Proceedings of the Joint Ontology Workshops 2017
Episode 3: The Tyrolean Autumn of Ontology

JOWO 2017

The Joint Ontology Workshops
Episode 3: The Tyrolean Autumn of Ontology

CREOL | DAO | DEW | EPINON | FOMI
FOUST II | ISD3 | ODLS | SHAPES 4.0 | WINKS

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PREFACE

JOWO – The Joint Ontology Workshops

JOWO 2017—Episode III: The Tyrolean Autumn, was the third edition of the 'Joint Ontology Workshops', which comprised a confederation of ten ontology workshops. It was hosted by the Free University of Bozen-Bolzano and held between September 21–23, 2017 in Bolzano, Italy.[1] JOWO's mission is to provide a platform for the diverse communities interested in building, reasoning with, and applying formalised ontologies in the wide spectrum of Information Systems, Artificial Intelligence, Philosophy, Linguistics and Cognitive Science, both in theory and applications.
The 2017 edition of JOWO collocated workshops that cover a broad spectrum of contemporary applied ontology research, including its philosophical and methodological foundations (FOUST II, DEW), the application of ontologies in particular domains (ODLS, FOMI), the role of ontology in related research areas like cognition (ISD3, EPINON), context (CREOL), data and knowledge (DAO, WINKS), shape and patterns (SHAPES 4.0).

JOWO 2017 included the following ten workshops:[2]

CREOL International Workshop on Contextual Representation of Objects and Events in Language[3]

DAO International Workshop on Data meets Applied Ontologies[4]

DEW International Workshop on Ontology Debugging & Evaluation[5]

EPINON International Workshop on Epistemology in Ontologies[6]

FOMI 8th International Workshop on Formal Ontologies meet Industry[7]

FOUST II 2nd Workshop on Foundational Ontology[8]

ISD3 3rd Image Schema Day[9]

[1] The first JOWO edition was 'Episode 1: 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, see http://ceur-ws.org/Vol-1517/.
The second JOWO edition was 'Episode 2: 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, see http://ceur-ws.org/Vol-1660/.
[2] A more detailed description of these workshops can be found below.
[3] See http://creol2017.di.unito.it/
[4] See https://smart.inf.unibz.it/index.php/2017/05/15/dao2017/
[5] See http://iaoa.org/jowo/dew2017/
[6] See http://www.loa.istc.cnr.it/workshops/epinon2017/home.html
[7] See http://www.loa.istc.cnr.it/workshops/FOMI2017/home.html
[8] See http://foust.inf.unibz.it/foust2/
[9] See http://isd.inf.unibz.it

ODLS 8th International Workshop on Ontologies and Data in Life Sciences[10]

SHAPES 4.0 - THE SHAPE OF THINGS 4th International Workshop on SHAPES[11]

WINKS International Workshop on Interaction-Based Knowledge Sharing[12]

JOWO 2017 was a great success. There were about 100 submissions, 69 accepted papers, and the conference had more than 100 participants. Particularly memorable were the four keynotes by Antonio Chella, Giancarlo Guizzardi, Alessandro Mosca, and Todd Oakley, and the concert by the "Hyperinstruments Ensemble" lead by Nicola Baroni.

[10] See https://wiki.imise.uni-leipzig.de/Gruppen/OBML/Workshops/2017-ODLS
[11] See http://www.loa.istc.cnr.it/workshops/SHAPES4/
[12] See http://www.iiia.csic.es/winks/

JOWO 2017 Workshops

Contextual Representation of Objects and Events in Language (CREOL)

Dealing with context is a key factor in the conceptualisation of human experience, and thus a major issue for understanding natural language, and a challenging issue for AI. It is well known that some properties of objects and events may be activated according to the context of occurrence, thus determining access to partial salient information rather than to all information. One typical case involving objects is that of an orange being passed between two children, or the same orange peeled on a table: in the former case the roundness prevails over other traits, and the orange is likely being used to play; in the latter one, the edible features are those principally conveyed by the scene. Similar and higher plasticity associated to contextual features also characterises events. Events are complex entities by nature, and representing and extracting them from textual documents is not a trivial task. Existing lexical resources encode very basic information on events: their linguistic realisation, roles of participants, and types. Additional properties of events are currently missing: duration of events, event internal substructure, event pre- and post- situations, relations to other events in terms of explanatory/causal and temporal relations. These properties are essential to promote reasoning on events and their participants, and they may vary according to the specific context of occurrence in a text/document.
Contextual access to objects and events needs to be investigated at its interface with language. The design of ontological and linguistic resources that account for the mentioned semantic phenomena involves collecting contextual information and devising context-aware procedures. For its first edition, CREOL has been organised as one of the Joint Ontology Workshops (JOWO). The Proceedings of the first edition collect three original papers: *Natural Language Template Selection for Temporal Constraints* by C. Maria Keet; *PRiSMHA (Providing Rich Semantic Metadata for Historical Archives)* by Anna Goy and colleagues; and *Collecting Information for Action Understanding: The Enrichment of the IMAGACT Ontology of Action* by Andrea Amelio Ravelli and colleagues.
The contributed works touch different aspects of the relationship between the representation of (abstract) concepts in ontologies and in language. Each paper focuses on different issues and all are centred around the main topics of the CREOL workshop: events and roles (the PRiSMHA project), actions and objects (the IMAGACT project), and the verbalisation of events and their time-related properties (the paper Natural Language Template Selection for Temporal Constraints).

Data meets Applied Ontologies (DAO)

The goal of the DAO workshop was to provide an opportunity for participants from academia and industry to present their latest developments in ontology-mediated data integration and analysis techniques, and data-driven industrial applications. The accepted contributions, five in total, presented applications of on-

tologies and related tools in fields like robotic journalism, civil engineering, policy monitoring, and 3D factory design. All submissions consisted of a demo description that was presented at the workshop. In the first paper, Hermann Bense describes the textOmatic*Composer, a semantic technology that automatically generates personalised multi-language news streams from very large scale ontologies. As application examples, he demoed the Focus Online and Handelsblatt portals. In another paper, Valerio Santarelli, Giacomo Ronconi, Marco Ruzzi and Domenico Fabio Savo present OntoGUI, a Protégé plugin that allows one to access heterogeneous data sources according to the ontology-based data access (OBDA) paradigm. Also related to OBDA, Alessandro Mosca presents an observatory portal of research and innovation of the Tuscany Region developed using ODBA technologies. Finally, Walter Terkaj demoed a GUI tool for the instantiation of OWL ontologies, and he showed, together with Giovanni Paolo Vigan, how the GUI can be used together with GIOVE-VF, an ontology-based virtual factory tool that supports the 3D design of factories.

Ontology Debugging & Evaluation (DEW)

Ontology engineering is a complex and error-prone task, which is, nonetheless, fundamental for many knowledge-intensive applications. To a large degree, successful ontology applications depend on an ability to detect, understand, and correct errors in ontologies and ontology-based knowledge bases. Success also depends on an ability to assess how well ontologies meet the requirements of a particular use. The main goal of the DEW workshop was to recall and advance the state of the art in ontology evaluation and debugging. Additionally, the workshop aimed to foster exchange on these topics between research-oriented and application-oriented communities. The workshop welcomed submissions describing methods, tools, and challenges in ontology debugging and evaluation, as well as quality criteria, metrics, experimental results, and lessons learned. Submissions ranged in emphasis, focusing to varying degrees on experience, pragmatics, and theory. Perspectives included those of ontology (re)users, ontology developers, and those responsible for quality assurance of ontologies incorporated into larger systems.

The workshop accepted a total of four submissions, covering different perspectives on ontology evaluation and debugging. Ricardo Guimarães and Renata Wassermann present preliminary work on the combination of atomic decompositions—a technique developed in the area of ontology modularisation—and the theory of local change, through the definition of a new relevance metric. Jean-Rémi Bourguet, Giancarlo Guizzardi, Alessander Botti Benevides, and Veruska Zamborlini describe three different approaches for representing changes in the standard web ontology language OWL 2, and compare them through an empirical analysis based on synthetic, but principled, random instances. In their submission, Claudia Schon and Steffen Staab studied the problem of instance-level updates of dynamic knowledge bases, taking into account the terminological knowledge, through a new notion of query-driven semantics. Finally, He Tan, Anders Adlemo, Vladimir Tarasov, and Mats Johansson present an evaluation for a real-life ontology from the avionics domain.

The event was successful, promoting deep and interesting discussions that permeated beyond the workshop sessions.

Epistemology in Ontologies (EPINON)

Formal ontologies and knowledge representation mainly focus on characterising how a given domain is structured, i.e., they identify a set of concepts, entities, and relations together with the constraints that hold for this domain. The structure of the characterisation is usually intended to reflect the point of view of significant experts or a realist view of how things about a particular domain are in reality. The aim of this workshop is to explore an epistemological stance in formal ontology and knowledge representation and focus on the assessment of the modelling provided by the ontology designer. In particular, we are interested in fostering two intertwined research directions. Firstly, we are interested in promoting discussions about the epistemological foundations of formal ontologies and of knowledge representation. A number of timely important problems are related to this point, for instance: the investigations of cognitively adequate ontological representations, the investigations on the provenance of data, the problem of the reliability of the source of information (both human and artificial, e.g. sensors), the problem of the epistemic reliability of the classification provided by ontology users, the problem of finding epistemically and cognitively well-founded rationales for the integration of ontological representations with other representational formats (e.g. deep neural networks, vector space models etc.).
Secondly, we are interested in formal and ontological approaches to the definitions of the concepts that are relevant to the assessment of the perspective of the ontology designer. Problems related to this direction include: ontology of general epistemological concepts (e.g. proof, argument, explanation, epistemic reliability, trust), ontology of cognitive concepts (perception, reasoning, sensations), ontology of data and measurements.
We aim to address to an interdisciplinary audience, by inviting scholars in philosophy, computer science, logic, conceptual modelling, knowledge representation, and cognitive science to contribute to the discussion.
The workshop proposed four contributions that approach the relationship between ontology and epistemology from heterogeneous interesting perspectives. Stanislaw Ambroszkiewicz discussed an intuitionistic foundation of the real numbers. Erden Miray Yazgan Yalkin presented a discussion of the concept of truth in the Buddhist tradition. Roberta Ferrario articulated a socio-material stance in developing formal ontologies. Giovanni Buonocore discussed the ontological status of relations in connection to philosophy of physics.

Formal Ontologies meet Industry (FOMI)

FOMI is an international forum where academic researchers and industrial practitioners meet to analyse and discuss application issues related to methods, theories, tools and applications based on formal ontologies. There is today wide agreement that knowledge modelling and the semantic dimension of information play

an increasingly central role in networked economy: semantic-based applications aim to provide a framework for information and knowledge sharing, reliable information exchange, meaning negotiation and coordination between distinct organisations or among members of the same organisation. Theoretical ideas seem often very promising, but their actual implementation brings up unexpected problems and issues. The FOMI 2017 Workshop aimed at collecting useful experiences and lessons learned covering the following areas:

1. Problems encountered in ontology-based applications;
2. New insights on known problematic issues;
3. Success stories of ontology implementations in industry;
4. Best practices on the application of ontological methodologies to real-world situations.

The accepted contributions at FOMI 2017, eight in total, address practical modelling concerns arising out of the application of computational ontologies in fields like civil engineering, finance, business process modelling and manufacturing. The two papers presented by Adamo et al. address the current limits of languages for process knowledge representation like BPMN and UML-AD and propose how to overcome these limits from an ontology-based perspective. Aameri and Grueninger introduce an initial set of modular ontologies for manufacturing applications and sketch an axiomatised ontology to represent geometric and topological constraints. Terkaj and Pauwels present an algorithm to automate the modularisation of ifcOWL, that is, the OWL version of the Industry Foundation Classes (IFC), a well-established standardised data model in the Building Information Modeling (BIM) area. The purpose is to facilitate the exploitation of Semantic Web technologies for the Architecture Engineering Construction (AEC) and Facility Management (FM) industries. Together with Schneider, Terkaj and Pauwels also present the Building Automation and Control Systems (BACS) ontology for the integrated representation of cyber-physical systems embedding building elements, sensors, actuators and devices. In the financial industry, Blums and Weigand present the Core Ontology of Financial Reporting Information Systems for a Shared Ledger Environment (COFRIS) for facilitating the reuse, transparency and sharing of financial reporting. In the same direction, the short paper of Browne et al. presents the implementation of an extended version of the Financial Industry Business Ontology (FIBO), which is called Global Fund Reporting Ontology (GFRO), to build semantic-based financial reporting compliant with current standards. Finally, the work presented by Detoni et al. provides a methodology to support ontology development by eliciting experts knowledge and know-how in conceptual models that are codified in the ARIS language. The approach is validated by a case study in the public security of Brazil.

2nd Workshop on Foundational Ontology (FOUST II)

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 for-

mal 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. The 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., parthood) 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 particular foundational ontologies.

Amongst specific areas, one which continues to excite a good deal of discussion on account of its fundamental nature is *mereology*, which is concerned with the analysis and formalisation of the part-whole relation. Several of the papers in this workshop address various different aspects of this topic. **Keet**, for example, draws attention to the plethora of different forms of part-whole relations that have been enumerated in the literature (including, for example, *spatial parthood*, *membership of a collection*, *material constitution*, and *participation in a process*), and explores how the properties of these relations are reflected in the specific formalisations adopted by different foundational ontologies. **Ru and Grüninger** are similarly concerned with handling multiple part-whole relations, but here in the context of solid physical objects, for which they distinguish *components*, *pieces*, *portions*, and *contained entities*, each of which they propose should be handled by a separate module within a collection of ontologies of solid physical objects. **Barton, Jansen and Ethier** discuss a completely different aspect of mereology, focussing on classifying the parthood relations that exist amongst dispositions — for example 'a disposition to break is part of fragility' vs 'the solubility of part of a tablet is part of the solubility of the whole tablet'. Finally **Mizoguchi and Borgo** study the notion of functional parthood, for which they propose an analysis in terms of another fundamental ontological category, *roles*.

Several papers in the workshop presented some current developments in existing foundational ontologies. **Porello and Guizzardi** propose a first-order modal axiomatisation of the Unified Foundational Ontology (UFO). **Benevides, Bourguet, Guizzardi and Peñaloza** also work with UFO, specifically the part (UFO-B) dealing with the ontology of events, which they show can be formalised within the Description Logic $\mathcal{SROIQ}$, thus enabling practical application of the theory using OWL 2 DL. **Mizoguchi and Toyoshima** present YAMATO, Yet Another More Ad-

vanced Top-level Ontology, with special attention to how it can handle examples involving change over time. **Chui and Grüninger** turn their attention to DOLCE, and in particular the problem of *verifying* it in the sense of ensuring that the models of the formal theory conform to the intended models of the ontology. The method they propose is modular, involving separate verification of an exhaustive set of subtheories of DOLCE.
The remaining papers cover a diverse set of concerns relating to foundational ontologies. **Grüninger, Chui and Katsumi** propose a view of upper ontologies as composed of a set of *generic* ontologies each concerned with the axiomatisation of a particular well-defined set of generic concepts. As in the paper of Chui and Grüninger, this leads to the possibility of a modular approach to ontology verification, using in this case the principles enshrined in the Common Logic Ontology Repository (COLORE). **Bennett, Hasse and Gilmore** discuss a way of handling contextually-defined concepts such as 'customer' (defined in the context of some commercial business), using a partition of the upper ontology to clarify the relations between the three broad top-level categories of 'independent', 'relative', and 'mediating' things. **Garbacz** discusses a different set of issues, relating to the classification of objects on the basis of their 'qualitative stability', that is, the extent to which they are liable to undergo change with respect to their qualities. **Schulz, Boeker, Vera Ramos and Jansen** address the matter of ontological education, taking a close look at two long-established and widely used pedagogical ontologies, the PIZZA and WINE ontologies, to determine to what extent they remain fit for purpose in the light of more recent developments, proposing suitable modifications where they are found to be deficient. Finally **Neuhaus** presents a critique of a widely cited definition of 'ontology'.

3rd Image Schema Day (ISD3)

Inspired by the concept of an embodied mind, in which all cognition is thought to manifest as direct consequences to the body's sensorimotor experiences, is the theory of image schemas. Image schemas are thought to be mental generalisations from repeated exposure to particular spatiotemporal relationships and capture concepts such as Containment, Support, Source-Path-Goal and Attraction. The theory was introduced in cognitive linguistics as a means to explain the large degree of spatial language found in language concerning abstract concepts as well as metaphors. In developmental psychology, image schemas are investigated as part of conceptual learning processes where they are thought to function as information skeletons for analogical reasoning and concept learning. In design and in more artistic domains, image schemas are used to describe the experience by which humans perceive information, for instance, how musical scales often are visualised as movement along a vertical axis. As of late, research in computer science has taken a liking to image schemas as they provide a straightforward way to approach the symbol grounding problem. Therefore, methods in both machine learning and traditional knowledge representation have been employed to simulate image schemas. Here, their integration into formal frameworks for concept invention and analogy engines, as well as how they can aid natural language

processing and understanding are some of the areas that could benefit from the integration of the information-rich image schemas.

As image schemas are studied from a wide range of scientific disciplines, one of the major issues for the research field is the prevalence of inconsistent views, definitions and research terminology. Therefore, one of the main purposes of ISD3 is to provide a meeting point for researchers on image schemas, regardless of scientific background, where ideas, methods and results can be discussed, in order to build bridges and to provide support from different directions. In this light, the workshop has three accepted papers from different fields of research. Shingo Imai approaches image schemas from a multi-linguistic perspective in his paper "Schema Conflict: Functional Schema and Configurational Schema". Jamie MacBeth, Dagmar Gromann and Maria M. Hedblom look at the relationship between the theory of image schemas and Conceptual Dependency Primitives, a classic theory in natural language processing in "Image Schemas and Conceptual Dependency Primitives: A Comparison". Finally, Cliff O'Reilly and Randy Harris take a more mathematical approach by demonstrating how some of the image schemas can be approached as vector space models in "Antimetabole and Image Schemata – Ontological and Vector Space Models".

Ontologies and Data in Life Sciences (ODLS)

Medicine, biology and life sciences produce hardly manageable and often incomprehensible amounts of data, information, and knowledge. Their computer-based retrieval, processing, integration, as well as their conceptual foundation, application, and reuse present ever new challenges to existing methods of knowledge representation, data bases, and data analysis and retrieval. The workshops on Ontologies and Data in Life Sciences (ODLS) cover the overall spectrum of biomedical information management, ranging from experimental data acquisition and preprocessing across analysis, structuring and interpretation of data, up to developing structured representations of knowledge, in particular in the form of ontologies, with their various applications. The primary aim of ODLS is an interdisciplinary exchange of ideas, fostering collaboration between ontologists, computer scientists, bio-informaticians, medical information scientists, physicians, biometricians, bio-chemists and philosophers, in academia and industry.
Works accepted for ODLS 2017 are distinguished into papers (of 6-12 pages) and extended abstracts (of 2-5 pages). The proceedings comprise five papers and seven extended abstracts. Topicwise, the majority of the submissions present a domain ontology embedded in its specific application context. Six such works cover a broad spectrum of domains. (1) The Spinal Cord Injury Ontology (SCIO) by Brazda et al. aims at supporting the representation of pre-clinical studies regarding spinal cord injury therapies. It is utilised in an information extraction lifecycle to populate a database with information from such studies. (2) OCL-SOP, the Ontology for Clinical Laboratory Standard Operating Procedures described by Maikore et al., defines laboratory experimental actions and related key entities, e.g. biochemical entities, equipment and data processing actions. A mobile application for semantic search in semantically annotated laboratory SOPs serves as

a use case. (3) Siemoleit et al. start from the BIOPASS project, which is concerned with a novel approach for navigation systems for surgical interventions. In its context the BIOPASS Situation Ontology (BISON) is designed to support situational awareness, by capturing endoscope locations and work steps of surgical interventions on the basis of anatomical landmarks and procedural data. (4) The TNM Ontology (TNM-O) in the work by Zabka et al. is a modular ontology developed for the management of versions of the Tumor-Node-Metastasis (TNM) classification system. The submission focuses on the use of rules expressed in the Semantic Web Rule Language (SWRL) to represent mapping criteria between TNM versions. (5) Dooley et al. introduce the Genetic Epidemiology Ontology (GenEpiO) as a central component of the Genomic Epidemiology Entity Mart (GEEM), an ontology-driven web platform for examining data standards related to genomic sequence repository metadata requirements. Finally for applied ontologies, (6) Tarini and Lange outline early versions of two ontologies, the Organoleptic Ontology and the Sensory Ontology, which are proposed to cover sensory aspects of food phenotypes and of the sensory perception of food. Both are seen to be complementary to existing food ontologies.

A second cluster, one with four submissions, focuses even more on ontology-based applications and less on specific ontologies. (7) Enea et al. are concerned with ontology matching and alignments, in particular with a visualization interface for ontology alignments. (8) SONG, the Search Ontology Generator presented by Uciteli et al., is based on a revised version of the Search Ontology (SO2). SONG is a tool for generating complex search queries from Excel templates, currently applied in post-market surveillance of medical devices. (9) Barton et al. discuss the utilisation of temporalised medical databases, in particular, their structuring, in the light of an analysis on the basis of referent tracking. (10) The integration of two major Argentinian databases, namely the National System of Biological Data (SNDB) and the Ocean Biogeographic Information System (OBIS), is targeted by Zarate et al. in an ontology-based manner.

The remaining two works relate to natural language processing, where (11) Schulz et al. report on experimental findings regarding the ambiguity of terms in SNOMED-CT, while (12) Kasáč et al. sketch the ontological foundations of their development of an annotation schema for mentions of drugs in clinical narratives, currently focusing on discharge letters.

This overall set of contributions in combination with the Joint Ontology Workshops (JOWO) keynotes and supporting program has led to a prosperous and inspiring workshop event in 2017, which was the eighth in a series of workshops that started in 2009 under the title *Ontologies in Biomedicine and Life Sciences* (OBML)[13]. Since then a work group named OBML[14] has been established in the context of the Special Interest Group *Informatics and Life Sciences*[15], which is itself a shared, interdisciplinary group associated with the *German Informatics Society* (GI)[16] and the *German Association for Medical Informatics, Biometry*

[13]See https://wiki.imise.uni-leipzig.de/Gruppen/OBML/Workshops/
[14]See https://wiki.imise.uni-leipzig.de/Gruppen/OBML/
[15]See http://fb-ilw.gi.de/
[16]See https://gi.de/

and Epidemiology (GMDS)[17]. Moreover, since the third edition OBML/ODLS workshops have been acknowledged as Supported Events by the *International Association for Ontology and its Applications* (IAOA)[18].
The OBML group runs ODLS workshops annually in Central Europe, striving for international participation also beyond that region. Becoming a part of IAOA's Joint Ontology Workshops in 2017 has yielded a distinguished ODLS edition and fruitful interactions with other communities, very well in line with the interdisciplinary spirit of ODLS.

SHAPES 4.0 – THE SHAPE OF THINGS

Shape, Form, and Structure are some of the most elusive notions and are pervasive in diverse disciplines from humanities (like literature studies, art history) to sciences (chemistry, biology, physics) and within these from the formal (mathematics, logic) to the empirical disciplines (engineering, cognitive science, architecture, environmental planning, design). Within domains such as computer science and artificial intelligence research, these notions are understood by mixing their common-sense meanings (e.g. to make sense of everyday perception and communication) and ad hoc technical specifications. Even in the different declinations of design the conception and sense of these notions change considerably. Several approaches have been proposed within the aforementioned disciplines to study the very notions of shape, form and structure from different viewpoints, yet a comprehensive treatment of these notions is lacking and no interdisciplinary perspective has emerged.
In these years, due to the popularity of the multi-agent approaches, the explosion of research and application in robotics, the cyber-physical and Internet of Things views, as well as social turns in geography and cultural heritage, there is a rising interest in interaction and its forms. The understanding of the term interaction is challenging due to the different types of entities it might involve and to the many contexts where it may occur. Conceived quantitatively or qualitatively, interaction can be located among agents and systems, among societies and cultures, among languages and stimuli, among views and interpretations. It puts an emphasis on such diverse aspects like emergence on the one hand and repetition on the other. Furthermore, it suggests a conception of form which is intrinsically dynamic, linked with temporality and, of course, action. This time-based notion of shape/form/structure demands not only an analysis of spatial configurations, but of spatio-temporal occurrences. As interactions of colours make clear (e.g. see the studies of Josef Albers), these occurrences may not always be literal sequences, they can happen simultaneously, but there must be time and space for something to take place. From here, we can start asking: Which shapes do patterns of interaction have? Are patterns themselves static or dynamic? What does that mean? Are these meta-level shapes easier to formulate or formalise? Which patterns of (social) interaction are desirable? How to use them for play, planning, storytelling, collaboration and other creative purposes?

[17] See https://gmds.de/index.php?id=228
[18] See http://iaoa.org/

This edition of Shapes 4.0 covers several topics. The paper "The Interplay between Shape and Feature Representation" by Sanfilippo et al. discusses modelling constructs for shape representation, from low-level geometric elements to general entities like protrusions and holes. The paper considers different modelling options from both the ontological and practical perspectives and provides some representation patterns. The paper by Cantale et al. "The Shape of a Benedictine Monastery: The SaintGall Ontology" presents an OWL 2 theory that formalises the layout of the Saint Gall monastery plan. With this work, the authors give the possibility to compare this ideal Benedictine monastery with its different realisation and reinterpretations around Europe across the centuries. The paper "Show, Don't Tell: Retrieving Cultural Assets Via Gestures" by Helmer et al. faces the limitations of textual representation in the case of intangible assets. They focus on the domain of (hand-held) tools aiming to record the gestures and a richer context than what is available in today's standard approaches. Maria M. Hedblom with the paper "Beneath the Paint: A Visual Journey through Conceptual Metaphor Violation" introduces us to the use of metaphors in artworks and on how these drive the interaction between an art piece and the observer. The discussion moves around a concrete painting from the author that is conceptualised via two metaphoric structures: 'UP is GOOD' and 'DARK is BAD'. The paper "Towards an Understanding of Place Forms through the Lens of Social Practice Theories" by A. Calafiore and G. Boella focuses on the meaning and role of patterns in the urban environment discussing the identification of place forms as the result of an interaction between the spatial and the social systems. S. Fiorini and M. Abel, with their contribution "Quality Patterns and Conceptual Spaces", discuss the understanding of qualities in ontological terms by linking Guarino's notion of quality fields/patterns and a special approach, called Holistic-Structure Spaces, within the Conceptual Spaces general framework. "The Shape of the Other", by Rafael Peñaloza, is a poem on shapes, people and their being 'others'. Klaus Gasteier, with his paper "Shaping a Structural and Visual Representation of Strategic Interaction", takes us into the notion of strategic interaction as the relation between concealed and exposed actions. This work sheds some light on the understanding and representation of conflict situations, including risks and potentials, via a new logographic sign language.

Workshop on Interaction-Based Knowledge Sharing (WINKS)

Sharing knowledge becomes increasingly important in the age of information and a growing number of gradually expanding, distributed systems heighten the need for a dynamic interactive sharing process. Interaction is understood here as any kind of communication between human and/or artificial agents. Knowledge can be learned, extracted, produced or elicited by a wide range of automated systems. These systems span across various disciplines and application scenarios ranging from Big Data to the Internet of Things. The increasing number and heterogeneity of knowledge sources has rendered knowledge sharing proportionally more complex. With new technologies, new knowledge sources keep on appearing and a centralised sharing process becomes more and more unrealistic.

Interaction-based knowledge sharing requires particular attention, both for its ambitious scope and for the fundamental issues that it raises. Indeed, the interactive property grants this type of knowledge sharing the same advantages as other dynamic systems. First, distributed sources can bring together their knowledge without giving precedence to one source. Second, it allows for integration from which new knowledge can emerge. Finally, interaction permits feedback during the sharing process, helping systems to control both the process and the success of the integration. However, the approach also shares the challenges of other dynamic systems: heterogeneity in vocabularies and methodologies between sources requires adaptability. Furthermore, new emergent knowledge necessitates the handling of novelty and unpredictable results. Finally, humans are a source of knowledge that artificial agents still have difficulties to decipher, especially when they are using natural language.

In this first edition the topics covered in the workshop addressed several of the above challenges. The paper "Vocabulary Alignment for Agents with Flexible Protocols" by Paula Chocrón and Marco Schorlemmer proposes a task-based approach to overcoming vocabulary heterogeneity by enabling agents to learn alignments based on shared procedural knowledge. The used protocols are flexible in the sense that they allow to consider differences in the specifications of agents by assigning weights and penalties. The work of Kemo Adrian and Enric Plaza offers "An Approach to Interaction-Based Concept Convergence in Multi-Agent Systems" which addresses vocabulary heterogeneity from an argumentation-based perspective. The paper proposes a new formalism to allow agents to argue the meaning of their concepts with the objective to reach an agreement by means of concept convergence. Lucía Gómez Álvarez, Brandon Bennett and Adam Richard-Bollans address the issue of ambiguity from the perspective of conceptual vagueness in their work entitled "Talking about Forests: An Example of Sharing Information Expressed with Vague Terms". The paper presents a framework for the representation of semantic variability as all admissible precise interpretations of a vague concept, which is illustrated with the example of 'forest'. Finally, Jamie C. Macbeth presented "Conceptual Primitive Decomposition for Knowledge Sharing via Natural Language", an approach that focuses on the grounding of linguistic expressions in primitive decomposition methods building on embodied human cognition. This representation system allows for an effective knowledge-sharing between ambiguous natural language expressions and more rigorous knowledge structures.

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