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Trends in Argumentation Logic

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Abstract:
In this paper, we introduce the subject of the special issue *Trends in Argumentation Logic*. Here we mainly describe two approaches to argumentation logic with explicating monotonic and non-monotonic, or defeasible, reasoning and explain the role of artificial intelligence in applying argumentation logic. Then we give a short overview of the papers contributed to the special issue.
Keywords: Aristotle, artificial intelligence, argumentation logic, monotonic reasoning, defeasible reasoning.

Argumentation logic is a formalized description of the methods in which humans reason and argue about their claims with the help of arguments for justifying and persuading [5]. In recent years, there has been an increasing interest in applying logic to study and address real-life decision-making procedures in the area of argumentation. With the development of next generation argumentation, the interplay between argumentation approaches and logic is gaining momentum.

Argumentation as an especial theory has its roots in the time of the ancient Greek philosophers, Aristotle and classical rhetoric, and has come a long way all these years with the models and techniques that have been developed so far and still are in a process of rapid evolution. Now, there are two main logical approaches to reasoning in argumentation, presenting its monotonicity and non-monotonicity. Let us remember that monotonicity holds true in any standard symbolic logic and means that if $\Sigma \vdash \phi$, then also $\Sigma \cup \Sigma' \vdash \phi$, where the sign $\vdash$ denotes a deduction from premises. But we can introduce a new deduction relation $\sim$ between premises and conclusions which is not monotonic: if $\Sigma \sim \phi$, then $\Sigma \cup \Sigma' \sim \phi$ does not hold true [6]. Hence, adding new premises does not expand, but restricts the set of our conclusions. Such reasoning is called non-monotonic. One of the cases of non-monotonicity appears, when we have a statement ψ that is inferred from Σ but in turn it cannot be a premise for other conclusions. Then we have $\Sigma \sim \psi$. But if $\Sigma \sim \phi$ holds true for some ϕ, from this it follows that $\Sigma \cup \psi \sim \phi$ does not hold true. This is exactly the case when we cannot build chains of inference. Aristotle demonstrated two logical techniques in argumentation at once: both monotonic (his *Prior Analytics* and *Posterior Analytics*) and non-monotonic (his *Topics* and *On Sophistical Refutations*).

Nevertheless, it has been recently learnt that some foundations of argumentation theory as a practice were laid down at the time of Ur III (about 1.5 thousand years earlier than Aristotle lived). The Sumerians and then the Akkadians were the first who proposed a monotony technique in argumentation [12], [13]. Mainly, they applied two inference rules: *modus ponens* and *modus tollens*, and then accepted inference chains.

Practical applications of argumentation seem to be suitable for dealing with problems that require expert reasoning with strict specifications and mostly with accepting the monotonicity of reasoning. First of all, it is presented by rule-based models in which we can obtain some forward and backward inference chains in accordance with some argumentation standards provided by domain experts. This is very applicable now, e.g., in medicine [2]. Another very significant area of studying argumentation is presented by legal norms and an applicability of logic and argumentation to them [3], [7], [8], [9], [11].

At the end of 20th century, a new trend in argumentation, called argumentation logic, emerged, drived by three notable and independent developments: updating and amending knowledge data bases [1], defeasible reasoning as an application of the non-monotonic logic [10] and artificial intelligence. Argumentation logic develops the idea that rational agents accept arguments as convincing, not just because their conclusions are justified by inferring them from their premises, but rather because those arguments are able to support their conclusions against counterarguments, supporting the opposite conclusion. Argumentation logic views disputes as sets of arguments that are taken as its atoms abstractly of their premise-conclusion logical form and

ordered on graphs by a binary attack relation symbolizing critical argumentation. It employs the non-monotonic skeptical or credible semantic algorithms and the notion of fixed point for interpreting different kinds of inferential relations within these abstract argumentative frameworks [4]. Contemporary developments in argumentation logic suggest using labelling or preference-based semantics, as well as considering deductive formalisms based on abstract argumentation frameworks.

Recently, logic-based systems for examining and assessing arguments have been broadly applied, generating various formal methods for argumentation-based reasoning which is not only monotonic. Moreover, argumentation logic has become a key research topic within Artificial Intelligence for formalizing both monotonic and non-monotonic human reasoning. It involves the examination of those procedures for the development and exchange of arguments, where arguments are efforts to persuade someone by providing reasons for accepting a conclusion or claim as valid. Thus, theories and approaches implementing argumentation logic can be found over a wide range of cases in related disciplines such as linguistics, sociology, law, ethics, computer science and others. This trend prompts researchers to pay attention to potential new related areas, based on either their theoretical foundations or their effective applications.

This special issue collects newly developed works from logic and argumentation, to stimulate possible outcomes from their interplay. This volume includes the selection of 6 papers from 14 submissions accepted to Argumentation Logic Workshop of the 7th World Congress and School on Universal Logic (UNILOG 2022) at Orthodox Academy of Crete (Greece). Among the experts who presented their research at the workshop but do not become the authors of the papers of the special issue, there are Katie Atkinson (University of Liverpool, UK), covering the topic of *Explainable AI for Legal Applications using Computational Models of Argument*, and Ivan Mikirtumov (St Petersburg University, Russia), covering the topic of *Processing: Metaphor and Model for an Interpretation of Arguments*. The selected papers of the issue discuss theoretical foundations in argumentation logic as well as challenges and real-world cases. Each submission underwent a peer-review process by at least two independent expert reviewers. A short overview of the six papers accepted for publication is presented below.

The paper *Argumentation: Reasoning Universalis* contributed by Antonis Kakas (Department of Computer Science, University of Cyprus) is a theoretical work in the area of computational argumentation. It presents how argumentation can form a universal basis for reasoning, capturing both informal and formal logical reasoning. It highlights why argumentation reasoning is proper for the logical foundations of AI, drawing an analogy between Aristotle's study of argumentation and computational argumentation in AI.

Dimitra Serakioti (Democritus University of Thrace, School of Educational Sciences, Greece) and Petros Stefaneas (School of Applied Mathematical and Physical Sciences, National Technical University of Athens, Greece), in their joint paper *Ambiguity in Argumentation: The Impact of Contextual Factors on Semantic Interpretation*, apply Halliday's Systemic Functional Grammar to present how interpretation can reconstruct the meaning of a dialogue and how we analyze ambiguities by bringing together two important strands of research: argumentation theory and text linguistics.

Vladimir A. Stepanov (Moscow, Russia) wrote the paper *Dynamic Approximation of Self-Referential Sentences* in which he proposes a new 6-value lattice of a non-classical logic via dynamic approximation for modeling of self-referential sentences. It handles those sentences as infinite iterations of self-predications and determines their truth-values with truth tables. The obtained new dual truth functions elegantly obey De Morgan laws.

The submission *Determining Argumentative Dispute Resolution Reveals Deep Disagreement over Harassment Issue (a Case-study of a Discussion in the Russian Parliament)* by Elena Lisanyuk (St Petersburg University, National Research University Higher School of Economics in Moscow, Russia) presents a methodology that combines concepts from argumentation logic, new dialectics, and logical-cognitive approach to argumentation and

aggregated formal and informal tools of analysis to develop an algorithm for determining dispute resolution.

In the research *Argumentation-based Logic for Ethical Decision Making*, Sofia Almpani (School of Electrical and Computing Engineering, National Technical University of Athens, Greece), Petros Stefaneas (School of Applied Mathematics, National Technical University of Athens, Greece), and Panayiotis Frangos (National Technical University of Athens, Greece) propose to define context-based scenarios for formalizing ethical reasoning on how far something can be accepted or rejected according to appropriate ethical rules creating a tool for verifying whether agent's decisions are ethically justified.

The paper *Non-Monotonic Reasoning in Medieval Theology: Problems and Assumptions* by Marcin Trepczyński (University of Warsaw, Poland) presents and analyzes cases of non-monotonic reasoning in medieval theological texts and outlines problems connected with identification of non-monotonicity specific for theology.

Additionally, in this special issue we publish two interviews: the *Public Theology Facing a Planet in Turmoil* given by Ted Peters (emeritus professor at the Graduate Theological Union, where he co-edits the journal, *Theology and Science*, on behalf of the Center for Theology and the Natural Sciences, in Berkeley, California, USA) to Konrad Szocik and the *Intellectual and Ethical Virtues in the Situation of War* given by Vojko Strahovnik (Department Chair and Associate Professor at the Department of Philosophy and Research Fellow in Philosophy at the Faculty of Theology, University of Ljubljana) to Andrew Schumann.

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