RESEARCH CENTRE

Inria Centre at Université Grenoble Alpes

IN PARTNERSHIP WITH:

Université de Grenoble Alpes

2024

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 **1**

1 Team members, visitors, external collaborators **2**

2 Overall objectives **2**

3 Research program **3**
3.1 Knowledge and belief representation semantics . . . 3
3.2 Standpoint logics and alignments . . . 3
3.3 Data interlinking with link keys . . . 4
3.4 Experimental cultural knowledge evolution . . . 4

4 Application domains **5**

5 New software, platforms, open data **5**
5.1 New software . . . 5
5.1.1 Lazylav . . . 5
5.1.2 Alignment API . . . 5
5.1.3 LinkEx . . . 6
5.2 Open data . . . 6

6 New results **7**
6.1 Cultural knowledge evolution . . . 7
6.1.1 Pluripotent agents . . . 7
6.1.2 Reasoning in SHIQ with standpoint axiom- and concept-level modalities . . . 7
6.1.3 Decision tree revision . . . 8
6.1.4 Opinion dynamics and belief propagation . . . 8
6.1.5 Studying cultural transmission through the *Class?* game . . . 8
6.1.6 Experiment reproducibility and repurposability . . . 8
6.2 Link keys . . . 9
6.2.1 Discovering a representative set of link keys in RDF datasets . . . 9

7 Partnerships and cooperations **9**
7.1 International research visitors . . . 9
7.1.1 Visits of international scientists . . . 9
7.1.2 Visits to international teams . . . 10
7.2 European initiatives . . . 10
7.2.1 H2020 projects . . . 10

8 Dissemination **10**
8.1 Promoting scientific activities . . . 10
8.1.1 Scientific events: organisation . . . 10
8.1.2 Scientific events: selection . . . 11
8.1.3 Journal . . . 11
8.1.4 Invited talks . . . 11
8.1.5 Leadership within the scientific community . . . 11
8.1.6 Scientific expertise . . . 12
8.1.7 Research administration . . . 12
8.2 Teaching - Supervision - Juries . . . 12
8.2.1 Teaching . . . 12
8.2.2 Supervision . . . 12
8.3 Popularization . . . 13
8.3.1 Productions (articles, videos, podcasts, serious games, ...) . . . 13
8.3.2 Participation in Live events . . . 13

9 Scientific production **13**
9.1 Major publications 13
9.2 Publications of the year 13
9.3 Cited publications 14

Project-Team MOEX

Creation of the Project-Team: 2017 November 01

Keywords

Computer sciences and digital sciences

A3.2. – Knowledge

A3.2.1. – Knowledge bases

A3.2.2. – Knowledge extraction, cleaning

A3.2.3. – Inference

A3.2.4. – Semantic Web

A3.2.5. – Ontologies

A3.2.6. – Linked data

A6.1.3. – Discrete Modeling (multi-agent, people centered)

A7.2. – Logic in Computer Science

A9. – Artificial intelligence

A9.1. – Knowledge

A9.9. – Distributed AI, Multi-agent

Other research topics and application domains

B8.5. – Smart society

B9. – Society and Knowledge

B9.5.1. – Computer science

B9.7.2. – Open data

B9.8. – Reproducibility

1 Team members, visitors, external collaborators

Research Scientists

- Jérôme Euzenat [Team leader, INRIA, Senior Researcher, HDR]
- Lucía Gómez Alvarez [INRIA, Researcher]

Faculty Members

- Manuel Atencia [UGA, Associate Professor, In secondment at Universidad de Malaga]
- Jérôme David [UGA, Associate Professor, Professor since 01/10/2024, HDR]
- Cássia Trojahn [UGA, Professor, from Sep 2024, HDR]

Post-Doctoral Fellow

- Helga Lendrin [INRIA, Post-Doctoral Fellow, until Mar 2024]

PhD Students

- Linda Gutsche [UGA (CDSN), from Sep 2024]
- Andrea Kalaitzakis [UGA (MIAI)]
- Richard Trézeux [UGA, from Oct 2024]

Interns and Apprentices

- Maroua Hibatollah Aaboud [UGA, Intern, until Jun 2024]
- Noévan Ast [INRIA, Intern, from Jun 2024 until Jul 2024]
- Linda Gutsche [ENS PARIS, Intern, until Jun 2024]
- Robin Huber [UGA, Intern, from Feb 2024 until May 2024]
- Moubarak Yahaya Moussa [UGA, Intern, from Feb 2024 until Jun 2024]

Administrative Assistant

- Julia Di Toro [INRIA]

Visiting Scientists

- Koji Hasebe [University of Tsukuba, from Sep 2024 until Oct 2024]
- Hiro Kataoka [UGA (MIAI), from Sep 2024]

2 Overall objectives

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 that 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 Standpoint logics and alignments

Both within human and artificial agent communities, diversity in world representations is to be expected. 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].

We have provided Standpoint logics [12] as a way to model heterogeneous knowledge held by different agents. Standpoint logics are first-order multi-modal logics allowing agents to establish individual standpoints, which involve specifying constraints and relations. It is close to epistemic logic, but its simplified semantics allows it to support more expressive underlying languages (usual in ontologies and knowledge bases) at the expense of the full-fledged modality nesting of usual Kripke semantics. Standpoint logics facilitate combining standpoints and establishing alignments between them.

This research line has two main objectives: Firstly, we aim to establish Standpoint logic as a robust framework in knowledge representation. Key reasoning tasks in standpoint logics include deriving global knowledge, determining standpoint-relative knowledge, and contrasting knowledge inferred from different standpoints. Secondly, while current standpoint representations capture static viewpoints, we will address the evolution of standpoints. We plan to investigate theoretical models of standpoint knowledge evolution, using notions of belief revision and building on our previous work modelling cultural evolution with dynamic epistemic logic.

3.3 Data interlinking with link keys

Vast amounts of RDF data are made available on the web by various institutions providing overlapping information. 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 identifiers.

We have introduced link keys [4, 1] 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 the same 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.

3.4 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 [14]. 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.

We adapt the experimental strategy, developed for cultural language evolution [15], 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 digital twins, social network analysis or social robotics in which the knowledge acquired by autonomous agents will have to be shared and adapted to changing situations.

5 New software, platforms, open data

5.1 New software

5.1.1 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 reports and data from the experiments and directions to repeat them.

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

Instead, git hashes are used 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: Anais Siebers, Adriana Luntraru, Jerome Euzenat, Yasser Bourahla, Iris Lohja, Fatme Danash, Irina Dragoste, Andrea Kalaitzakis

5.1.2 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 provides 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. It may well be the last formal release, clone from the repo instead.

The Alignment API is now hosted by gitlab and versioned with git.

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, Jerome Pierson, Luz Maria Priego-Roche, Nicolas Guillouet

5.1.3 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

Contact: Jérôme David

5.2 Open data

Since the team is involved into experimental work, we are strongly concerned by its reproducibility. We used to describe our experiments and publish our data in INRIA's gforge repository. However, after the decision to close it, we decided to develop our own at `https://sake.re` to which we moved all previous experiments. Thanks to INRIA support teams, old URLs have been redirected, but not all experiments have yet been repurposed to be exposed as Jupyter notebooks. We also developed the ability to automatically generate Docker container specifications to rerun experiments but these have to be repurposed.

We have developed a git-based methodology for describing experiments before performing them, committing their results and their analysis through Jupyter notebooks. Experiments can be reproduced by checking out exact software versions and running the same parameters. They are also easily repurposed with different parameters. When experiments are published in papers, they are also published in Zenodo. These are an important step towards accountability, portability, reproducibility and long term storage.

Semantically describing experiments would provide more benefits. Beyond being searchable through flat metadata, a knowledge graph of experiment descriptions may be able to provide answers to scientific and methodological questions. This includes identifying non experimented conditions or retrieving specific techniques used in experiments. In turn, this is useful for researchers as this information can be used for re-purposing experiments, checking claimed results or performing meta-analyses.

As all our production, results once published are available under creative commons CC-BY 4.0 License. They do not include personal data, beyond the name of the authors.

We had the pleasure to see that this strategy initially developed around our *Lazy lavender* framework (§5.1.1) also works with other simulators, developed in different languages (§6.1.4).

This activity led to further experiments and publications related to reproducibility (see §6.1.6).

6 New results

6.1 Cultural knowledge evolution

6.1.1 Pluripotent agents

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

This year we tried to fit our intuition that randomly forgetting parasitic knowledge in pluripotent agents may help them develop more correct knowledge. While temporarily detrimental to their knowledge correctness, forgetting randomly selected knowledge brings long-term benefits when agents are assigned a single task. However, when agents specialising in different tasks interact, one task will gradually monopolise the collectively available resources, causing the entire society to specialise in the same task. These results improve our understanding of how the formation, evolution, and prevalence of specialised knowledge affect individual agents and agent societies.

This work is part of the PhD thesis of Andreas Kalaïtzakis defended on November 29th, 2024 [13].

6.1.2 Reasoning in SHIQ with standpoint axiom- and concept-level modalities

Participants: Maroua Hibatollah Aaboud, Lucía Gómez Alvarez *(Correspondent)*, Moubarak Yahaya Moussa.

In prior work we had shown that it is possible to add standpoints to numerous decidable fragments of first-order logics – including very expressive DLs up to SROIQbs – while preserving their reasoning complexity, so long as standpoint modalities are limited to the axiom level. A more expressive tighter modal integration, where standpoint modalities are also allowed to occur in concept expressions, had so far only been investigated for the much less expressive EL+ logic.

This year we pushed this line of research showing that the SHIQ logic allows for a tight modal integration with standpoints without compromising its ExpTime reasoning complexity [7]. The core insight toward this result is that any satisfiable knowledge base admits a model with only polynomially many worlds. This allowed us to establish a polynomial equisatisfiable translation into plain SHIQ which, beyond showing the theoretical result, enables us to use highly optimised OWL reasoners to provide practical reasoning support for ontology languages extended by standpoint modelling.

6.1.3 Decision tree revision

Participants: Jérôme Euzenat, Linda Gutsche *(Correspondent)*.

We explored whether the adaptation operators on decision trees used in our work on cultural knowledge evolution are valid belief revision operators [11]. Although they intuitively seem to satisfy success, consistency, and minimality of change, they do not align with typical closed-by-deduction belief set revision in any typical logic. To address this, we expressed the problem as a base revision approach in which decision trees are formulas of a logic. We showed that the adaptation operators do indeed correspond to base revision operators.

6.1.4 Opinion dynamics and belief propagation

Participants: Jérôme Euzenat *(Correspondent)*, Koji Hasebe, Hiro Kataoka.

Opinion dynamics models how social organisation and interactions determine opinions. Belief propagation also studies how logical beliefs propagate within a network. However, it is expected that opinions and beliefs do not evolve independently. Yet, there is hardly any attempts to connect them.

We put forth a model in which opinions and beliefs, besides these two social operations, are also connected by two ‘cognitive’ operations: opinion formation from beliefs and belief alignment with opinions. They aim at reducing the cognitive dissonance between beliefs and opinions adopted from the social propagation. The four resulting operations are very flexible in their implementations. We used the DeGroot opinion dynamic model and belief revision game operations for the social operations. We based the cognitive operations on cultural values held by the agents. The value-based mechanism is balanced with the inertia, or propensity to avoid change, of agents. They allow for modelling various types of agents (favouring opinions, favouring beliefs, eager to change, resisting to change, etc.).

We showed that the outcome of the propagation processes depends on graph topology, initial opinions and beliefs as in classical opinion dynamics and belief revision games. In addition, we show that both opinions influence beliefs and beliefs influence opinions and that outlier beliefs do not spread more but have an influence on the final beliefs.

6.1.5 Studying cultural transmission through the *Class?* game

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

We used the example of the *Class?* game, that we designed (see §8.3) to study the transmission of knowledge among agents. More precisely, it is used to implement transmission chain experiments which illustrate the emergence of variation during transmission. Our goal is to show that variation can also occur when computers are used to transmit knowledge exactly. This is due to the induction of knowledge from the message to pass, its integration within pre-existing knowledge and the generation of a new message to be passed, instead of errors in the analog transmission of messages.

6.1.6 Experiment reproducibility and repurposability

Participants: Jérôme Euzenat *(Correspondent)*.

We contributed to the methodology of reproducing experimental results in the field of machine learning. We provided a systematic approach to reproducing (using the available implementation), replicating (using an alternative implementation) and reevaluating (using different datasets) state-of-the-art experiments [9]. This approach enables the early detection and correction of deficiencies and thus the development of more robust and transparent machine learning methods. This work was illustrated by the independent reproduction, replication, and reevaluation of initially published experiments with Knowledge-enhanced neural networks. These were performed in order to reimplement and extend the method based on safe grounds.

6.2 Link keys

The investigation of link keys has been pursued following the properties of link key extraction (§3.3).

6.2.1 Discovering a representative set of link keys in RDF datasets

Participants: Jérôme David *(Correspondent)*.

The various algorithms aimed at discovering link keys usually output a large number of candidates, making link key selection and validation a challenging task. We proposed an approach combining Formal Concept Analysis (FCA) for discovering link key candidates and building a link key lattice, and hierarchical clustering over a given set of candidates for building a representative set of link keys [6]. Such a set balances the (minimal) number of candidates to be validated with the (maximal) number of links between individuals. We performed a series of experiments over different RDF datasets, showing the effectiveness of the approach and the ability of hierarchical clustering to return a concise and meaningful set of candidates while preserving the ordinal structure of the link key lattice.

7 Partnerships and cooperations

7.1 International research visitors

7.1.1 Visits of international scientists

Koji Hasebe

Status Assistant professor

Institution of origin: University of Tsukuba

Country: Japan

Dates: 2024-09-12 – 2024-10-16

Context of the visit: Work on opinion dynamics and belief propagation (see §6.1.4)

Mobility program/type of mobility: research stay

Hiro Kataoka

Status Intern

Institution of origin: University of Tsukuba

Country: Japan

Dates: 2024-09-12 – 2024-12-31

Context of the visit: Work on opinion dynamics and belief propagation (see §6.1.4)

Mobility program/type of mobility: research stay (in parallel to study)

7.1.2 Visits to international teams

Research stays abroad

Lucía Gómez Álvarez

Visited institution: TU Dresden

Country: Germany

Dates: 2024-11-30 – 2024-12-04

Context of the visit: This visit was held in the context of the collaboration with the Computational Logic Group at the TU Dresden, with Sebastian Rudolph and Tim Lyon (see §6.1.2).

7.2 European initiatives

7.2.1 H2020 projects

Participants: Jérôme Euzenat *(Correspondent)*, 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 Dissemination

Participants: Lucía Gómez Álvarez, Cássia Trojahn, Jérôme David, Jérôme Euzenat, Helga Lendrin.

8.1 Promoting scientific activities

8.1.1 Scientific events: organisation

Member of organizing committees

- Cássia Trojahn and Jérôme Euzenat have been organisers of the 19th Ontology matching workshop of the 24th ISWC, Baltimore (MD US), 2024 (with Pavel Shvaiko, Ernesto Jiménez Ruiz, and Oktie Hassanzadeh)
- Lucía Gómez Álvarez has been organiser of the 3rd Workshop on Knowledge Diversity (KoDis) of the 21st KR 2024 conference, held in Hanoi (VT) 2024 (with Srdjan Vésic).

8.1.2 Scientific events: selection

Member of 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 "International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)".
- 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 agents and artificial intelligence (ICAART)".
- Lucía Gómez Álvarez had been programme committee member of the International Conference on Principles of Knowledge Representation and Reasoning (KR).
- Lucía Gómez Álvarez and Jérôme Euzenat had been programme committee member of the "AAAI Conference on Artificial Intelligence (AAAI)".
- Jérôme David, Lucía Gómez Álvarez and Jérôme Euzenat had been programme committee member of the "European Conference on Artificial Intelligence (ECAI)".
- Jérôme David had been programme committee member of the "European Knowledge Acquisition Workshop (EKAW)".
- Jérôme Euzenat had been programme committee member of the "Conférence nationale d'intelligence artificielle (CNIA)".

8.1.3 Journal

Member of editorial boards

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

Reviewer - reviewing activities

- Jérôme David reviewed for *IEEE Transactions on knowledge and data engineering*
- Jérôme Euzenat has reviewed for *Journal of artificial intelligence research* and *Semantic web journal*

8.1.4 Invited talks

- Lucía Gómez Álvarez and Jérôme Euzenat had been invited to the "Belief revision, argumentation and ontologies (BRAOn)" seminar, Madeira (PT), 2024
- Jérôme Euzenat gave a presentation "Vers une interface pour naviger dans les treillis de RCA (Towards an interface for navigating RCA lattices)" to the SmartFCA project meeting, Nancy (FR), 2024-06-21

8.1.5 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.

8.1.6 Scientific expertise

- Cássia Trojahn is member of the sectorial scientific commission "Data and model science" of the French research institute for development (IRD)
- Jérôme David had been member of the selection committee for associate professor position (section 26) at Université Grenoble Alpes (SHS department)
- Jérôme David had been member of the selection committee for associate professor position (section 27) at Université de Tours (IUT de Blois)
- Jérôme Euzenat was evaluator for exchange grants of the European project TAILOR (member of the "connectivity fund scientific board")

8.1.7 Research administration

- Jérôme David is member of the LIG laboratory council
- Jérôme David is member of the "Commission du développement technologique" of INRIA Grenoble Rhône-Alpes
- Jérôme Euzenat is member of the COS (Scientific Orientation Committee) of INRIA Grenoble Rhône-Alpes

8.2 Teaching - Supervision - Juries

8.2.1 Teaching

Responsibilities

- Jérôme David was the 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, 30h/y, L2 MIASHS, UGA, France
- Licence: Jérôme David, Programmation, 52.5h/y, L3 MI, UGA, France
- Licence: Jérôme David, Système, 18h/y, L3 MIASHS, UGA, France
- Licence: Jérôme David, Reseaux, 12h/y, L3 MIASHS, UGA, France
- Licence: Jérôme Euzenat, Programmation Logique, 12h/y, L2 MIASHS, UGA, France
- Master: Jérôme David, Programmation Java 2, 30h/y, M1 MIASHS, UGA, France
- Master: Jérôme David, Conception orientée-objet, 30h/y, M1 Informatique, UGA, France
- Master: Jérôme Euzenat, Semantics of distributed knowledge, 27h/y, M2R MoSIG, UGA, France

8.2.2 Supervision

- Andreas Kalaitzakis, "Cultural evolution of knowledge within cognitively-restricted agents: accuracy, specialization and benefits", defended on 2024-11-29 (Jérôme Euzenat) [13]
- Linda Gutsche, "Modelling cultural knowledge evolution with dynamic epistemic logics and belief revision", in progress since 2024-09-01 (Jérôme Euzenat and Lucía Gómez Álvarez)
- Richard Trézeux, "Reinforcement learning and knowledge evolution", in progress since 2024-10-01 (Jérôme David and Jérôme Euzenat)

8.3 Popularization

We have developed a card game, *Class?*, to illustrate knowledge representation and knowledge acquisition and revision through playing. It has been used in various mediation activities.

8.3.1 Productions (articles, videos, podcasts, serious games, ...)

- Publication of a paper towards mathematics teachers and didacticians presenting our experience in using *Class?* in the context of the French education curriculum [5].

8.3.2 Participation in Live events

- Presentation of the *Class?* game in the training session for teachers of «Numérique et sciences de l'informatique», Saint-Martin d'Hères (FR), 2024-02-05
- Introduction of the *Class?* game to mathematics-interested tenth graders (2^{nd} MathC2+), Saint-Martin d'Hères (FR), 2024-07-03.

9 Scientific production

9.1 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 (cit. on p. 4).

[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 (cit. on p. 4).

[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 (cit. on pp. 3, 4).

9.2 Publications of the year

National journals

[5] L. van den Berg and J. Euzenat. 'Class? en classe: jouer avec des classifications pour combiner mathématiques et informatique'. In: *Recherches et recherches-actions en didactique de l'informatique* 1.1 (2024), pp. 1–15. URL: https://hal.science/hal-04621556 (cit. on p. 13).

International peer-reviewed conferences

[6] N. Abbas, A. Bazin, J. David and A. Napoli. 'Discovering a Representative Set of Link Keys in RDF Datasets'. In: *Proc. 24th international conference on knowledge engineering and knowledge management (EKAW)*. EKAW 2024 - 24th International Conference on Knowledge Engineering and Knowledge Management. Amsterdam, Netherlands: Springer Verlag, 2024, pp. 53–68. DOI: 10.1007/978-3-031-77792-9_4. URL: https://hal.science/hal-04884974 (cit. on p. 9).

[7] L. Gómez Álvarez and S. Rudolph. 'Reasoning in SHIQ with axiom- and concept-level standpoint modalities'. In: *Proc. 21st International Conference on Principles of Knowledge Representation and Reasoning (KR)*. KR 2024 - 21st International Conference on Principles of Knowledge Representation and Reasoning. Hanoi, Vietnam: No commercial editor., 2024, pp. 383–393. DOI: 10.24963/kr.2024/36. URL: https://hal.science/hal-04884917 (cit. on p. 7).

[8] M. A. N. Pour, A. Algergawy, E. Blomqvist, P. Buche, J. Chen, P. G. Cotovio, A. Coulet, J. Cufi, H. Dong, D. Faria, L. Ferraz, S. Hertling, Y. He, I. Horrocks, L. Ibanescu, D. S. Jain, E. Jiménez-Ruiz, N. Karam, F. Kraus, P. Lambrix, H. Li, Y. Li, P. Monnin, H. Paulheim, C. Pesquita, A. Sharma, P. Shvaiko, M. Silva, G. Sousa, C. Trojahn, J. Vataščinová, B. Yaman, O. Zamazal and L. Zhou. 'Results of the Ontology Alignment Evaluation Initiative 2024'. In: *Proceedings of the 19th International Workshop on Ontology Matching co-located with the 23rd International Semantic Web Conference (ISWC 2024) Baltimore, USA, November 11, 2024*. 19th International Workshop on Ontology Matching (OM 2024). Baltimore, United States, 11th Nov. 2024. URL: https://inria.hal.science/hal-04892635.

[9] L. S. Werner, N. Layaïda, P. Genevès, J. Euzenat and D. Graux. 'Reproduce, Replicate, Reevaluate.The Long but Safe Way to Extend Machine Learning Methods'. In: *Proceedings of the 38th Annual AAAI Conference on Artificial Intelligence*. AAAI 2024 - 38th Annual AAAI Conference on Artificial Intelligence. Vancouver, Canada, 2024, pp. 1–9. URL: https://inria.hal.science/hal-04035305 (cit. on p. 9).

Scientific book chapters

[10] J. David, J. Euzenat, N. Layaïda, N. Layaïda and M.-C. Rousset. 'Interrogation du web sémantique'. In: *Du big data à l'IA: 60 ans d'expérience en traitement des données, des informations et des connaissances à Grenoble*. UGA Éditions, 2024, pp. 603–623. URL: https://hal.science/hal-04884916.

9.3 Cited publications

[11] C. Alchourrón, P. Gärdenfors and D. Makinson. 'On the logic of theory change: partial meet contraction and revision functions'. In: *Journal of symbolic logic* 50.2 (1985), pp. 510–530 (cit. on p. 8).

[12] L. Gómez Álvarez and S. Rudolph. 'Standpoint Logic: Multi-Perspective Knowledge Representation'. In: *Proc. 12th FOIS*. Bozen-Bolzano (IT), 2021, pp. 3–17 (cit. on p. 3).

[13] A. Kalaitzakis. 'Cultural evolution of knowledge within cognitively-restricted agents: accuracy, specialization and benefits'. Thèse d'informatique. Grenoble (FR): Université Grenoble Alpes, 2024. URL: https://moex.inria.fr/files/theses/thesis-kalaitzakis.pdf (cit. on pp. 7, 12).

[14] A. Mesoudi. *Cultural Evolution: How Darwinian theory can explain human culture and synthesize the social sciences*. University of Chicago Press, Chicago (IL US), 2011 (cit. on p. 4).

[15] L. Steels, ed. *Experiments in cultural language evolution*. John Benjamins, Amsterdam (NL), 2012 (cit. on p. 4).