

Evolving Knowledge

IN COLLABORATION WITH: Laboratoire d'Informatique de Grenoble (LIG)

DOMAIN

Perception, Cognition and Interaction

THEME

Data and Knowledge Representation and Processing

Inria

Contents

Project-Team MOEX

Creation of the Project-Team: 2017 November 01

Keywords

Computer sciences and digital sciences

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1 Team members, visitors, external collaborators

Research Scientist

- Jerome Euzenat [Team leader, INRIA, Senior Researcher, HDR]

Faculty Members

- Manuel Atencia [UGA, Associate Professor]
- Jérôme David [UGA, Associate Professor]

Post-Doctoral Fellow

- Helga Lendrin [INRIA, Post-Doctoral Fellow]

PhD Students

- Yasser Bourahla [UGA, until Aug 2023]
- Alda Canito [University of Porto, from Apr 2023 until Jul 2023]
- Andrea Kalaitzakis [UGA]

Interns and Apprentices

- Adrien Bonnardel [UGA, Intern, from Sep 2023]
- Charline Fiorentino [UGA, Intern, until Jun 2023]
- Adriana Luntraru [MIAI GRENOBLE ALPES, Intern, from Feb 2023 until Jul 2023]
- Giorgio Orioles [INRIA, Intern, from Feb 2023 until Jun 2023]
- Emma Rechon-Reguet [UGA, Intern, until May 2023]
- Anais Siebers [INRIA, Intern, from Apr 2023 until Sep 2023]

Administrative Assistant

- Julia Di Toro [INRIA]

Visiting Scientist

- Koji Hasebe [University of Tsukuba, from Jul 2023 until Jul 2023, Invited professor]

2 Overall objectives

Human beings are apparently able to communicate knowledge. However, it is impossible for us to know if we share the same representation of knowledge.

mOeX addresses the evolution of knowledge representations in individuals and populations. The ambition of the mOeX project is to answer, in particular, the following questions:

- How do agent populations *adapt* their knowledge representation to their environment and to other populations?
- How must this knowledge *evolve* when the environment changes and new populations are encountered?

- How can agents preserve knowledge *diversity* and is this diversity beneficial?

We study them chiefly in a well-controlled computer science context.

For that purpose, we combine knowledge representation and cultural evolution methods. The former provides formal models of knowledge; the latter provides a well-defined framework for studying situated evolution.

We consider knowledge as a culture and study the global properties of local adaptation operators applied by populations of agents by jointly:

- *experimentally* testing the properties of adaptation operators in various situations using experimental cultural evolution, and
- *theoretically* determining such properties by modelling how operators shape knowledge representation.

We aim at acquiring a precise understanding of knowledge evolution through the consideration of a wide range of situations, representations and adaptation operators.

In addition, we still investigate RDF data interlinking with link keys, a way to link entities from different data sets.

3 Research program

3.1 Knowledge and belief representation semantics

We work with knowledge and beliefs represented in computers. In principle, the difference between them is based on their epistemological status: knowledge is true belief. But they can both be expressed in the same knowledge representation languages (like description logics, conceptual graphs and object-based languages). Their semantics is usually defined within model theory initially developed for logics.

We consider a language L as a set of syntactically defined expressions (often inductively defined by applying constructors over other expressions). A representation ($o \subseteq L$) is a set of such expressions. It may also be called an ontology. An interpretation function (I) is inductively defined over the structure of the language to a structure called the domain of interpretation (D). This expresses the construction of the "meaning" of an expression in function of its components. A formula is satisfied by an interpretation if it fulfills a condition (in general being interpreted over a particular subset of the domain). A model of a set of expressions is an interpretation satisfying all the expressions. A set of expressions is said consistent if it has at least one model, inconsistent otherwise. An expression (δ) is then a consequence of a set of expressions (o) if it is satisfied by all of their models (noted $o \models \delta$).

The languages dedicated to the semantic web (RDF and OWL) follow that approach. RDF is a knowledge representation language dedicated to the description of resources; OWL is designed for expressing ontologies: it describes concepts and relations that can be used within RDF.

A computer must determine if a particular expression (taken as a query, for instance) is the consequence of a set of axioms (a knowledge base). For that purpose, it uses programs, called provers, that can be based on the processing of a set of inference rules, on the construction of models or on procedural programming. These programs are able to deduce theorems (noted $o \vdash \delta$). They are said to be sound if they only find theorems which are indeed consequences and to be complete if they find all the consequences as theorems.

3.2 Data interlinking with link keys

Vast amounts of RDF data are made available on the web by various institutions providing overlapping information. To be fully exploited, different representations of the same object across various data sets, often using different ontologies, have to be identified. When different vocabularies are used for describing data, it is necessary to identify the concepts they define. This task is called ontology matching and its result is an alignment A, i.e. a set of correspondences $\langle e, r, e' \rangle$ relating entities e and e' of two different ontologies by a particular relation r (which may be equivalence, subsumption, disjointness, etc.) [4].

At the data level, data interlinking is the process of generating links identifying the same resource described in two data sets. Parallel to ontology matching, from two datasets (d and d') it generates a link set made of pairs of resource identifier.

We have introduced link keys [4, 1, 11] which extend database keys in a way which is more adapted to RDF and deals with two data sets instead of a single relation. An example of a link key expression is:

$$\{\langle \mathsf{auteur}, \mathsf{creator}\rangle\}\{\langle \mathsf{titre}, \mathsf{title}\rangle\}\ linkkey\ \langle \mathsf{Livre}, \mathsf{Book}\rangle$$

stating that whenever an instance of the class Livre has the same values for the property auteur as an instance of class Book has for the property creator and they share at least one value for their property titre and title, then they denote the same entity. More precisely, a link key is a structure $\langle K^{eq}, K^{in}, C\rangle$ such that:

- K^{eq} and K^{in} are sets of pairs of property expressions;
- C is a pair of class expressions (or a correspondence).

Such a link key holds if and only if for any pair of resources belonging to the classes in correspondence such that the values of their property in K^{eq} are pairwise equal and the values of those in K^{in} pairwise intersect, the resources are the same. Link keys can then be used for finding equal individuals across two data sets and generating the corresponding owl:sameAs links. Link keys take into account the non functionality of RDF data and have to deal with non literal values. In particular, they may use arbitrary properties and class expressions. This renders their discovery and use difficult.

3.3 Experimental cultural knowledge evolution

Cultural evolution applies a generalised version of the theory of evolution to culture. It considers how culture spreads and evolves within human societies [17]. In computer science, cultural evolution experiments are performed through multi-agent simulation: a society of agents adapts its culture through a precisely defined protocol: agents perform repeatedly and randomly a specific task, called game, and their evolution is monitored. This aims at discovering experimentally the states that agents reach and the properties of these states.

Experimental cultural evolution has been successfully and convincingly applied to the evolution of natural languages [18]. Agents play *language games* and adjust their vocabulary and grammar as soon as they are not able to communicate properly, i.e. they misuse a term or they do not behave in the expected way. It showed its capacity to model various such games in a systematic framework and to provide convincing explanations of linguistic phenomena.

We adapt this experimental strategy to knowledge representation [2]. Agents use their, shared or private, knowledge to play games and, in case of failure, they use adaptation operators to modify this knowledge. We monitor the evolution of agent knowledge with respect to their ability to perform the game (success rate) and with respect to the properties satisfied by the resulting knowledge itself. Such properties may, for instance, be:

- Agents converge to a common knowledge representation (a convergence property).
- Agents converge towards different but compatible (logically consistent) knowledge (a logical epistemic property), or towards closer knowledge (a metric epistemic property).
- That under the threat of a changing environment, agents that have operators that preserve diverse knowledge recover faster from the changes than those that have operators that converge towards a single representation (a differential property under environment change).

Our goal is to determine which operators are suitable for achieving desired properties in the context of a particular game.

4 Application domains

Our work on data interlinking aims at application to linked data offered in RDF on the web. It has found applications in thesaurus and bibliographical data interlinking.

mOeX's work on cultural knowledge evolution is not directly applied and rather aims at isolating general principles of knowledge evolution. However, we foresee its potential impact in the long term in fields such as smart cities, the internet of things or social robotics in which the knowledge acquired by autonomous agents will have to be shared and adapted to changing situations.

5 Highlights of the year

The highlights of the year are undoubtly Yasser Bourahla's Phd thesis "Multi-agent simulation of cultural ontology evolution through interaction" [10], and Jérôme David's habilitation "Measures for knowledge – with applications to ontology matching and data interlinking" [11].

6 New software, platforms, open data

6.1 New software

6.1.1 Lazylav

Name: Lazy lavender

Keywords: Reproducibility, Multi-agent, Simulation

Scientific Description: Lazy lavender aims at supporting mOeX's research on simulating knowledge evolution. It is not a general purpose simulator. However, it features some methodological innovations in term of facilitating publication, recording, and replaying of experiments.

Functional Description: Lazy Lavender is a simulation environment for cultural knowledge evolution, i.e. running randomised experiments with agent adjusting their knowledge while attempting to communicate. It can generate detailed report and data from the experiments and directions to repeat them.

Release Contributions: Lazy is continuously evolving and do not feature stable releases.

Instead, use git hashes to determine which version is used in a simulation.

URL: `https://gitlab.inria.fr/moex/lazylav/`

Publications: hal-03426130, hal-01661140, hal-01661139, hal-01180916, hal-03939919, hal-03905183

Contact: Jerome Euzenat

Participants: Jerome Euzenat, Yasser Bourahla, Iris Lohja, Fatme Danash, Irina Dragoste, Andrea Kalaitzakis

6.1.2 Alignment API

Keywords: Ontologies, Alignment, Ontology engineering, Knowledge representation

Scientific Description: The API itself is a Java description of tools for accessing the common format. It defines five main interfaces (OntologyNetwork, Alignment, Cell, Relation and Evaluator).

We provide an implementation for this API which can be used for producing transformations, rules or bridge axioms independently from the algorithm that produced the alignment. The proposed implementation features: - a base implementation of the interfaces with all useful facilities, - a library of sample matchers, - a library of renderers (XSLT, RDF, SKOS, SWRL, OWL, C-OWL, SPARQL), - a library of evaluators (various generalisation of precision/recall, precision/recall graphs), - a flexible test generation framework that allows for generating evaluation data sets, - a library of wrappers for several ontology APIs , - a parser for the format.

The API implementation provides an extended language for expressive alignments (EDOAL). EDOAL supports many types of restrictions inspired from description logics as well as link keys. It is fully supported for parsing and serialising in XML. It also provide other serialisers, to OWL and SPARQL queries in particular.

To instanciate the API , it is sufficient to refine the base implementation by implementing the align() method. Doing so, the new implementation will benefit from all the services already implemented in the base implementation.

Functional Description: Using ontologies is the privileged way to achieve interoperability among heterogeneous systems within the Semantic web. However, as the ontologies underlying two systems are not necessarily compatible, they may in turn need to be reconciled. Ontology reconciliation requires most of the time to find the correspondences between entities (e.g. classes, objects, properties) occurring in the ontologies. We call a set of such correspondences an alignment.

Release Contributions: See release notes.

This is the last release made from gforge svn repository. After it, the Alignment API is hosted by gitlab and versioned with git. It may well be the last formal release, clone from the repo instead.

The Alignment API compiles in Java 11 (jars are still compiled in Java 8).

URL: `https://moex.gitlabpages.inria.fr/alignapi/`

Publications: hal-00825931, hal-00781018

Contact: Jerome Euzenat

Participants: Armen Inants, Chan Le Duc, Jérôme David, Jerome Euzenat, Jérôme Pierson, Luz Maria Priego-Roche, Nicolas Guillouet

6.1.3 LinkEx

Keywords: LOD - Linked open data, Data interlinking, Formal concept analysis

Functional Description: LinkEx implements link key candidate extraction with our initial algorithms, formal concept analysis or pattern structures. It can extract link key expressions with inverse and composed properties and generate compound link keys. Extracted link key expressions may be evaluated using various measures, including our discriminability and coverage. It can also evaluate them according to an input link sample. The set of candidates can be rendered within the Alignment API's EDOAL language or in dot.

URL: `https://gitlab.inria.fr/moex/linkex`

Publications: hal-02168775, hal-01179166

Author: Jérôme David

Contact: Jérôme David

6.2 Open data

The experimental activity of the mOeX team is logged into the Sakere platform (`https://sake.re`). It serves as a repository of experiment logbooks providing access to simulation software, experiment scripts and parameters, resulting raw data and analysis notebooks. The experimentation and publication process is documented on the site. This data is fully retrievable and auditable through git.

7 New results

7.1 Cultural knowledge evolution

In 2023, the work on cultural knowledge evolution has progressed in several directions, tasks, values, motivations, all based on the protocol described in the PhD dissertation of Yasser Bourahla [10].

Concerning link keys the work on extracting link keys led to the PhD dissertation of Nacira Abbas and part of the habilitation of her supervisor Jérôme David [11].

7.1.1 Measuring knowledge diversity

Participants: Adrien Bonnardel, Yasser Bourahla, Jérôme David, Jérôme Euzenat *(Correspondent)*.

Assessing knowledge diversity is useful in our experiments. We had proposed to use an entropy-based diversity measure inspired from [16] and using an ontology distance measure. However, in such measures the maximal diversity is not obtained with a uniform distribution and it has to be computed. This year, we implemented its computation and developed a normalised version of this measure. It should help reconsidering the results previously obtained on knowledge diversity [10] with this new method.

7.1.2 Pluripotent agents

Participants: Jérôme Euzenat, Andrea Kalaitzakis *(Correspondent)*.

Following last years' results, we continued investigating resource-limited agents tackling multiple tasks. We found, by varying the number of tasks assigned to each agent and the number of common properties across these tasks, that agents transfer knowledge from one task to another [7]. In addition, we showed that agents with limited memory will specialize on a subset of tasks, whose number depends on available memory. However, it seems that maximising task accuracy and achieving consensus are mutually exclusive [8].

When imposing an equidistribution of the tasks that agents play, global benefits have been identified. First, the agents achieve comparable precision in all tasks. Second, the total wealth acquired by agents is higher and more equitably distributed, but lower than with unlimited agents. The wealth is the accumulation of points acquired when agents make the correct decision. The question is then how could agents adopt this behaviour without imposing it. We attempted to reach this goal by replacing agents from one generation to the other favouring those disagreeing more often (lower success rate), assuming that they have rare knowledge. However, this only has a temporary effect.

This work is part of the PhD thesis of Andreas Kalaitzakis.

7.1.3 Value-sensitive cultural evolution

Participants: Jérôme Euzenat *(Correspondent)*, Adriana Luntraru.

Cultural values are cognitive representations of general objectives, such as independence or mastery, that people use to distinguish whether something is "good" or "bad". More specifically, people may use their values to evaluate alternatives and pick the most compatible one. We consider values as grounding agent behaviour in cultural knowledge evolution, and more specifically in the way they evolve their ontologies. We used the cultural values of independence, novelty, authority and mastery to influence the choice of which agent adapts in a population of agents sharing the same values. From a weighted aggregation of how much agents adhere to these values, they determine which one adapts its knowledge when two agents disagree, e.g. novelty will give more change to rare knowledge, though mastery will promote knowledge that has proved efficient. Results [14] show that agents do not improve the accuracy of their knowledge without using the mastery value (akin the success biais in social learning [10]). Under certain conditions, independence causes the agents to converge to successful interactions faster, and novelty increases knowledge diversity, but both effects come with a large reduction in accuracy. We did not find any significant effects of authority.

This was the master work of Adriana Luntraru.

7.1.4 Intrinsic motivation, curiosity and creativity

Participants: Jérôme Euzenat *(Correspondent)*, Anaïs Siebers.

In cultural knowledge evolution simulations, agent knowledge might be confined to specific areas because the tasks that they perform do not require them to explore more. We considered how agents may be provided with the intrinsic motivation to explore and how this affects their knowledge. Three different kinds of motivation were investigated: curiosity (the will to explore the unknown), creativity (the will to act differently) and non-exploration (the will to not explore new things). Moreover, intrinsic motivation was modelled directly or learned through reinforcement learning. Finally, agents either explored on their own or picked specific interaction partner(s). We have shown that such settings may have a significant effect on the agent knowledge [15]. Contrary to the expectations and other studies, this did not lead to an increase in knowledge completeness. Out of all intrinsic motivations, curiosity had the highest accuracy and completeness. Models with reinforcement learning performed similarly as direct models. As expected, intrinsic motivation led to faster convergence of the agents' knowledge, especially with social agents. Heterogeneously motivated agents only had a higher accuracy and completeness than homogeneously motivated agents in specific cases.

This was the master work of Anaïs Siebers.

7.1.5 Awareness and forgetting in dynamic epistemic logic

Participants: Manuel Atencia, Jérôme Euzenat *(Correspondent)*, Line van den Berg.

Agents use their own vocabularies to reason and talk about the world. Public signature awareness is satisfied if agents are aware of the vocabularies, or signatures, used by all agents. Logics and in particular Dynamic Epistemic Logic rely on public signature awareness. However, this assumption is not desirable for dynamic and open multi-agent systems because it prevents agents to use vocabulary other agents are unaware of and to extend it when encountering new information. We propose a new semantics for awareness that enables us to drop public signature awareness [6]. This semantics is based on partial valuation functions and weakly reflexive relations. We added dynamic modalities for raising public and private awareness in which a distinction is made between becoming aware of a proposition and learning its truth value. As a result, the semantics introduced can be used to model agent interaction without the public signature awareness assumption.

This work is part of the PhD thesis of Line van den Berg defended in October 2021.

7.1.6 A social science and the humanities approach to cultural knowledge evolution

Participants: Helga Lendrin *(Correspondent)*, Jérôme Euzenat.

We defined a protocol to experiment with human learners various modalities of knowledge transmission based on the *Class?* game that we designed. In particular, we want to test the effect of the medium on knowledge acquisition and evolution. This protocol involves groups of pupils learning how to play the game and transmitting it to the next group. Transmission modalities varied in terms of face-to-face physical presence, online or written transmission. A series of tests have been designed in order to determine which playing strategies are acquired by pupils after transmission and after playing.

7.2 Link keys

The investigation of link keys has been pursued following the properties of link key extraction (§3.2).

7.2.1 Link key redundancy

Participants: Jérôme David *(Correspondent)*.

We have continued studying how Formal Concept Analysis and its extensions are well adapted to support the discovery of link keys. Different link key candidates can generate sets of identity links between individuals that can be considered as equal when they are regarded as partitions of the identity relation and thus involving a kind of redundancy. We have studied such a redundancy through partition pattern structures [5]. In particular, experiments showed that redundancy of link key candidates while not significant when based on identity of partitions appears to be much more significant when based on similarity.

This work is part of the PhD thesis of Nacira Abbas, co-supervised by Jérôme David and Amedeo Napoli (LORIA).

8 Partnerships and cooperations

8.1 International research visitors

8.1.1 Visits of international scientists

Participants: Koji Hasebe.

Country: Japan

Dates: 2023-07-01 – 2023-07-31

Context of the visit: This visit was held on the context of the collaboration with the multi-agent system lab at the University of Tsukuba.

Mobility program/type of mobility: This visit was supported by an invited professor position from INRIA.

8.1.2 Visits to international teams

Research stays abroad

Participants: Jérôme Euzenat.

Visited institution: University of Tsukuba

Country: Japan

Dates: 2023-10-25 – 2023-1-13

Context of the visit: This visit was held on the context of the collaboration with the multi-agent system lab at the University of Tsukuba.

Mobility program/type of mobility: This has been a research stay supported by the Kyoukan PAI Project (20 006913 01 9183) supported by the Région Auvergne Rhône-Alpes.

8.2 European initiatives

8.2.1 H2020 projects

Participants: Jérôme Euzenat *(Correspondent)*, Yasser Bourahla, Andreas Kalaitzakis.

Since September 2023, Jérôme Euzenat represents the University Grenoble Alpes within the TAILOR network:

Program: H2020-ICT-48-2020

Title: Trustworthy AI through the integration of learning, optimisation and reasoning

Partner Institution(s):
- Linköping University (coordinator)
- CNR, INRIA, University college Cork, KU Leuven... Université Grenoble Alpes...

Duration: September 2020–August 2024

Web site: https://tailor-network.eu/

Abstract: UGA is mostly involved in the work packages concerning trustworthy AI and social AI.

8.3 National initiatives

8.3.1 ELKER

Participants: Manuel Atencia *(Correspondent)*, Jérôme David, Jérôme Euzenat.

mOeX coordinates the ELKER project:

Program: ANR-PRC

Title: Extending link keys: extraction and reasoning

Partner Institution(s):
- Université Grenoble Alpes (coordinator)
- INRIA Nancy Lorraine (Orpailleur)
- Université Paris 13

Duration: October 2017–March 2023

Web site: https://project.inria.fr/elker/

Abstract: The goal of ELKER is to extend the foundations and algorithms of link keys (see §3.2) in two complementary ways: extracting link keys automatically from datasets and reasoning with link keys.

8.3.2 MIAI

Participants: Manuel Atencia, Jérôme David, Jérôme Euzenat *(Correspondent)*, Yasser Bourahla, Andreas Kalaitzakis.

mOeX holds the MIAI Knowledge communication and evolution chair

Program: ANR-3IA

Title: Multidisciplinary institute in artificial intelligence

Partner Institution(s):
- Université Grenoble Alpes (coordinator)

Duration: July 2019–December 2023

Web site: https://miai.univ-grenoble-alpes.fr

Abstract: The MIAI Knowledge communication and evolution chair aims at understanding and developing mechanisms for seamlessly improving knowledge (see §3.3). It studies the evolution of knowledge in a society of people and AI systems by applying evolution theory to knowledge representation.

9 Dissemination

Participants: Jérôme David, Jérôme Euzenat, Helga Lendrin.

9.1 Promoting scientific activities

9.1.1 Scientific events: organisation

Member of the organizing committees

- Jérôme Euzenat had been organiser of the 18th Ontology matching workshop of the 23th ISWC, held online, 2023 (with Pavel Shvaiko, Ernesto Jiménez Ruiz, Cássia Trojahn dos Santos and Oktie Hassanzadeh) [9]

9.1.2 Scientific events: selection

Member of the conference program committees

- Jérôme Euzenat had been programme committee member of the "International Joint Conference on Artificial Intelligence (IJCAI)"
- Jérôme Euzenat had been programme committee member of the "European Conference on Artificial Intelligence (ECAI)".
- Jérôme David and Jérôme Euzenat had been programme committee member of the "International semantic web conference (ISWC)".
- Jérôme Euzenat had been programme committee member of the "International conference on formal ontologies for information systems (FOIS)".
- Jérôme Euzenat had been programme committee member of the "International conference on conceptual structures (ICCS)".
- Jérôme David had been programme committee member of the "European semantic web conference (ESWC)".

- Jérôme David had been programme committee member of "Extraction et gestion des connaissances (EGC)".
- Jérôme David had been programme committee member of "Ingénierie des connaissances (IC)".
- Jérôme Euzenat had been programme committee member of the "Journées Françaises d'intelligence artificielle fondamentale (JIAF)".

9.1.3 Journal

Member of the editorial boards

- Jérôme Euzenat is member of the editorial board of *Journal of web semantics* (area editor) and the *Semantic web journal*.

9.1.4 Invited talks

- Jérôme Euzenat had been invited to the SESAME seminar to give a talk on "Multi-agent simulation of cultural knowledge evolution", Montpellier (FR), 2023-02-17
- Jérôme Euzenat had been invited to the Dagsthul seminar on "Autonomous agents on the web", Wadern (DE), 2023-02-19 – 24 [13]

9.1.5 Leadership within the scientific community

- Jérôme David is member of the board of the Extraction and gestion des connaissances (Knowledge extraction and management) conference series.
- Jérôme Euzenat is EurAI fellow.

9.1.6 Scientific expertise

- Jérôme Euzenat had been member of the Interdisciplinary assessment board for the interdisciplinary and cross-disciplinary research programme in Artificial Intelligence of the Spanish Ministry of Universities, 2023.
- Jérôme David had been president of the selection committee for an assistant professor (section 27) at Université Grenoble Alpes (SHS department)
- Jérôme Euzenat member of the selection committee for the associate professor position 27MCF1141 at Université de Lorraine (IUT Saint-Dié)
- Jérôme David had been member of the selection committee for lecturer position (Polytech'Nantes)
- Jérôme Euzenat was evaluator for exchange grants of the European project TAILOR (member of the "connectivity fund scientific board")

9.1.7 Research administration

- Jérôme David is member of the LIG laboratory council.
- Jérôme David is member of the local "Commission du développement technologique".
- Jérôme Euzenat is member of the local COS (Scientific Orientation Committee).

9.2 Teaching - Supervision - Juries

9.2.1 Teaching

Responsibilities

- Jérôme David is coordinator of the Master "Mathematiques et informatiques appliquées aux sciences humaines et sociales" (Univ. Grenoble Alpes);

Lectures

- Licence: Jérôme David, Algorithmique et programmation par objets, 70h/y, L2 MIASHS, UGA, France
- Licence: Jérôme David, Système, L3 MIASHS, 18h/y, UGA, France
- Licence: Jérôme David, Programmation par objets avancée et structures de données, 18h/y, L3 MIASHS, UGA, France
- Licence: Jérôme David, Reseaux, 12h/y, L3 MIASHS, UGA, France
- Licence: Yasser Bourahla, Langage formel, 38h/y, L2 MIASHS, UGA, France
- Licence: Yasser Bourahla, Programmation fonctionnelle, 41h/y, L1 MIASHS, UGA, France
- Licence: Yasser Bourahla, Programmation Logique, 22h/y, L2 MIASHS, UGA, France
- Licence: Yasser Bourahla, Projet de programmation, 20h/y, M1 MIASHS, UGA, France
- Licence: Yasser Bourahla, Système d'exploitation, 12h/y, L3 MIASHS, UGA, France
- Licence: Yasser Bourahla, Soutient algorithmique, 10h/y, L3 MIASHS, UGA, France
- Licence: Yasser Bourahla and Jérôme Euzenat, Programmation Logique, L2 MIASHS, 34h/y, UGA, France
- Master: Jérôme David, Systèmes d'exploitation, M1 DCISS, 18h/y, UGA, France
- Master: Jérôme David, Programmation Java 2, 30h/y, M1 MIASHS, UGA, France
- Master: Jérôme David, Stage de programmation, 10h/y, M2 MIASHS, UGA, France
- Master: Jérôme David, Soutien programmation, 10h/y, M1 MIASHS, UGA, France
- Master: Jérôme Euzenat, Semantics of distributed knowledge, 27h/y, M2R MoSIG, UGA, France

9.2.2 Supervision

- Nacira Abbas, "Analyse formelle de concepts pour la découverte de clés de liage dans le web des données", https://www.theses.fr/2023UPASG045, defended on 2023-10-13 (Jérôme David and Amedeo Napoli)
- Yasser Bourahla, "Multi-agent simulation of cultural ontology evolution through interaction", [10], defended on 2023-07-11, (Manuel Atencia and Jérôme Euzenat)
- Andreas Kalaitzakis, "Effects of collaboration and specialisation on agent knowledge evolution", in progress since 2020-10-01 (Jérôme Euzenat)

9.2.3 Juries

- Jérôme David was reviewer and member of the PhD committee of Armita Khajeh Nassiri on "Expressive Rule Discovery for Knowledge Graph Refinement", Université Paris-Saclay, 2023-07-13
- Jérôme Euzenat was member of the PhD committee of Fatima Danash on "FORT: a modular Foundational Ontological Relations Theory for representing and reasoning over the composition of tangible entities – observations from cultural heritage", Université Grenoble-Alpes, 2023-09-28
- Jérôme Euzenat was reviewer and member of the PhD committee of Abdelhafid Dahhani on "Exploitation de l'isomorphisme de graphe et de l'alignement d'ontologies pour enrichir les objets logiciels de connaissances sémantiques – application aux objets sages", Université de Savoie Mont-Blanc, 2023-12-14

9.3 Popularization

9.3.1 Interventions

- Presentation of the *Class?* game to the French «info sans ordi (computer science unplugged)» group, Lyon (FR), 2023-10-04
- Introduction of the *Class?* game to a tenth graders (2^{nd} MathC2+), Montbonnot (FR), 2023-06-28.
- Introduction of the *Class?* game to tenth grader class within the Fête de la science (Science fair), Montbonnot (FR), 2023-10-09

10 Scientific production

10.1 Major publications

[1] M. Atencia, J. David and J. Euzenat. 'On the relation between keys and link keys for data interlinking'. In: *Semantic Web – Interoperability, Usability, Applicability* 12.4 (2021), pp. 547–567. DOI: 10.3233/SW-200414. URL: https://hal.science/hal-03426150.

[2] Y. Bourahla, M. Atencia and J. Euzenat. 'Knowledge improvement and diversity under interaction-driven adaptation of learned ontologies'. In: AAMAS 2021 - 20th ACM international conference on Autonomous Agents and Multi-Agent Systems. London, United Kingdom, 2021, pp. 242–250. URL: https://hal.archives-ouvertes.fr/hal-03426130.

[3] J. Euzenat. 'Interaction-based ontology alignment repair with expansion and relaxation'. In: *Proc. 26th International Joint Conference on Artificial Intelligence (IJCAI), Melbourne (VIC AU)*. 2017, pp. 185–191.

[4] J. Euzenat and P. Shvaiko. *Ontology matching*. en. 2^{nd}. Heidelberg (DE): Springer-Verlag, 2013. 520 pp. URL: http://book.ontologymatching.org.

10.2 Publications of the year

International journals

[5] N. Abbas, A. Bazin, J. David and A. Napoli. 'Discovery of link keys in resource description framework datasets based on pattern structures'. In: *International Journal of Approximate Reasoning* 161 (Oct. 2023), p. 108978. DOI: 10.1016/j.ijar.2023.108978. URL: https://hal.science/hal-04368386.

[6] L. van den Berg, M. Atencia and J. Euzenat. 'Raising awareness without disclosing truth'. In: *Annals of Mathematics and Artificial Intelligence* 91.4 (2023), pp. 431–464. DOI: 10.1007/s10472-022-09809-y. URL: https://hal.science/hal-04351134.

International peer-reviewed conferences

[7] A. Kalaitzakis and J. Euzenat. 'Multi-tasking resource-constrained agents reach higher accuracy when tasks overlap'. In: *Proc. 20th European conference on multi-agents systems (EUMAS)*. EUMAS 2023 - 20th European conference on multi-agents systems. Napoli, Italy: Springer Verlag, 2023, pp. 425–434. DOI: 10.1007/978-3-031-43264-4_28. URL: https://hal.science/hal-04351111.

National peer-reviewed Conferences

[8] A. Kalaitzakis and J. Euzenat. 'À quoi sert la spécialisation en évolution culturelle de la connaissance?' In: *Actes 31e journées francophones sur Systèmes multi-agent (JFSMA)*. JFSMA 2023 - 31e journées francophones sur Systèmes multi-agent. Strasbourg, France: No commercial editor., 2023, pp. 76–85. URL: https://hal.science/hal-04351105.

Edition (books, proceedings, special issue of a journal)

[9] P. Shvaiko, J. Euzenat, E. Jiménez-Ruiz, O. Hassanzadeh and C. Trojahn, eds. *Proceedings of The 18th International Workshop on Ontology Matching (OM 2023) collocated with the 22nd International Semantic Web Conference ISWC-2023 November 7th, 2023, Athens, Greece*. 18th ISWC workshop on ontology matching (OM 2023). Vol. 3591. ceur-ws.org, 2023, pp. 1–202. URL: https://hal.science/hal-04351128.

Doctoral dissertations and habilitation theses

[10] Y. Bourahla. 'Multi-agent simulation of cultural ontology evolution through interaction'. Université Grenoble Alpes [2020-....], 11th July 2023. URL: https://theses.hal.science/tel-04347698.

[11] J. David. 'Measures for knowledge – with applications to ontology matching and data interlinking'. Université Grenoble Alpes, 15th May 2023. URL: https://theses.hal.science/tel-04357558.

Reports & preprints

[12] J. Euzenat. *Stepwise functional refoundation of relational concept analysis*. 9518. INRIA, Oct. 2023, p. 73. URL: https://hal.science/hal-04230481.

Other scientific publications

[13] J. Euzenat. 'Society = Autonomy + Adaptation'. In: *Proc. Dagstuhl seminar on Agents on the web*. Dagstuhl seminar on Agents on the web 2023. Wadern, Germany: Schloß Dagstuhl - Leibniz-Zentrum für Informatik, 2023, p. 86. URL: https://hal.science/hal-04351093.

[14] A. Luntraru. 'Value-sensitive knowledge evolution'. Master's thesis, Université Grenoble Alpes, Grenoble (FR), 27th June 2023. URL: https://inria.hal.science/hal-04351158.

[15] A. Siebers. 'Intrinsic exploration-motivation in cultural knowledge evolution'. Master's thesis, Ruhr Universität, Bochum (DE), 25th Sept. 2023. URL: https://inria.hal.science/hal-04351162.

10.3 Cited publications

[16] T. Leinster. *Entropy and diversity: the axiomatic approach*. Cambridge university press, Cambridge (UK), 2021.

[17] A. Mesoudi. *Cultural Evolution: How Darwinian theory can explain human culture and synthesize the social sciences*. University of Chicago Press, Chicago (IL US), 2011.

[18] L. Steels, ed. *Experiments in cultural language evolution*. John Benjamins, Amsterdam (NL), 2012.