

# JOWO 2022

## The Joint Ontology Workshops

Proceedings of the Joint Ontology Workshops 2021  
Episode VIII: The Svear Sommar of Ontology

Jönköping, Sweden, August 15–19, 2022

Edited by

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and for the workshops

CAOS | Ensusto | FMKD  
FOUST | IFOW | OSS | RobOntics

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# PREFACE

## **JOWO – The Joint Ontology Workshops**

These proceedings present the papers and extended abstracts that took part in the Joint Ontology Workshops (JOWO'22): Episode VIII: The Svear Summer of Ontology.

Yearly organised, JOWO is one of the main events of the research mission of the International Association for Ontology and its Applications (IAOA). Taking the form of an umbrella conference, each year JOWO hosts a series of workshops and tutorials that, together, address a wide spectrum of topics related to theoretical and applied ontology research. Traditional domains include areas in the full span of cognitive science and humanities, knowledge representation and conceptual modelling, artificial intelligence and robotics, logic and philosophy, and linguistics and natural language processing. With such an interdisciplinary outlook, the purpose of JOWO is to provide a platform for the diverse communities interested in building, reasoning with, and applying formalised ontologies.

Biyearly, the event is held in conjunction with the IAOA's flagship conference Formal Ontology in Information Systems (FOIS) and, biyearly, it is a stand-alone event. Running since 2015, each edition of JOWO has its own character with a different set of workshops and tutorials - all dependent on the selection made by the yearly organisational team - and as an umbrella event, JOWO continues to grow in importance and influence.

The eighth edition of JOWO took place as a stand-alone event at Jönköping University, Sweden, between the 15th and 19th of August, 2022. Held predominantly as an on-site event, remote presentation and participation were also offered as the complete scientific program was live-streamed. The conference had just over 50 on-site participants and over 70 participants joined the conference online.

During the conference week, JOWO'22 ran two parallel sessions to provide enough time for the contributing workshops and tutorials. In the end, the scientific program consisted of seven workshops, three tutorials, three shared keynotes and a panel debate.

The workshops covered a broad spectrum of contemporary applied ontology research, including its foundational aspects (FOUST VI) and application in specific domains, in particular, cognitive science (CAOS VI), knowledge diversity (FMKD), cognitive robotics (RobOntics III), social services (OSS), modelling the food industries (IFOW III), and sustainability (Ensusto).

The workshops that were included in the eighth edition of JOWO, and thus part of these proceedings, are:

**CAOS VI:** Cognition And OntologieS IV

**Ensusto:** Energy, Materials and Sustainability Ontology Workshop

**FOUST VI:** Foundational Ontologies

**FMKD:** First Workshop on Formal Models of Knowledge Diversity

**IFOW III:** The Third Integrated Food Ontology Workshop

**OSS:** Ontologies for Social Services

**RobOntics III:** Ontologies for Autonomous Robotics

There were 46 papers submitted for peer-review to these workshops, of which 29 were accepted for this volume: 22 as regular papers, 6 as short papers, and 1 as an abstract.

The participants were also offered the chance to further extend their ontology-focused skillset by participating in three tutorials of different scientific characters. First, He Tan held a semantic web tutorial on “*Knowledge Graphs.*” Then Tiago Prince Sales, Joao Paolo A. Almeida and Giancarlo Guizzardi organised a tutorial on how to “*Implement Better Ontologies with gUFO.*” Finally, the intersection between ontological modelling and linguistic research was investigated in the tutorial “*Generating Text from Ontologies in Multiple Languages*” organised by Maria Keet and Zola Mahlaza.

No scientific gathering is complete without the expertise of a few invited speakers. Thus, the scientific highlights of the event were the three presentations of the shared keynotes. First up was Janna Hastings (University of Zurich/University of St. Gallen). In her talk “*Ontologies in the age of deep learning,*” she promoted ontology research in the setting of recent computer technologies. This was followed by a talk by Peter Gärdenfors (University of Lund) who presented selected parts of his paradigm-shifting research on “*Conceptual spaces, event structure and cognitive ontology.*” The final keynote speaker, invited as part of the FMKD workshop, was Sebastian Rudolph (Technical University Dresden). He took the opportunity to build on Gärdenfors’ research and presented a more formal theory of knowledge representation in his talk “*The Matrix Has You – Toward Compositional Conceptual Spaces.*”

The panel debate “A Foustian Struggle,” organised as part of the FOUST workshop, took the format of a deep-dive into the differences in ontological modelling languages as the founders of some of the world’s most influential foundational ontologies battled it out on how best to model a series of complicated scenarios. Representing their foundational ontology by participating in the panel debate were: John Bateman representing GUM, Stefano Borgo representing DOLCE, Giancarlo Guizzardi representing UFO, Michael Grünniger representing TUpper, Riichiro Mizoguchi representing YAMOTO, and J. Neil Otte, John Beverley, and Alan Ruttenberg representing BFO.

Alongside providing a strong, state-of-the-art scientific program, JOWO is an important venue for networking. Therefore, JOWO'22 offered its on-site participants a rich social program. Some of the highlights were a conference reception with Swedish “skumpa och smörgåstårta,” a half-day tour with a hiking excursion visiting the candy-capital Gränna and the old industry-village Röttle, a BBQ on the beach, and a conference dinner embraced in the rainbow-colour of the sunset over the lake Vättern.

Building on a rich history, the eighth edition of JOWO, Episode VIII: The Svear Summer of Ontology, was the latest edition in a series of multi-national event locations. The previous editions of the JOWO series were the following:

- The first JOWO edition was ‘[Episode I: The Argentine Winter of Ontology](#)’, held in Buenos Aires, Argentina, in co-location with the 24th International Joint Conference on Artificial Intelligence (IJCAI 2015). The proceedings of JOWO 2015 appeared as volume 1517 of CEUR.
- The second JOWO edition was ‘[Episode II: The French Summer of Ontology](#)’, held in Annecy, France, in co-location with the 9th International Conference on Formal Ontology in Information Systems (FOIS 2016). The proceedings of JOWO 2016 appeared as volume 1660 of CEUR.
- The third JOWO edition was ‘[Episode III: The Tyrolean Autumn](#)’, hosted by the Free University of Bozen-Bolzano in Bolzano, Italy, on September 21–23, 2017. The proceedings of JOWO 2017 appeared as volume 2050 of CEUR.
- The fourth JOWO edition was ‘[Episode IV: The South African Spring](#)’, held in Cape Town, South Africa, in co-location with the 10th International Conference on Formal Ontology in Information Systems (FOIS 2018). The proceedings of JOWO 2018 appeared as volume 2205 of CEUR.
- The fifth JOWO edition was ‘[Episode V: The Styrian Autumn of Ontology](#)’, held in Graz, Austria, on September 23–25, 2019. The proceedings of JOWO 2019 appeared as volume 2518 of CEUR.
- The sixth JOWO edition was ‘[Episode VI: The Bolzano Summer of Knowledge](#)’, (virtually) held in Bolzano, Italy, between August 31 and October 7, 2020. The proceedings of JOWO 2020 appeared as volume 2708 of CEUR.
- The seventh JOWO edition was ‘[Episode VII: The Bolzano Summer of Knowledge 2.0](#)’, (virtually) held in Bolzano, Italy, on September 10–18, 2021. The proceedings of JOWO 2020 appeared as volume 2969 of CEUR.

## **Acknowledgements**

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## **General Chairs**

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# JOWO 2022 Workshops

## CAOS VI

### 6th International Workshop on Cognition And Ontologies

#### Programme Chairs

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‘CAOS: Cognition And OntologieS’ is a workshop series devoted to bridging the gap between the cognitive sciences and research on formal ontologies. Its focus is the formal modelling and the representation of key cognitive phenomena and concepts, broadly understood, as they can be found across language, psychology, and reasoning.

CAOS aims to engage a diverse and interdisciplinary audience from research areas in philosophy and linguistics, psychology, cognitive science and computer science, and related fields. Its purpose is to promote the development of cutting-edge research, strengthen international research collaborations, and offer discussions of unconventional research topics in an open venue eager to engage in scientific discourse.

Therefore, we are happy that the sixth edition of CAOS accepted papers from a broad spectrum of topics, with contributors from different areas of expertise. Further, the international flare of the venue is showcased by the diversity of the contributions, which are authored by people from ten countries and fifteen institutions. We are also proud to report that our community is growing: out of 25 authors, 20 were newcomers to our workshop series. More specifically, the sixth edition of CAOS accepted six papers for publication, present in this volume, and four abstracts for oral presentation.

Mauricio Pedroza-Torres and Roberto Aguirre suggest using sensorimotor signals to explain pre-conceptual representation. Maria Rosaria Stufano Melone, Stefano Borgo and Oliver Kutz analyse architectural rules using a framework based on image schemas and ontology. Martin Thomas Horsch and Björn Schembera present mid-level ontology documentation of epistemic metadata of cognitive processes. Gabriele Sacco, Loris Bozzato and Oliver Kutz use a methodology of weighted Description Logics to represent mereological relations. Felix Weber, Ahmed M. H. Abdel-Fattah and Kai-Uwe Kühnberger aim to introduce goal representations in the framework of conceptual spaces, and Stefano De Giorgis, Aldo Gangemi and Dagmar Gromann present ISAAC, an image schema abstractor based on modular ontology.

The abstracts presented at the venue (not included in this volume) explored a variety of research topics. César Bernabé, Luiz Santos, Annika Jacobsen and Marco Roos presented the abstract “Using goal models and a metadata model to share ontology intended uses as ontology domain context.” Sanja Sreckovic presented “Embodied inference” and defended the idea that reasoning includes bodily relations. Adam Kaliski and Emil Weydert presented the abstract “Interactions between defaults and roles in defeasible description logics,” and Līga Zariņa, Jurgis Škilters and Ģirts Ratnieks presented an abstract on “Spatial ontology scheme for natural language constrained by topological and geometrical features.”

## **Ensusto**

### **The Energy, Materials and Sustainability Ontology Workshop**

#### **Programme Chairs and Committee**

Martin Glauer	Otto von Guericke University Magdeburg, Germany
Janna Hastings	University of St. Gallen, Switzerland
Till Mossakowski	Otto von Guericke University Magdeburg, Germany
Fabian Neuhaus	Otto von Guericke University Magdeburg, Germany

The Energy, Materials and Sustainability Ontology (Ensusto) Workshop 2022 provides a venue for presenting ontologies and their applications in the domains of renewable energy, materials and sustainability. The primary goal of this workshop was to offer researchers and practitioners in these domains an opportunity to meet and exchange experiences in developing and using ontologies, and to provide a forum for the exchange of knowledge and best practices for ontologies in these domains. We were welcoming participation also from those who have just started to apply ontologies in these domains or who are not yet using ontologies in these domains but are interested in learning more.

## FMKD

### 1st International Workshop on Formal Models of Knowledge Diversity

#### Programme Chairs

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Sebastian Rudolph	TU Dresden, Germany

The Formal Models of Knowledge Diversity (FMKD) workshop intends to create a space of confluence and a forum for discussion for researchers interested in knowledge diversity in a wide sense, including diversity in terms of diverging perspectives, different beliefs, semantic heterogeneity and others. The importance of understanding and handling the different forms of diversity that manifest between knowledge formalisations (ontologies, knowledge bases, or knowledge graphs) is widely recognised and has led to the proposal of a variety of systems of representation, tackling overlapping aspects of this phenomenon.

The topics of interest include philosophical and cognitive analysis of knowledge diversity, formal models for the representation of knowledge diversity, ontological approaches capturing multiple perspectives and viewpoints, context and concept formation in such systems, consistency (or not) in multi-perspective systems, assessment and mitigation of inconsistencies, communication between knowledge-diverse systems, argumentation-based approaches for dealing with inconsistency, aggregation of diverse or inconsistent knowledge; judgement aggregation, uncertainty in the context of knowledge diversity, and applications of formal models of knowledge diversity.

In particular, the first edition of the workshop (FMKD 2022) featured a keynote about compositional conceptual spaces by Sebastian Rudolph along other works on the topics of measuring and controlling knowledge diversity by Bourahla et al.; representation heterogeneity, by Giunchiglia and Bagchi; generalizing Condorcet jury theorem by Jonas and Rudolph; and reference, predication and quantification in the presence of vagueness and polysemy, by Bennett. The variety of the topics presented and the success of the event reflect the importance of the topic in the current research map.



## FOUST

### 6th Workshop on Foundational Ontology

#### Programme Chairs

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Stefano Borgo	Laboratory for Applied Ontology (ISTC-CNR), Italy

Foundational ontology is about categories of reality or thought which are common to all or almost all subject-matters. Commonly considered examples of such categories include ‘object’, ‘quality’, ‘function’, ‘role’, ‘process’, ‘event’, ‘time’, and ‘place’. There are several foundational ontologies that provide a systematic formal representation of these categories, their relationships, and interdependencies. Amongst existing foundational ontologies, there is both a substantial measure of agreement and some dramatic disagreements. There is currently no uniform consensus concerning how a foundational ontology should be organised, how far its

‘reach’ should be (e.g., is the distinction between physical and non-physical entities sufficiently fundamental to be included here?), and even what role it should play in relation to more specialised domain ontologies.

The main use of foundational ontologies is as a starting point for the development of domain ontologies and application ontologies. A foundational ontology provides an ontology engineer with a conceptual framework that enables her to analyse a given domain, identify the entities in the domain as specialisations of the generic categories in the foundational ontology, and often reuse relationships (e.g., part-hood) from the foundational ontology. The utilisation of foundational ontologies for the development of domain and application ontologies has two main benefits. Firstly, the ontology engineer can reuse an existing set of well-studied ontological distinctions and design principles instead of having to develop an ad-hoc solution. Secondly, if two domain ontologies are based on the same foundational ontology, it is easier to integrate them.

FOUST is an ontology workshop series that offers researchers in foundational ontology an opportunity to present their results. This includes work on specific areas of foundational ontology as well as work on a particular foundational ontology. Topics covered in this edition of FOUST include, amongst others, mereology, space and time representations, functions, viewpoints, and templates.

## **IFOW**

### **3rd Integrated Food Ontology Workshop**

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Francesco Vitali	Institute of Agricultural Biology and Biotechnology, Italy

Academic, agricultural and public health agencies are considering the benefits and complexities of adopting ontology in their research and data management and reporting infrastructure. What vocabulary, tool ecosystem and data models are needed to correlate agricultural treatments, nutritional data, eating patterns, biomarkers, pathogens, and phytochemical levels with disease and health phenotypes? This workshop seeks to define the coverage of the different ecological, agricultural, nutritional, dietary, public health, one health surveillance, food security, and trade domains that food-related ontologies are modelling, and the use of data translation tools for bringing legacy data into the ontology fold.

The workshop had a few hybrid (combination physical and virtual) sessions on August 15 and 16: Two presentation and discussion sessions about the development and application of ontologies and open graph databases towards agricultural production, food processing, ingredient and nutritional composition. As well, a workshop for a few hours of think-tank / white-boarding which focused on the topic of fermentation.

## OSS

### International Workshop on Ontologies for Social Services

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Vijay Mago	Lakehead University, Canada

Semantic technologies provide a formal way to represent knowledge in ways that are interpretable by computers and a related technology stack to store, integrate and query information semantically. The Workshop on Ontologies for Social Services (OSS) aims to foster communication and strengthen interdisciplinary work at the intersection of semantic technologies and social services. We invite researchers from the Knowledge Representation, Semantic Web, Machine Learning, and Social Science communities to submit theoretical contributions, novel algo-

rhythms, artifacts, and tools related to social services. In addition, we welcome reports from Social Work practitioners on their experiences using semantic-enabled technologies, best practices, and insights.

The first workshop on ontologies for social services brought together researchers working on ontological definitions of services and related topics. Competing formal definitions of services provided for a lively discussion on what makes a service, and how such definitions can remain consistent through various transformations. Four works introduced domain-level ontologies with service definitions for healthcare, social services, and occupations. Each introduced related topics such as stakeholders, their needs, events where stakeholders and services interact, and contextual metadata to retain meaning. One definition provided an upper-level services ontology, proposing a definition for "pure" services and how families of services can be distinguished. Three of the works followed The Open Biological and Biomedical Ontology (OBO) Foundry methodologies. Finally, four works defined data models allowing interoperability between systems that share data. Two of the data models demonstrated how such definitions could retain their semantic meaning through a complex network of data transformations; one system being an ecosystem of repositories with different data models in a decentralized system, and the second proposing a layered schema architecture that can incorporate metadata from various sources.

## **RobOntics**

### **3rd International Workshop on Ontologies for Autonomous Robotics**

#### **Programme Chairs**

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Daniel Beßler	University of Bremen, Germany
Mihai Pomarlan	University of Bremen, Germany
Mohammed Diab	Imperial College London, UK
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Stefano de Giorgis	University of Bologna, Italy

Many difficult problems remain in autonomous robotics, some of which are related to the representation of knowledge about the world and how this knowledge can be used to generate behavior. Therefore, there is a need for a place where the communities of knowledge representation, ontology engineering, and robotics

can meet to exchange challenges and ideas. Now at its third edition, RobOntics is such a venue.

The workshop welcomes papers of various types, including position papers or literature reviews. This year's contributions however have all presented early, but promising work that combines ontological reasoning with robotics applications. In particular, the papers have focused on the robot interacting with an environment where it is either the only agent, or, when present, other agents do not communicate. Öztürk et al. encode knowledge about the robotic skill of picking up regularly shaped items into an ontology. Pomarlan et al. present a method to guide the attention of an agent's perception system by using an ontology of image schemas. Coffelt et al. present a system to reason about failure, in particular to assess its cause and potential workarounds, for an autonomous underwater robot. Dhanabalachandran et al. describe a system that reasons with image schemas so as to improve a robot's understanding of the skill of stacking.

The workshop took place on the 17th of August as a hybrid, but mostly in-person, session.

