



D5.3

Second report on dissemination & upscaling support activities

Grant Agreement n°:	690974
Project Acronym:	MIREL
Project Title:	MIning and REasoning with Legal texts
Website:	http://www.mirelproject.eu/
Contractual delivery date:	31/12/2017
Actual delivery date:	30/12/2017
Contributing WP	All work packages
Dissemination level:	Public
Deliverable leader:	UNS
Contributors:	UNS



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 690974



Document History

Version	Date	Author	Partner	Description
0.1	28/12/2016	Guillermo Simari	UNS	Initial draft
1.0	19/1/2017	Guillermo Simari	UNS	Final Version

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Executive Summary

This document contains a report that covers progress in dissemination activities performed by the members of the project over the first year. Several publications in journals and conferences were published; these documents are listed and commented in the first subsection. In addition, as it is described below in detail, two workshops were organized, and a tutorial and a course were given.

1 Dissemination activities

This section presents all publications that have been produced in the context of MIREL. Links with respects to the other work packages are highlighted.

1.1 Publications

Publications have been grouped with respect to the work package they concern. Links with respect to the other work packages are highlighted.

1.1.1 WP1: Conceptual and formal frameworks for mining and reasoning on legal texts

- Matías Menni. The construction of π_0 in Axiomatic Cohesion, *Tbilisi Mathematical Journal* 10(3) (2017), pp. 183–207, 2017.

Abstract: This paper presents a construction suggested by Lawvere to rationalize, within a generalization of Axiomatic Cohesion, the classical construction of π_0 as the image of a natural map to a product of discrete spaces. A particular case of this construction produces, out of a local and hyperconnected geometric morphism $p : \mathcal{E} \rightarrow \mathcal{S}$, an idempotent monad $\pi_0 : \mathcal{E} \rightarrow \mathcal{E}$ such that, for every X in \mathcal{E} , $\pi_0 X = 1$ if and only if $(p^* \Omega)! : (p^* \Omega)1 \rightarrow (p^* \Omega)X$ is an isomorphism. For instance, if \mathcal{E} is the topological topos (over $\mathcal{S} = \text{Set}$), the π_0 -algebras coincide with the totally separated (sequential) spaces. To illustrate the connection with classical topology it is shown that the π_0 -algebras in the category of compactly generated Hausdorff spaces are exactly the totally separated ones. Also, in to relate the construction above with the axioms for Cohesion it is proven that, for a local and hyperconnected $p : \mathcal{E} \rightarrow \mathcal{S}$, p is pre-cohesive if and only if $p^* : \mathcal{S} \rightarrow \mathcal{E}$ is cartesian closed. In this case, $p! = p^* \pi_0 : \mathcal{E} \rightarrow \mathcal{S}$ and the category of π_0 -algebras coincides with the subcategory $p^* : \mathcal{S} \rightarrow \mathcal{E}$.

- X. Parent, L. van der Torre. The pragmatic oddity in a norm-based semantics. In *Proc. of the 16th International Conference on Artificial Intelligence and Law (ICAIL-2017)*, 2017.

Abstract: The ideal worlds of a possible worlds semantics may satisfy both a primary obligation and an associated secondary obligation, for example the obligation to keep a promise and the obligation to apologise for not keeping it. This is known as the pragmatic oddity introduced by Prakken and Sergot. It is argued that an adequate treatment of the pragmatic oddity within a norm-based semantics can be obtained, by not allowing primary and secondary obligations to aggregate, because they are obligations of a different kind. On the basis of this conceptual analysis, two logics



are introduced, depending on the stance taken on the representation of normative conflicts, presenting sound and complete proof systems for these logics. Then, a formal analysis is given, extensions are discussed, and various topics for further research are highlighted.

- Herzig, Y. Li, Y. Wang, R. Fervari. Strategically Knowing How. In The 26th International Joint Conference on Artificial Intelligence (IJCAI2017), 2017.

Abstract: This paper introduces a single-agent logic of goal-directed knowing how extending the standard epistemic logic of knowing that with a new knowing how operator. The semantics of the new operator is based on the idea that knowing how to achieve φ means that there exists a (uniform) strategy such that the agent knows that it can make sure φ . An intuitive axiomatization of our logic and prove the soundness, completeness and decidability of the logic are given. The crucial axioms relating knowing that and knowing how illustrate an understanding of knowing how in this setting. This logic can be used in representing and reasoning about both knowledge-that and knowledge-how.

- Xavier Parent, Leon van der Torre. Detachment in Normative Systems: Examples, Inference Patterns, Properties. *IfCoLog Journal of Logics and their Applications*, Volume 4 (9)

Abstract. There is a variety of ways to reason with normative systems. This partly reflects a variety of semantics developed for deontic logic, such as traditional semantics based on possible worlds, or alternative semantics based on algebraic methods, explicit norms or techniques from non-monotonic logic. This diversity raises the question how these reasoning methods are related, and which reasoning method should be chosen for a particular application. In this paper we discuss the use of examples, inference patterns, and more abstract properties. First, benchmark examples can be used to compare ways to reason with normative systems. We give an overview of several benchmark examples of normative reasoning and deontic logic: van Fraassen's paradox, Forrester's paradox, Prakken and Sergot's cottage regulations, Jeffrey's disarmament example, Chisholm's paradox, Makinson's Möbius strip, and Horty's priority examples. Moreover, we distinguish various interpretations that can be given to these benchmark examples, such as consistent interpretations, dilemma interpretations, and violability interpretations. Second, inference patterns can be used to compare different ways to reason with normative systems. Instead of analysing the benchmark examples semantically, as it is usually done, in this paper we use inference patterns to analyse them at a higher level of abstraction. We discuss inference patterns reflecting typical logical properties such as strengthening of the antecedent or weakening of the consequent. Third, more abstract properties can be defined to compare different ways to reason with normative systems. To define these more abstract properties, we first present a formal framework around the notion of detachment. Some of the ten properties we introduce are derived from the inference patterns, but others are more abstract: factual detachment, violation detection, substitution, replacements of equivalent, implication, para-consistency, conjunction, factual monotony, norm monotony, and norm induction. We consider these ten properties as desirable for a reasoning method for normative systems.



- Célia da Costa Pereira, Beishui Liao, Alessandra Malerba, Antonino Rotolo, Andrea G. B. Tettamanzi, Leon van der Torre and Serena Villata. Handling Norms in Multi-agent Systems by Means of Formal Argumentation. *IfCoLog Journal of Logics and their Applications*, Volume 4 (9).

Abstract. Formal argumentation is used to enrich and analyse normative multi-agent systems in various ways. In this chapter, we discuss three examples from the literature of handling norms by means of formal argumentation. First, we discuss how existing ways to resolve conflicts among norms using priorities can be represented in formal argumentation, by showing that the so-called Greedy and Reduction approaches can be represented using the weakest and the last link principles respectively. Based on such representation results, formal argumentation can be used to explain the detachment of obligations and permissions from hierarchical normative systems in a new way. Second, we discuss how formal argumentation can be used as a general theory for developing new approaches for normative reasoning, using a dynamic ASPIC-based legal argumentation theory. We show how existing logics of normative systems can be used to analyse such new argumentation systems. Third, we show how argumentation can be used to reason about other challenges in the area of normative multiagent systems as well, by discussing a model for arguing about legal interpretation. In particular, we show how fuzzy logic combined with formal argumentation can be used to reason about the adoption of graded categories and thus address the problem of open texture in normative interpretation. Our aim to discuss these three examples is to inspire new applications of formal argumentation to the challenges of normative reasoning in multi-agent systems.

- Antonino Rotolo, Celia Da Costa Pereira, Beishui Liao, Alessandra Malerba, Andrea Tettamanzi, Leendert van der Torre. Combining Fuzzy Logic and Formal Argumentation for Legal Interpretation, *ICAIL 2017*.

Abstract. The interpretation of a norm is often uncertain and conflicting. In this paper we propose a model for arguing about legal interpretation, which considers the problems of vagueness. After motivating our adoption of graded categories as a tool to tackle the problem of open texture in legal interpretation, we introduce a model based on fuzzy logic and argumentation. Then, we conduct a case study by using an example from medically assisted reproduction.

- Matteo Cristani, Francesco Olivieri, Antonino Rotolo. Changes to temporary norms. *ICAIL 2017*

Abstract. Normative systems accommodate temporary norms of several types, which can also be modified in different, and codified ways. In this paper we address the problem of modifying temporary norms that are represented by means of the combination of two known formalisms in the current literature. The framework evolves from a known one, which provides a system of norms at two distinct layers, and represents changes at the two layers as means to provide room for the codified change types. This results in four novel operators that *anticipate* and *extend* norms in two different combined ways, by preserving or not the effects of the norms in the period of time generated by the temporal modifications. We study these new operators and show how they relate to the operators of annulment and abrogation analysed elsewhere.



1.1.2 WP2: Norm mining

- M. Teruel, L. Alonso Alemany, C. Cardellino, S. Villata. A Low-cost, High-coverage Legal Named Entity Recognizer, Classifier and Linker. In Proc. of the 16th International Conference on Artificial Intelligence and Law (ICAIL-2017), 2017.

Abstract: In this paper, a method for improving Information Extraction in legal texts by creating a legal Named Entity Recognizer, Classifier and Linker is described. With this tool, it is possible to identify relevant parts of texts and connect them to a structured knowledge representation, the LKIF ontology. More interestingly, this tool has been developed with relatively little effort, by mapping the LKIF ontology to the YAGO ontology and through it, taking advantage of the mentions of entities in the Wikipedia. These mentions are used as manually annotated examples to train the Named Entity Recognizer, Classifier and Linker. The approach has been evaluated on holdout texts from the Wikipedia and also on a small sample of judgments of the European Court of Human Rights, resulting in a very good performance, i.e., around 80 per cent F-measure for different levels of granularity. An extensive error analysis to direct further developments is introduced, and it is expected that this approach can be successfully ported to other legal subdomains, represented by different ontologies.

- L. Di Caro, L. Robaldo, G. Boella, K. Adebayo. Legalbot: a Deep Learning-Based Conversational Agent in the Legal Domain. In Proc. of the 22nd International Conference on Natural Language & Information Systems (NLDB 2017), 2017.

Abstract: This paper presents a deep learning based dialogue system which has been trained to answer user queries posed as questions during a conversation. The proposed system, though generative, takes advantage of domain specific knowledge for generating valid answers. The evaluation analysis shows that the proposed system obtained a promising result.

- L. Robaldo, X. Sun. Reified Input/Output logic: Combining Input/Output logic and Reification to represent norms coming from existing legislation. In The Journal of Logic and Computation, 2017.

Abstract: In this article, a proposal to combine Input/Output logic, a well-known formalism for normative reasoning, with the reification-based approach of Jerry R. Hobbs is presented. The latter is a wide-coverage logic for Natural Language Semantics (NLS) able to handle a fairly large set of linguistic phenomena into a simple logical formalism. The result is a new framework that we will call 'reified Input/Output logic'. This article represents the first step of a long-term research aiming at filling the gap between Input/Output logic and the richness of NLS. Future work includes using reified Input/Output logic as the underlying formalism for applications in legal informatics to process and reason on existing legal texts, which are available in natural language only.



- M. Teruel, L. Alonso Alemany, C. Cardellino, S. Villata. Learning Slowly To Learn Better: Curriculum Learning for Legal Ontology Population. In Proc. of the 30th Florida Artificial Intelligence Research Society (FLAIRS), 2017.

Abstract: In this paper, an ontology population approach for legal ontologies is presented, exploiting Wikipedia as a source of manually annotated examples of legal entities. YAGO, a Wikipedia-based ontology, and LKIF, an ontology specifically designed for the legal domain are aligned and through this alignment, it is possible to effectively populate the LKIF ontology, with the aim to obtain examples to train a Named Entity Recognizer and Classifier to be used for finding and classifying entities in legal texts. Since examples of annotated data in the legal domain are very few, a machine learning strategy called curriculum learning is applied with the aim of overcoming problems of overfitting by learning increasingly more complex concepts. A comparison of the performance of this method to identify Named Entities with respect to batch learning as well as two other baselines is presented. Results are satisfying and foster further research in this direction.

- M. Teruel, L. Alonso Alemany, C. Cardellino, S. Villata. Legal NERC with ontologies, Wikipedia and curriculum learning. In Proc. of European Chapter of the Association for Computational Linguistics (EACL), 2017.

Abstract: This paper introduces a Wikipedia-based approach to develop resources for the legal domain. A mapping between a legal domain ontology, LKIF (Hoekstra et al., 2007), and a Wikipedia-based ontology, YAGO (Suchanek et al., 2007), is established and through that we populate LKIF. Moreover, the mentions of those entities in Wikipedia text are used to train a specific Named Entity Recognizer and Classifier. This classifier works well in the Wikipedia, but, as could be expected, performance decreases in a corpus of judgments of the European Court of Human Rights. However, this tool will be used as a preprocess for human annotation. A technique called curriculum learning aimed is used to overcome problems of overfitting by learning increasingly more complex concepts. However, in this particular setting, the method works best by learning from most specific to most general concepts, not the other way around.

- L. Robaldo, X. Sun. Reified Input/Output logic - a position paper. In Proceedings of Workshop on Artificial Intelligence for Justice (AI4J), collocated at the 22nd European Conference on Artificial Intelligence (ECAI 2016), The Hague, The Netherlands., 2016.

Abstract: This paper introduces a new approach to formalize obligations and permissions from existing legislation. Specifically, the proposal is to combine two frameworks: Input/Output logic and the logic of prof. J.R. Hobbs. The former is a well-known framework in normative reasoning. The latter is a neo-Davidsonian wide-coverage first order logic for Natural Language Semantics. The general idea is to wrap Input/Output logic around Hobbs's logic, in order to fill the gap between current logical formalizations of legal text, mostly propositional, and the richness of Natural Language Semantics.



- K. J. Adebayo, L. Di Caro, G. Boella. Text Segmentation With Topic Modeling And Entity Coherence. In Proceedings of the 16th International Conference on Hybrid Intelligent Systems (HIS2016), 2016.

Abstract: This paper describes a system that uses entity and topic coherence for improved Text Segmentation (TS) accuracy. First, Linear Dirichlet Allocation (LDA) algorithm was used to obtain topics for sentences in the document. Then entity mapping across a window in order to discover the transition of entities within sentences is performed. The information obtained is used to support our LDA-based boundary detection for proper boundary adjustment. The significance of the entity coherence approach as well as the superiority of our algorithm over existing works is reported.

- Rohan Nanda, Giovanni Siragusa, Luigi Di Caro, Martin Theobald, Guido Boella, Livio Robaldo, Francesco Costamagna, Concept Recognition in European and National Law, Proceedings of JURIX 2017, pp. 193 – 198.

Abstract: This paper presents a concept recognition system for European and national legislation. Current named entity recognition (NER) systems do not focus on identifying concepts which are essential for interpretation and harmonization of European and national law. We utilized the IATE (Inter-Active Terminology for Europe) vocabulary, a state-of-the-art named entity recognition system and Wikipedia to generate an annotated corpus for concept recognition. We applied conditional random fields (CRF) to identify concepts on a corpus of European directives and Statutory Instruments (SIs) of the United Kingdom. The CRF-based concept recognition system achieved an F1 score of 0.71 over the combined corpus of directives and SIs. Our results indicate the usability of a CRF-based learning system over dictionary tagging and state-of-the-art methods.

1.1.3 WP3: Reasoning on norms

- Katie Atkinson, Pietro Baroni, Massimiliano Giacomin, Anthony Hunter, Henry Prakken, Chris Reed, Guillermo R. Simari, Matthias Thimm, and Serena Villata. Towards Artificial Argumentation. *AI Magazine* 38, 3 (2017), 25–36. 2017.

Abstract: Humans argue. This distinctive feature is at the same time an important cognitive capacity and a powerful social phenomenon. It has attracted attention and careful analysis since the dawn of civilization, being intimately related to the origin of any form of social organization, from political debates to law, and of structured thinking, from philosophy to science and arts. As a cognitive capacity, argumentation is important for handling conflicting beliefs, assumptions, viewpoints, opinions, goals, and many other kinds of mental attitudes. When we are faced with a situation where we find that our information is incomplete or inconsistent, we often resort to the use of arguments in favor and against a given position in order to make sense of the situation. When we interact with other people we often exchange arguments in a cooperative or competitive fashion to reach a final agreement or to defend and promote an individual position.



- J. Dauphin, M. Cramer. Theory and Applications of Formal Argumentation. In Proc. of the 2017 International Workshop on Theory and Applications of Formal Argument, 2017.

Abstract: Multiple extensions of Dung's argumentation frameworks (AFs) have been proposed to model features of argumentation that cannot be directly modeled in AFs. One technique that previously has proven useful to study and combine such extensions is the meta-argumentation methodology involving the notion of a flattening. To faithfully model the interaction between explanation argumentation in scientific debates, Šešelja and Straßer have introduced Explanatory Argumentation Frameworks (EAFs). In this paper, first it is proven that the flattening technique works as expected for recursive (higher-order) attacks. Then, this technique is applied to combine EAFs with multiple other extensions that have been proposed to AFs, namely with recursive attacks, joint attacks and a support relation between arguments. This gives rise to Extended Explanatory Argumentation Frameworks (EEAFs). The applicability of EEAFs is illustrated by using them to model a piece of argumentation from a research-level philosophy book.

- J. Dauphin, M. Cramer. ASPIC-END: Structured Argumentation with Explanations and Natural Deduction. In Proc. of the 2017 International Workshop on Theory and Applications of Formal Argument., 2017.

Abstract: This work presents ASPIC-END, an adaptation of the structured argumentation framework ASPIC+ that can incorporate explanations and natural deduction style arguments. An instantiation of ASPIC-END is discussed that models argumentation about explanations of semantic paradoxes (e.g. the Liar paradox), and it is shown that ASPIC-END satisfies rationality postulates akin to those satisfied by ASPIC+.

- G. Casini, T. Meyer. Belief Change in a Preferential Non-Monotonic Framework. In Proc. of the 26th International Joint Conference on Artificial Intelligence (IJCAI2017), 2017.

Abstract: Belief change and non-monotonic reasoning are usually viewed as two sides of the same coin, with results showing that one can formally be defined in terms of the other. In this paper it is shown that also it is possible to integrate the two formalisms by studying belief change within a (preferential) non-monotonic framework. This integration relies heavily on the identification of the monotonic core of a non-monotonic framework. Belief change operators in a non-monotonic propositional setting with a view towards preserving consistency are considered. These results can also be applied to the preservation of coherence—an important notion within the field of logic-based ontologies. It is shown that the standard AGM approach to belief change can be adapted to a preferential non-monotonic framework, with the definition of expansion, contraction, and revision operators, and corresponding representation results. Surprisingly, preferential AGM belief change, as defined here, can be obtained in terms of classical AGM belief change.

- B. Liao, L. van der Torre. Defense semantics of argumentation: encoding reasons for accepting arguments. In The paper has been presented on MIREL workshop at ICAIL. It will be resubmitted to AICOL series, 2017.

Abstract: In this paper, how the defense relation among abstract arguments can be used to encode the reasons for accepting arguments it is shown. After introducing a novel notion of defenses and



defense graphs, a defense semantics together with a new notion of defense equivalence of argument graphs is proposed, and defense equivalence with standard equivalence and strong equivalence is compared, respectively. Then, based on defense semantics, two kinds of reasons for accepting arguments are defined, i.e., direct reasons and root reasons, and a notion of root equivalence of argument graphs is introduced. Finally, how the notion of root equivalence can be used in argumentation summarization is demonstrated.

- K. Satoh R. Arisaka, L. van der Torre. Abstract Agent Argumentation (Triple-A). In The paper has been presented on MIREL workshop at ICAIL. It will be resubmitted to AICOL series., 2017.

Abstract: A Dung style theory of abstract argumentation called triple-A is introduced here, in which each agent decides autonomously whether to accept or reject his own arguments. The agents may take some of the arguments of other agents into account, which we call their trusted arguments. An agent is called selfish if he ignores all arguments of other agents, and he is called social if he treats all arguments of other agents like his own. The extensions of globally accepted arguments are defined using a game theoretic equilibrium definition.

- C. Deagustini, S. Dalibon, S. Gottifredi, M. Falappa, C. Chesnevar, G.R. Simari. Defeasible argumentation over relational databases In *Argument and Computation*, Vol. 8, 2017.

Abstract: Defeasible argumentation has been applied successfully in several real-world domains where it is necessary to handle incomplete and contradictory information. In recent years, there have been interesting attempts to carry out argumentation processes supported by massive repositories developing argumentative reasoning applications. One of such efforts builds arguments by retrieving information from relational databases using the DBI-DeLP framework; this article presents eDBI-DeLP, which extends the original DBI-DeLP framework by providing two novel aspects that refine the interaction between DeLP programs and relational databases. First, the expressiveness of dbi-delp programs is expanded by providing ways of controlling how the information in databases is recovered; this is done by introducing filters that enable an improved fine-grained control on the argumentation processes that become useful in applications, providing the semantics and the implementation of such filters. Second, an argument comparison criterion is presented that can be adjusted at the level of literals to model particular features such as credibility and topic expertise, among others. These new tools can be particularly useful in environments such as medical diagnosis expert systems, decision support systems, or recommender systems based on argumentation, where datasets are often provided in the form of relational databases.

- M. Budan, M. Cobo, D. Martinez, G.R. Simari. Bipolarity in temporal argumentation frameworks. In *International Journal of Approximate Reasoning*, Int. J. Approx. Reasoning 84: 1-22 (2017).

Abstract: A Timed Argumentation Framework (TAF) is a formalism where arguments are only valid for consideration during specific intervals of time, called availability intervals, which are defined for every individual argument. The original proposal is based on a single abstract notion of attack between arguments that remains static and permanent in time. Thus, in general, when identifying the set of acceptable arguments, the outcome associated with a TAF will vary over time. Here, an extension of TAF is presented adding the capability of modeling a support relation between



arguments. In this sense, the resulting framework provides a suitable model for different time-dependent issues; thus, the main contribution of this work is to provide an enhanced framework for modeling a positive (support) and negative (attack) interaction which varies over time, features that are highly relevant in many real-world situations. This addition leads to a Timed Bipolar Argumentation Framework (T-BAF), where classical argument extensions can be defined, aiming at advancing in the integration of temporal argumentation in different application domains.

- Gabriella Pigozzi, Leendert van der Torre. Multiagent Deontic Logic and its Perspectives and its Challenges from a Normative Systems Perspective. *IFCoLog Journal of Logic and its Applications*, Vol. 84, 2017, pp 2929-2994.

This article gives an overview of several challenges studied in deontic logic, with an emphasis on challenges involving agents. The work starts with traditional modal deontic logic using preferences to address the challenge of contrary-to-duty reasoning, and STIT theory addressing the challenges of non-deterministic actions, moral luck and procrastination. Then, the presentation turns to alternative norm-based deontic logics detaching obligations from norms to address the challenge of Jørgensen's dilemma, including the question how to derive obligations from a normative system when agents cannot assume that other agents comply with their norms. It discusses also some traditional challenges from the viewpoint of normative systems: when a set of norms may be termed 'coherent', how to deal with normative conflicts, how to combine normative systems and traditional deontic logic, how various kinds of permission can be accommodated, how meaning postulates and counts-as conditionals can be taken into account,

- M. Budan, G.I. Simari, I. Viglizzo, G.R. Simari. An approach to characterize graded entailment of arguments through a label-based framework. In *International Journal of Approximate Reasoning*, Vol. 82, 1-22, 2017.

Abstract: Argumentation theory is a powerful paradigm that formalizes a type of commonsense reasoning that aims to simulate the human ability to resolve a specific problem in an intelligent manner. A classical argumentation process takes into account only the properties related to the intrinsic logical soundness of an argument in order to determine its acceptability status. However, these properties are not always the only ones that matter to establish the argument's acceptability—there exist other qualities, such as strength, weight, social votes, trust degree, relevance level, and certainty degree, among others. In this work, the argumentative process is refined to improve the analysis of arguments by considering their special features in order to obtain results that are more refined. Towards this end, a proposal is introduced to add meta-level information to the arguments in the form of labels representing quantifiable data ranking over a range of fuzzy valuations. These labels are propagated through an argumentative graph according to the relations of support, conflict, and aggregation between arguments. Through this process the final labels that are useful in determining argument acceptability are obtained.



- C. Dodaro, W. Faber, N. Leone, G. Amendola, F. Ricca. On the Computation of Paracoherent Answer Sets. In Proc. of the 31st AAAI Conference on Artificial Intelligence (AAAI-17), 2017.

Abstract: Answer Set Programming (ASP) is a well-established formalism for nonmonotonic reasoning. An ASP program can have no answer set due to cyclic default negation. In this case, it is not possible to draw any conclusion, even if this is not intended. Recently, several paracoherent semantics have been proposed that address this issue, and several potential applications for these semantics have been identified. However, paracoherent semantics have essentially been inapplicable in practice, due to the lack of efficient algorithms and implementations. In this paper, this lack is addressed, and several different algorithms to compute semi-stable and semi-equilibrium models are proposed and implemented into an answer set solving framework. An empirical performance comparison among the new algorithms on benchmarks from ASP competitions is given as well.

- Luciano H. Tamargo, Diego C. Martinez, Antonino Rotolo, Guido Governatori, Temporalised Belief Revision in the Law, Proceedings of JURIX 2017, pp. 49-58.

Abstract: This paper presents a belief revision operator for legal systems that considers time intervals. This model relates techniques about belief revision formalisms and time intervals with temporalised rules for legal systems. The goal is to formalise a temporalised belief base and corresponding timed derivation, together with a proper revision operator. This operator may remove rules when needed or adapt intervals of time when contradictory norms are added in the system.

- Aldo Marzullo, Claudio Stamile, Giorgio Terracina, Francesco Calimeri, Sabine Van Huffel: A tensor-based mutation operator for Neuroevolution of Augmenting Topologies (NEAT).CEC 2017: 681-687

Abstract: In Genetic Algorithms, the mutation operator is used to maintain genetic diversity in the population throughout the evolutionary process. Various kinds of mutation may occur over time, typically depending on a fixed probability value called mutation rate. In this work we make use of a novel data-science approach in order to adaptively generate mutation rates for each locus to the Neuroevolution of Augmenting Topologies (NEAT) algorithm. The trail of high quality candidate solutions obtained during the search process is represented as a third-order tensor; factorization of such a tensor reveals the latent relationship between solutions, determining the mutation probability which is likely to yield improvement at each locus. The single pole balancing problem is used as case study to analyze the effectiveness of the proposed approach. Results show that the tensor approach improves the performance of the standard NEAT algorithm for the case study.

- Francesco Calimeri, Claudio Stamile, Luca Surace: S-Rep Model for Fundus Image Analysis, ISSPIT-2017, to appear

Abstract: It is already known that some features of fundus images are significantly altered in subjects suffering from certain pathologies; indeed, by proper observing the alterations it is possible to obtain important biomarkers that help the diagnosis of those pathologies. To this aim, we introduce a new specific tool for detecting and monitoring vessels alterations in fundus images over



time. In this work, we show how to extend an existing protocol for fundus image analysis by introducing a skeletal representations (S-Rep) model that represents the blood vessel to analyze. Furthermore, we describe how to perform statistical analysis on those model using the composite principal nested spheres (CPNS) framework. SRep formally describes quasi-Tube geometry objects, which are suitable to represent blood vessels structures in fundus images; CPNS allows to statistically discover the presence of longitudinal changes in these structures by analyzing the principal modes. Thanks to these formalisms it is possible to detect specific regions featuring significant longitudinal variations. Our method is experimentally validated over simulated data generated over real images, and results prove the viability of the proposed method.

- Calimeri F, Caracciolo M, Marzullo A, Stamile C: BioHIPI: Biomedical Hadoop Image Processing Interface, Proceedings of the Third International Conference on Machine Learning, Optimization, and Big Data - MOD 2017, Volterra, Italy, September 14–17, 2017

Abstract: Nowadays, the importance of collecting large amounts of data is becoming increasingly crucial, along with the application of efficient and effective analysis techniques, in many areas. One of the most important field in which Big Data is becoming of fundamental importance is the biomedical domain, also due to the decreasing cost of acquiring and analyzing biomedical data. Furthermore, the emergence of more accessible technologies and the increasing speed-up of algorithms, also thanks to parallelization techniques, is helping at making the application of Big Data in healthcare a fast-growing field. This paper presents a novel framework, Biomedical Hadoop Image Processing Interface (BioHIPI), capable of storing biomedical image collections in a Distributed File System (DFS) for exploiting the parallel processing of Big Data on a cluster of machines. The work is based on the Apache Hadoop technology and makes use of the Hadoop Distributed File System (HDFS) for storing images, the MapReduce libraries for parallel programming for processing, and Yet Another Resource Negotiator (YARN) to run processes on the cluster.

- Francesco Calimeri, Aldo Marzullo, Claudio Stamile and Giorgio Terracina: Blood Vessel Segmentation using Hypercube NeuroEvolution of Augmenting Topologies (HyperNeat), WIRN 2017, 27th Italian Workshop on Neural Networks – June 14-16, Vietri sul Mare, Salerno, Italy

Abstract: Image recognition has been capturing interest of researchers for many years, mainly because it finds countless real-life applications. Recently, deep-learning based approaches greatly improved performance of state-of-the-art visual recognition systems; however, such systems have been primarily trained by means of supervised and unsupervised learning algorithms. Different approaches based on evolutionary algorithms are taking place, showing that evolution might have a significant role in the development of visual systems. Hypercube-based NeuroEvolution of Augmenting Topologies (HyperNEAT) is a neuroevolution method for evolving large-scale neural networks using the geometric regularities of the task domain. In this work, we investigate the effectiveness of Hyper-NEAT on a particular image processing task: the automatic segmentation of blood vessels in retinal fundus digital images. We tested the method over the DRIVE and STARE datasets, and the experimental analyses showed that HyperNeat can achieve high level of accuracy on the study case. The work does not primarily aim at improving the state of the art, but rather at investigating the use of the HyperNEAT in a particular image segmentation task; indeed, the



proposed approach consists of one of the first applications of HyperNEAT to image processing tasks to date, and, to the best of our knowledge, the first application of this evolutionary approach on a biomedical image processing task.

- Francesco Calimeri, Davide Fuscà, Stefano Germano, Simona Perri, Jessica Zangari: Boosting the Development of ASP-Based Applications in Mobile and General Scenarios. AI*IA 2016: 223-236

Abstract: Answer Set Programming (ASP) is a well-established declarative programming paradigm in close relationship with other formalisms such as Satisfiability Modulo Theories, Constraint Handling Rules, FO(.) (First-Order logic extensions), Planning Domain Definition Language and many others; it became widely used in AI and recognized as a powerful tool for knowledge representation and reasoning, especially for its high expressiveness and the ability to deal also with incomplete knowledge. In the latest years, the community produced significant theoretical results and a number of robust and efficient implementations; this has been moving the focus from a strict theoretical scope to more practical aspects, and ASP has been increasingly employed in a number of different domains and for the development of industrial-level and enterprise applications. Although different development tools have been released, there is still a lack of proper means for an effective, large-scale applicability of ASP, especially in the mobile setting. In this work we show a general framework for integrating ASP reasoners into external systems and its use for designing and implementing ASP-based applications to different extents. In particular, we illustrate the integration of the ASP system DLV on the Android platform, and a full-native ASP-based mobile app for helping players of a live game of checkers.

- Davide Fuscà, Stefano Germano, Jessica Zangari, Marco Anastasio, Francesco Calimeri, Simona Perri: A framework for easing the development of applications embedding answer set programming. PPDP 2016: 38-49

Abstract: Answer Set Programming (ASP) is a well-established declarative problem solving paradigm which became widely used in AI and recognized as a powerful tool for knowledge representation and reasoning (KRR), especially for its high expressiveness and the ability to deal also with incomplete knowledge. Recently, thanks to the availability of a number of robust and efficient implementations, ASP has been increasingly employed in a number of different domains, and used for the development of industrial-level and enterprise applications. This made clear the need for proper development tools and interoperability mechanisms for easing interaction and integration with external systems in the widest range of real-world scenarios, including mobile applications and educational contexts. In this work we present a framework for integrating the KRR capabilities of ASP into generic applications. We show the use of the framework by illustrating proper specializations for some relevant ASP systems over different platforms, including the mobile setting; furthermore, the potential of the framework for educational purposes is illustrated by means of the development of several ASP-based applications.

- Francesco Calimeri, Aldo Marzullo, Claudio Stamile, Giorgio Terracina: Optic Disc Detection Using Fine Tuned Convolutional Neural Networks. SITIS 2016: 69-75



Abstract: The detection of the Optic Disc (OD) is an significant step in retinal fundus images analysis, it allows to extract relevant information that proved to be useful for the prevention of several pathologies, such as glaucoma, hypertension, diabetes and other cardiovascular diseases, which manifest their effects in the retina. In this work we present a supervised method for automatically detecting the position of the Optic Disc in retinal fundus digital images, the goal has been achieved by means of a proper reuse of previous knowledge from a pre-trained Convolutional Neural Network (CNN), already able to detect faces in an image. Experimental analyses showed high level of accuracy in the detection of the optic disc on the DRIVE, STARE and DRIONS databases.

1.1.4 WP4: Case Studies and Evaluation

- M. Teruel, R. Gazzotti, L. Alonso Alemany, S. Villata, C. Cardellino, C. Faron-Zucker. Bottom-up enrichment of top-down ontologies through annotation. In The paper has been presented on MIREL workshop at ICAIL. It will be resubmitted to AICOL series, 2017.

Abstract: A methodology is presented with the aim of enhancing domain-specific ontologies by (i) addressing a manual annotation of texts with the concepts in the domain ontology, (ii) matching the annotated concepts with the closest YAGO-Wikipedia concept available, and (iii) using concepts from other ontologies that cover complementary domains. This method reduces the difficulty of aligning ontologies, because annotators are asked to associate two labels from different inventories to a concrete example, which requires a simple judgment. In a second phase, those correspondences are consolidated into a proper alignment. The resulting alignment is a partial connection between diverse ontologies, and also a strong connection to Linked Open Data. By aligning these ontologies, the ontological coverage for texts in that domain is increased. Moreover, by aligning domain ontologies to the Wikipedia (via YAGO), it is possible to obtain manually annotated examples for some of the concepts, effectively populating the ontology with examples. Two applications of this process in the legal domain are presented. First, sentences of the European Court of Human Rights with the LKIF ontology are annotated, at the same time matching them with the YAGO ontology. Second, a corpus of customer questions and answers from an insurance web page with the P&C ontology for the insurance domain are annotated, matching it with the YAGO ontology and complementing it with a financial ontology.

- Fabien Gandon, Guido Governatori, Serena Villata, Normative Requirements as Linked Data, Proceedings of JURIX 2017, pp. 1-10

Abstract: We propose a proof of concept for the ontological representation of normative requirements as Linked Data on the Web is introduced. Starting from the LegalRuleML ontology, an extension of this ontology to model normative requirements and rules is proposed. Furthermore, an operational formalization of the deontic reasoning over these concepts on top of the Semantic Web languages is defined.



- The European legal taxonomy syllabus: A multi-lingual, multi-level ontology framework to untangle the web of European legal terminology (G. Boella L. Di Caro L. Robaldo L. Humphreys S. Praduroux P. Rossi A. Violato G. Ajani), In Applied Ontology, volume 11, 2017.

Abstract: This paper describes a new concept of legal ontology together with an ontology development tool, called European Legal Taxonomy Syllabus (ELTS). The tool is used to model the legal terminology created by the Uniform Terminology project on EU consumer protection law as an ontology. ELTS is not a formal ontology in the standard sense, i.e., an axiomatic ontology formalized, for instance, in description logic. Rather, it is a lightweight ontology, i.e. a knowledge base storing low-level legal concepts, connected via low-level semantic relations, and related to linguistic patterns that denote legal concepts in several languages spoken in the European Union (EU). In other words, ELTS is a multi-lingual and multi-jurisdictional terminological vocabulary enriched with concepts denoted by vocabulary entries, with semantic relations between different concepts. The choice of such an architecture is based on past studies in comparative law and is motivated by the need to reveal the differences between national systems within the EU. Past literature in comparative law highlights that axiomatic ontologies freeze legal knowledge in an unreal steadiness, i.e., they render it disconnected from legal practice. Much more flexibility is needed to make the knowledge base acceptable to legal practitioners. ELTS was developed together with legal practitioners on the basis of the comparative view of European law. The ontology framework is designed to help professionals study the meaning of national and European legal terms and how they inter-relate in the transposition of European Directives into national laws. The structure and user interface of ELTS is suitable for building multi-lingual, multi-jurisdictional legal ontologies in a bottom-up and collaborative manner, starting from the description of legal terms by legal experts. It also takes into account the interpretation of norms, the dynamic character of norms and the contextual character of legal concepts in that they are linked to their legal sources (legislation, case law and doctrine).

- G. Lenzini, C. Bartolini, L. Robaldo. Towards legal compliance by correlating Standards and Laws with a semi-automated methodology. In Proceedings of the 28th Benelux conference on Artificial Intelligence, 2016.

Abstract: Since generally legal regulations do not provide clear parameters to determine when their requirements are met, achieving legal compliance is not trivial. The adoption of standards could help create an argument of compliance in favour of the implementing party, provided there is a clear correspondence between the provisions of a specific standard and the regulation's requirements. However, identifying such correspondences is a complex process which is complicated further by the fact that the established correlations may be overridden in time e.g., because newer court decisions change the interpretation of certain legal provisions. To help solve these problems, a framework is introduced that supports legal experts in recognizing correlations between provisions in a standard and requirements in a given law. The framework relies on state-of-the-art Natural Language Semantics techniques to process the linguistic terms of the two documents, and maintains a knowledge base of the logic representations of the terms, together with their defeasible correlations, both formal and substantive. An application of the framework is



shown by comparing a provision of the European General Data Protection Regulation with the ISO/IEC 27018:2014 standard.

1.2 Events

The following events have been organized in the context of MIREL.

1.2.1 International Workshop on Logic-Based Formalisms for Legal Reasoning

The workshop has been organized from the 18th to the 19th of May 2017 at the Department of Mathematics and Computer Science - University of Calabria - Rende, Italy. The organizers of the workshops were Nicola Leone (Univ. of Calabria), Francesco Calimeri (DLVSystem), Wolfgang Faber (Huddersfield University).

The aim of the LBFLR 2017 workshop is to bridge the gap between the community working on legal ontologies and legal reasoning and the community working on reasoning methods and formal logic, especially Answer Set Programming (ASP). The workshop will foster discussion on different approaches for working in the legal domain, about both (legal) knowledge representation and (legal) reasoning.

1.2.2 MIREL 2016 - Workshop on 'Mining and REasoning with Legal texts

The workshop has been organized the 16th of June 2017 in London. It was collocated at the 16th International Conference on Artificial Intelligence and Law (ICAIL 2017), which was in turn organized by Guido Governatori (Data61) and Clara Smith (UNLP). The organizers of the workshop were Livio Robaldo (UL), Serena Villata (INRIA), Grigoris Antoniou (HUD), and Luigi Di Caro (UNITO).

As in the previous editions, the workshop fostered scientific discussions aimed at considering relations between approaches based on language technologies applied to the legal domain (representing legal knowledge) and those based on legal reasoning (using the legal knowledge to build specialized services and applications).

The program of the workshop was the following:

Session 1 - Normative modeling (Chair: Guillaume Aucher)

9.15 - 10.05: Marcello Ceci. Legal Patterns for Different Constitutive Rules.

10.05 - 10.30: Giovanni Sileno, Alexander Boer, and Tom van Engers. A Petri net-based notation for normative modeling: evaluation on deontic paradoxes.

Session 2 - Argumentation and Decision Making (Chair: Giovanni Casini)



11:00 - 11:25: Guillaume Aucher, Annie Foret, Jean-Baptiste Lenhof, Francois Schwarzentruher. Principles for a judgement editor based on Multi-BDDs.

11:25 - 11:50: Ryuta Arisaka, Ken Satoh and Leon van der Torre. Abstract Agent Argumentation (Triple-A).

11:50 - 12:15: Beishui Liao and Leendert van der Torre. Defense semantics of argumentation: encoding reasons for accepting arguments.

12:15 - 12:40: Karl Branting, Alexander Yeh, Brandy Weiss, Elizabeth Merkhofer and Bradford Brown. Inducing Predictive Models for Decision Support in Administrative Adjudication.

14:00 - 15:00: Invited speaker -- Joris Hulstijn (Chair: Leon van der Torre)

Dialogues for Contract Monitoring: a new approach to data protection

Abstract. Current legal frameworks for data protection have a number of flaws. The notion of informed consent does not work in practice. Legislation only covers personal data, but it doesn't cover data about groups and it doesn't cover conditions on usage of data for certain purposes. Regulatory agencies have little capacity. End-users play no role in the supervision. On the other hand, we observe that many business models are based on personal data. Access to data should therefore be seen as a counteroffer in a contract. We need a different approach to data protection that addresses the needs of end-users. In this lecture, I will sketch a dialogue framework to facilitate contract negotiations and monitoring, in the application domain of data protection. The idea is to empower end-users to negotiate better terms and conditions in their contracts, monitor compliance, and challenge the data controller in case of breaches of contract. That means that in addition to the current legal framework for data protection, which is generally based on public law, we suggest to use private law as the legal framework of choice. In addition, we discuss a governance structure to enable effective enforcement. Based on this framework, we will propose a research agenda. We need linguistically motivated notions to characterise the problem, because essentially, it involves a problem of interpretation. How to account for differences in background during contract negotiations? What counts as evidence of a breach of contract? How can legal terms and conditions be explained to the general public? We also need formal reasoning techniques, to solve the deontic epistemic puzzles triggered by data protection. For instance, suppose I give permission that my data be used for purpose P (improve healthcare). The controller argues that P implies Q (sell medicine). Is the controller allowed to use my data for purpose Q?

Session 3 - Ontologies and Computational linguistics for the legal domain (Chair: TBA)

15:00 - 15:25: Cristian Cardellino, Milagro Teruel, Raphaël Gazzotti, Laura Alonso Alemany, Serena Villata and Catherine Faron-Zucker. Bottom-up enrichment of top-down ontologies through annotation.



16.00 - 16.25: Sean Goltz and Michael Mayo. Enhancing Regulatory Compliance by Using Artificial Intelligence Text Mining to Identify Penalty Clauses in Legislation.

16:25 - 16:50: Mirna El Ghosh and Habib Abdulrab. Application of Ontology Modularization for Building a Criminal Domain Ontology.

16:50 - 17:15: Chiseung Soh, Seungtak Lim, Kihyun Hong and Young-Yik Rhim. Ontology Modeling for Criminal Law.

1.2.3 COURSE: Foundations of argumentation for argument mining

This course was organized by Laura Alonso Alemany (Cordoba), Patrick Saint-Dizier (IRIT) within the 29th European Summer School in Logic, Language, and Information.

The course aimed at providing an introduction to the fundamental concepts in the area of argumentation mining. This is an area with strong background in linguistics and in artificial intelligence, with clearly applied goals. The course aimed to provide students with an insight of the phenomena that are found in argumentative texts and dialogues, their complexity and their characteristics. Then, it described different approaches to formalizing these phenomena and the argumentation process in general. Finally, it presented different applications of argumentation mining, in the domains of legal texts, debating or mining scientific literature, and we show different approaches to bridge the gap between theory and application. A special emphasis was devoted to the manual annotation of argumentative texts for different purposes, for students to narrow down abstract concepts and to better understand the idiosyncrasy of argumentative phenomena, all of this with applied goals in sight.

1.2.4 COURSE: argumentation mining

This course was organized by Serena Villata (INRIA) and Elena Cabrio (INRIA) within the 29th European Summer School in Logic, Language, and Information.

Argumentation mining aims at automatically extracting arguments from textual corpora, to provide structured data for computational models of argument and reasoning engines. It has recently become a hot topic also due to its potential in processing information from the Web (social media, online newspapers, product reviews, etc.). In a typical argumentation mining pipeline, sentences recognized as argumentative are extracted from the input document, and argument components (claims and supporting evidences) are identified within such sentences. Then, links between argument components are predicted to construct complete arguments. Finally, the connections between arguments are inferred (e.g., support and attack relations), so as to produce a complete argument graph. Recent advances in computational linguistics and machine learning promise to enable breakthrough applications to this research area. In this course, we introduce argumentation



models and methods, review existing systems and applications, and discuss challenges and perspectives of this new research area.

1.2.5 Akoma Ntoso Summer School

The Akoma Ntoso summer school was organized by Monica Palmirani during her secondment #7, at Stanford University. The summer school Akoma Ntoso focused on USA legal documents in order to test the difficulties in common law environment. The Summer School was successful conducted, ten States from the USA participated;

The school aimed at providing knowledge of the most significant ICT standards emerging for legislation, judiciary, parliamentary and administrative documents with particular regard to Akoma Ntoso standard. The course provided understanding of Akoma Ntoso principles, impacts, scenarios in the different phases of the legislative, parliamentary and administrative processes.

Tools based on Akoma Ntoso XML standards were presented jointly with the ability to participate in the drafting and use of standard-compliant documents throughout law-making process. In particular we aimed at creating consciousness in the stakeholders in the legal domain about the benefits of Akoma Ntoso and the possibilities provided by the correct usage of Semantic Web technologies such as XML standards, ontologies, natural language processing techniques applied to legal texts, legal knowledge modelling and reasoning tools. The program's learning process assists participants to develop knowledge, skills and capabilities in using and managing shared and interoperable standards for legislative document enabling access, communication, processing, modelling, representing and integration of legislation through IT technologies, in an open and cooperative framework.

1.2.6 BRAON: 3rd Madeira Workshop On Belief Revision, Argumentation, Ontologies and Norms.

The workshop was held in the island of Madeira, Portugal, from November 16 to 20, 2017. The main topic of the workshop was the applications of Belief Revision and Argumentation in a wide sense. These applications are not only a computational issue, since a valid topic the application of belief revision in formal epistemology, psychology, economics, etc., also applications of these formalism in Ontologies and Norms are specially recognized as relevant.

The future of the mentioned areas of research lies with our young PhDs and junior researchers, in this edition, one full day was devoted to their work. The activities included: (a) short presentations of PhD's proposals or research plans, with a panel of senior researchers in a Doctoral consortium style, (b) short presentations about methodologies followed in the existing lines of research in BRAON, and (c) a meeting with a brainstorming style between juniors and seniors with an open agenda.



1.2.7 Workshop “Designing Icons for the General Data Protection Regulation”

The workshop was organized on the 14th of July 2017 at Stanford University by Monica Palmirani, Michele Martoni, and Luca Cervone during their secondment #7, together with Arianna Rossi (LAST-JD student) and Margaret Hagan, director of the Stanford Legal Design Lab.

The new European data protection framework, the General Data Protection Regulation (or GDPR) will come into effect next year. It proposes that companies use standardized icons to help people understand how their personal data is being used by websites, apps, and other services.

This is a groundbreaking requirement to use visuals in law — but there’s little guidance about what these icons should be, or how to design them well. The workshop aimed to begin the process of creating effective, usable visuals that will fulfill the GDPR’s mandate.

In particular, the workshop focused on the icons and design insights that we create during the workshop will be taken forward, for policy and academic research purposes. Our group will test the icons more extensively with laypeople, lawyers, judges, and other experts. In the weeks following the workshop, we will run the icons through tests and refinements, so that we can propose icons that are the most effective. The workshop aimed to both increase lay people’s understandings, and to lessen legal disputes around them.

1.2.8 Workshop “Big Data, Reasoning and Decision Making (BRaD 2017)”

The International Workshop on Big Data, Reasoning and Decision Making (BRaD 2017) took place at Zhejiang University, Hangzhou, P.R. China on 29-30 September, 2017.

The purpose of this workshop is to gather researchers and practitioners in multi-disciplinary fields (including logic, artificial intelligence, cognitive science, etc), to discuss research related to knowledge acquisition, representation, reasoning and decision making in the context of Big Data.

Although corpora of legal documents may be deemed by some to be a little bit too small to be considered Big Data per se, legislation at the basis of and regulates our everyday life and societies, many categories of Big Data (e.g., medical records in eHealth, financial data, geographical data, etc.) must comply with and are thus highly dependent on specific norms. Matching and annotating Big Data with legislative information will produce even more and richer Big Data, thus the need of developing high-performance and scalable approaches to (normative) reasoning.

1.2.9 The International Conference on Legal Knowledge and Information Systems

The 30th international conference on Legal Knowledge and Information Systems (JURIX) was organized by Luxembourg University and took place in Luxembourg from the 13th to the 15th of December 2017. The website of the conference is available at: <https://jurix2017.gforge.uni.lu/>.



The conference has provided an international forum for research on the intersection of Law, Artificial Intelligence and Information Systems, under the auspices of The JURIX Foundation for Legal Knowledge Systems. MIREL is one of the sponsors of the conference.

1.2.10 Presentations in the China Smart Industry Summit Forum

Leon van der Torre and Beishui Liao gave keynote speeches at the 7th China Smart Industry Summit Forum. Leon van der Torre presented the project MIREL as a whole, while Beishui Liao gave a talk titled “Legal reasoning systems: The state of the art”, where he introduced some existing approaches based on defeasible logic, argumentation, and answer set programming.

This summit was sponsored by the Chinese Society of Artificial Intelligence and hosted by Foshan Metro Smart Manufacturing Industry Development Co., Ltd.; it was held in Shunde, Guangdong from October 12 to 13, 2017. The talk introduced the MIREL project explaining the details regarding problems addressed, goals to be reached, and the structure of the network of institutions involved.



Figure 1 - Prof. van der Torre presenting MIREL at the 7th China Smart Industry Summit

1.2.11 Other Presentations and Activities

Livio Robaldo presented the MIREL project in the following venues during his secondment #56:

- The Stanford Center for Legal Informatics (CodeX) (<https://law.stanford.edu/codex-the-stanford-center-for-legal-informatics>)
- The Department of Linguistics of Stanford University (<https://linguistics.stanford.edu>)



- Nuance San Francisco (<https://www.nuance.com>)
- Information Science Institute of USC (<https://www.isi.edu>)
- SRI Corporate Headquarters (<https://www.sri.com>)