Report from Dagstuhl Perspectives Workshop 15362

Present and Future of Formal Argumentation

Edited by

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Abstract

This report documents the program and the outcomes of Dagstuhl Perspectives Workshop 15362 "Present and Future of Formal Argumentation". The goal of this Dagstuhl Perspectives Workshop was to gather the world leading experts in formal argumentation in order to develop a SWOT (Strength, Weaknesses, Opportunities, Threats) analysis of the current state of the research in this field and to draw accordingly some strategic lines to ensure its successful development in the future. A critical survey of the field has been carried out through individual presentations and collective discussions. Moreover, working group activity lead to identify several open problems in argumentation.

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1 Executive Summary

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Diverse kinds of reasoning and dialogue activities can be captured by argumentation models in a formal and still quite intuitive way, thus enabling the integration of different specific techniques and the development of applications humans can trust. Formal argumentation lays on solid bases, such as extensively studied theoretical models at different levels of abstraction, efficient implementations of these models, as well as a variety of experimental studies in several application fields. In order to be able to convert the opportunities of the present into actual results in the future, the formal argumentation research community needs however to reflect about the current assets and weaknesses of the field and to identify suitable strategies to leverage the former and to tackle the latter. As an example, the definition of standard modeling languages and of reference sets of benchmark problems are still in their infancy, reference texts for newcomers are missing, the study of methodological guidelines for the use of theoretical models in actual applications is a largely open research issue.

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The goal of this Dagstuhl Perspectives Workshop was to gather the world leading experts in formal argumentation in order to develop a SWOT (Strength, Weaknesses, Opportunities, Threats) analysis of the current state of the research in this field and to draw accordingly some strategic lines to ensure its successful development in the future.

The Perspectives Workshop was held between August 30 to September 4, 2015, with 22 participants from 10 countries. With the aim of developing a critical survey of the field for the argumentation community and for potential newcomers, the organizers agreed to assemble a handbook of formal argumentation, and encouraged participants to present their view on different topics in the area. Besides individual presentations, the program included collective discussions on general issues arising from individual presentations, as well as working groups.

Individual presentations concerned introductory overviews, logical problems and requirements for formal argumentation, specific formalisms and methodologies, relationship between different approaches and applications. While a limit of half an hour per talk was initially established, we decided to leave the time for discussion relatively open, since several open topics and new developments were envisaged out of presentations.

Collective discussions have been arranged along four topics, i.e. basic concepts and foundations, specific formalisms for argumentation, algorithms, and connections both inside the argumentation field and with outside research topics.

We organized three discussion groups each headed by one organizer (see Section 4). Each group was asked to identify the most important open problems in argumentation. Interestly enough, there was little intersection between the three outcomes, i.e. the three groups came out with different problems. Many of them concerned foundational issues of the theory, e.g, how to formally represent various kinds of arguments and how to identify sets of postulates on the reasoning activity over arguments in specific contexts. On the other hand, the relationship between argumentation and other research fields (e.g. natural language processing, machine learning, human computer interaction, social choice) was seen to be of major importance, especially to develop more applications.

The unique setting and atmosphere of Dagstuhl provided the ideal environment to exchange ideas on future directions of argumentation, with discussions often lasting all the evening and the first part of the night.

The Perspectives Workshop concluded with the presentation of the results yielded by the group discussions, that in our opinion will lead to collaborative research, scientific papers and funded international projects in the future.

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3 Overview of Talks

3.1 Argumentation theory in formal and computational perspective

Bart Verheij (University of Groningen, NL)

Joint work of van Eemeren, Frans; Verheij, Bart
Main reference F. H.van Eemeren, B. Garssen, E. C. W. Krabbe, A. F. Snoeck Henkemans, B. Verheij, J. H. M. Wagemans, "Handbook of Argumentation Theory," ISBN 978-90-481-9472-8, Springer, 2014.
URL http://www.springer.com/de/book/9789048194728

As authors of a recent handbook of argumentation theory (not focused on the formal as is the present handbook), we have planned chapter 1 of the handbook of formal argumentation with three aims:

1. Introduce argumentation theory as an interdisciplinary research discipline.
2. Provide a bridge from informal to formal argumentation theory.
3. Aim at a readership of people with various backgrounds.

As such, the approach of the chapter tries to balance the kinds of methods, research styles and ideas, found across the triangle of cognitive systems:
bottom corner: Theoretical systems (philosophical paradigms, formalisms)
top-left corner: Artificial systems (software, robots)
top-right corner: Natural systems (texts, dialogs)

We hope the chapter can contribute to theoretical progress (growth towards standardized theory, connections with related theory) and applied progress (growth of relevant software support, collections of relevant knowledge). As a means, we suggest an enhanced exchange and collaboration between researchers of different backgrounds.

3.2 Historical Overview of Formal Argumentation

Henry Prakken (Utrecht University, NL)

The history of formal argumentation is described in terms of a main distinction between argumentation-based inference and argumentation-based dialogue. For both aspects of argumentation historical influences and trends are sketched.

3.3 Argumentation, nonmonotonic reasoning and logic

Alexander Bochman (Holon Institute of Technology, IL)

We provide s formal description of logical systems that can properly host various argumentation frameworks. It is shown, in particular, that the majority of such systems are representable as extensions of Dung's argumentation frameworks in suitable logical languages.

3.4 Abstraction1 vs. Abstraction2 in Formal Argumentation

Leendert van der Torre (University of Luxembourg, LU)

Joint work of Gabbay, Dov; Liao, Beishui; van der Torre, Leendert

We define abstraction1 as an equivalence relation over inputs to classify operators to compute conclusions, such as the use of dominance graphs in voting theory, and abstraction2 as a way of handling complexity, reusability, interoperability, and independence of implementation, such as the use of artificial languages in computer science, and (maybe) the use of natural language. Papers and theories about formal argumentation can be classified according to their stance towards abstraction. There are theories that do not consider abstract arguments, theories that consider both abstract1 and structured or instantiated arguments, and theories that consider abstract2 arguments only. We argue that research in these three classes is based on three distinct methodologies, and thus have distinct evaluation criteria. Though these two kinds of abstract1/2 argumentation theory are studied in two distinct volumes of the handbook on formal argumentation, we bring them here together in one chapter to look for common threads in the two disciplines, such as the role of refinement as the inverse of abstraction, and the role and use of auxiliary arguments. We consider also the role of fallacies in argumentation.

3.5 Requirements Analysis for Formal Argumentation

Tom Gordon (Fraunhofer FOKUS – Berlin, DE)

We suggest applying software engineering methods for "agile" requirements analysis to the development and evaluation of formal models of argumentation. The aim and purpose would be to help assure that formal models of argument are useful as a foundation for software tools supporting real argumentation tasks in domains such as law, politics and humanities scholarship and to help avoid developing a technical conception of "argument" far removed its meaning in fields of argumentation practice. We conclude with a list of some open issues and problems for which there are thus far no adequate formal models of argument, perhaps because prior research has not been sufficiently requirements driven.

3.6 Dung's traditional argumentation

Massimiliano Giacomin (University of Brescia, IT)

Joint work of Baroni, Pietro; Caminada, Martin; Giacomin, Massimiliano

This talk introduces Dung's argumentation frameworks and presents an overview on the semantics for abstract argumentation, including some of the most influential proposals. In particular, the talk reviews Dung's original notions of complete, grounded, preferred, and stable semantics, as well as subsequently proposed notions like semi-stable, ideal, eager,

naive, stage, CF2, stage2 and resolution-based semantics. Both extension-based and labelling-based definitions are considered. Furthermore, the talk reviews some general properties for semantics evaluation, analyzes the notions of argument justification and skepticism, and discusses the relationships among argumentation frameworks and their semantics. The final part of the presentation is focused on various lines of technical developments of Dung's model and open issues.

3.7 Abstract Dialectical Frameworks and Graph-Based Argument Processing

Gerhard Brewka (Universität Leipzig, DE)

Joint work of Brewka, Gerhard; Woltran, Stefan
Main reference G. Brewka, S. Woltran, "GRAPPA: A Semantical Framework for Graph-Based Argument Processing," in Proc. of the 21st Europ. Conf. on Artificial Intelligence (ECAI'14), Frontiers in Artificial Intelligence and Applications, Vol. 263, pp. 153–158, IOS Press, 2014.
URL http://dx.doi.org/10.3233/978-1-61499-419-0-153

Graphical models are widely used in argumentation to visualize relationships among propositions or arguments. The intuitive meaning of the links in the graphs is typically expressed using labels of various kinds. In this talk we introduce a general semantical framework for assigning a precise meaning to labelled argument graphs which makes them suitable for automatic evaluation. Our approach rests on the notion of explicit acceptance conditions, as first studied in Abstract Dialectical Frameworks (ADFs). The acceptance conditions used here are functions from multisets of labels to truth values. We define various Dung style semantics for argument graphs. We also introduce a pattern language for specifying acceptance functions. Moreover, we show how argument graphs can be compiled to ADFs, thus providing an automatic evaluation tool via existing ADF implementations. Finally, we also discuss complexity issues.

3.8 Abstract Rule-based Argumentation

Henry Prakken (Utrecht University, NL)

Joint work of Modgil, Sanjay; Prakken, Henry

First the standard ASPIC+ framework for structured argumentation is presented. Then several ways to use it are discussed, some variations of the framework are sketched and relations with other work are discussed.

3.9 Assumption-based argumentation

Pietro Baroni (University of Brescia, IT)

Joint work of Fan, Xiuyi; Schulz, Claudia; Toni, Francesca

The presentation describes the basic notions of ABA, its relationships with other formalisms, its syntax and semantics, the computational tool of dispute trees and the uses of the formalism for dialogues and explanation.

3.10 Argumentation Based on Logic Programming

Guillermo Simari (National University of the South – Bahía Blanca, AR)

Joint work of García, Alejandro J.; Simari, Guillermo R.

In this chapter, the connections between Logic Programming and Argumentation through the formalisms introduced in the literature are explored. These relations have enriched both areas contributing to their development. Some argumentation formalisms were used to define semantics for logic programming and also logic programming was used for providing an underlying representational language for non-abstract argumentation formalisms. Finally, different applications of the reasoning mechanisms based on argumentation in different areas of Artificial Intelligence such as Possibilistic Reasoning, Backing and Undercutting, Strength and Time, Decision Making, Planning, Ontologies, and Knowledge-based Systems are presented.

3.11 Constructing Argument Graphs with Deductive Arguments

Guillermo Simari (National University of the South – Bahía Blanca, AR)

Joint work of Besnard, Philippe; Hunter, Anthony

A deductive argument is a pair where the first item is a set of premises, the second item is a claim, and the premises entail the claim. This can be formalized by assuming a logical language for the premises and the claim, and logical entailment (or consequence relation) for showing that the claim follows from the premises. Examples of logics that can be used include classical logic, modal logic, description logic, temporal logic, and conditional logic. A counterargument for an argument A is an argument B where the claim of B contradicts the premises of A. Different choices of logic, and different choices for the precise definitions of argument and counterargument, give us a range of possibilities for formalizing deductive argumentation. Further options are available to us for choosing the arguments and counterarguments we put into an argument graph. If we are to construct an argument graph based on the arguments that can be constructed from a knowledgebase, then we can be exhaustive in including all arguments and counterarguments that can be constructed from the knowledgebase. But there are other options available to us. We consider some of the possibilities in this review.

3.12 Argumentation Schemes

Chris Reed (University of Dundee, GB)

Joint work of Macagno, F.; Reed, C.; Walton, D.

Argumentation schemes have been an influential component of both the philosophy and pedagogy of argumentation and critical thinking and also of formal and computational models of structured argumentation. In this chapter, we explore a number of issues relating to argumentation schemes. First, the challenges posed by critical questions are tackled, showing how different types of schemes correspond to different types of structure in both structured argumentation complexes and also in dialogical interactions. Next, we explore the connections between argumentation schemes and argument mining, including the particularly pernicious challenge of corpora and data management. As a part of this topic, the question of how nets of argumentation schemes can be composed. Finally, there is the issue of classification and organisation of schemes, whether taxonomically, ontologically, or on the basis of clusters, in order to provide clarity and structure for both practical and formal uses of argumentation schemes.

3.13 Rationality Postulates and Critical Examples

Martin Caminada (University of Aberdeen, GB)

We present the proposed structure of the chapter on Rationality Postulates and Critical Examples in the Handbook of Formal Argumentation.

1. Introduction
2. Preliminaries
3. Direct consistency, indirect consistency and closure
   a. restricted rebut solutions
      i. transposition
      ii. contraposition
      iii. semi-abstract approach of Dung and Tang
      iv. on the need of complete-based semantics
   b. unrestricted rebut solutions
4. Non-interference and crash resistance
   a. erasing inconsistent arguments
   b. requiring consistent entailment and forbidding strict-on-strict
5. Rationality postulates and other instantiations
6. Summary and discussion

3.14 Argument-Based Entailment as Discussion

Martin Caminada (University of Aberdeen, GB)

We describe the proposed structure of the chapter on Argument-Based Entailment as Discussion in the Handbook of Formal Argumentation.

1. Introduction
2. The preferred game
3. The stable game
4. The ideal game
5. The grounded games
   a. the standard grounded game (SGG)
   b. the grounded persuasion game (GPG)
   c. the grounded discussion game (GDG)
   d. overview and comparison
6. Discussion

3.15 On the Relation between AA, ABA and LP

Martin Caminada (University of Aberdeen, GB)

In the current talk, we examine the equivalences and differences between Assumption-Based Argumentation, Abstract Argumentation and Logic Programming. It is proposed that this could be the topic of an additional chapter in the Handbook of Formal Argumentation.

3.16 Computational Problems in Formal Argumentation and their Complexity

Wolfgang Dvorak (Universität Wien, AT)

Joint work of Dunne, Paul E.; Dvořák, Wolfgang

Several computational challenges arise in the process of formal argumentation. Understanding the computational complexity of these problems and different sources thereof is essential for the design of efficient argumentation systems that scale well with the size of argumentation scenarios. On a high-level there are three main tasks where computational challenges arise: (1) constructing arguments and identifying conflicts between them; (2) resolving the conflicts and identifying sets of coherent arguments; (3) drawing conclusions from the selected arguments. While the necessary computations in (1) and (3) are often purely in the underlying logic/formalism the tasks arising in (2) are argumentation problems at their core, and thus are often studied independently of a concrete instantiation of (1) and (3). We discuss three formalisms such that the different computational aspects are covered, namely Dung's Abstract Argumentation Frameworks, Assumption-based Argumentation (ABA)

and Abstract Dialectical Frameworks (ADFs). The complexity of reasoning tasks highly depends on the applied semantics and we categorize semantics by different levels of complexity (by their location in the so-called polynomial hierarchy) which is in accordance with the performance of existing argumentation systems for different semantics. As most of these problems are of high worst-case complexity, we also consider properties of instances, like being in a specific graph class, that reduce the complexity. Finally, we also show techniques from parametrized complexity that allow for a more fine-grained complexity classification taking structural properties into account.

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3.17 Implementations

Matthias Thimm (Universität Koblenz-Landau, DE)

We survey both the current state-of-the-art of general techniques and specific software systems for solving tasks in abstract argumentation frameworks, structured argumentation frameworks, and approaches for visualizing and analysing argumentation. Furthermore, we discuss general challenges and further promising techniques for solving these problems such as parallel processing and approximation techniques. Finally, we address the issue of evaluating software systems empirically with linkage to the International Competition on Computational Models of Argumentation.

3.18 Advanced techniques

Ringo Baumann (Universität Leipzig, DE)

The aim of the talk is to give an overview of fundamental properties of abstract argumentation frameworks typically considered for nonmonotonic formalisms. In particular, we shed light on the following issues/questions:

1. *Replaceability:* Is it, and if so how, possible to *simplify* parts of a given AF F, s.t. the modified version F' and F cannot be semantically distinguished by further information which might be added later to both simultaneously?
2. *Expressibility:* Is it, and if so how, possible to *realize* a given candidate set of extensions within a single AF F?
3. *Existence and uniqueness:* Is it, and if so how, possible to decide (without computing) whether a certain AF *possesses* an acceptable set of arguments w.r.t. a certain semantics? Moreover, in what situation the solution is *unique*? We study these questions for three classes of AFs, namely finite, finitary as well as the unrestricted case of arbitrary AFs.

3.19 A principle based evaluation of argumentation semantics

Leendert van der Torre (University of Luxembourg, LU)

Joint work of van der Torre, L.; Vesic, S.

This chapter gives a classification of argumentation semantics based on a set of principles. Starting from Baroni and Giacomin's original classification, we extend their analysis with other semantics and principles proposed in the literature.

3.20 Locality and Modularity in Abstract Argumentation

Pietro Baroni (University of Brescia, IT)

Joint work of Baroni, Pietro; Giacomin, Massimiliano; Liao, Beishui

The presentation discusses the motivations for investigating locality and modularity properties in abstract argumentation and surveys the main results available in the literature concerning directionality, SCC-recursiveness and decomposability and their uses for efficient computation, interchangeability and summarization.

3.21 Semantic Instantiations

Emil Weydert (University of Luxembourg, LU)

Formal argumentation is characterized by diverging accounts and a number of controversial issues. This raises the question of validation and common foundations for an area which in the past had a mainly proof-theoretical flavour. The present chapter discusses approaches trying to semantically ground argument systems and argumentation-based reasoning. In fact, arguments can be interpreted as constraints over epistemic states. Adopting a very general perspective where arguments are seen as inferential graphs over a defeasible conditional logic, it becomes possible to exploit powerful semantic techniques from default reasoning. A proptotypical instance are Dung-style acceptance functions based on the ranking measure semantics for default inference.

3.22 Processing Argumentation in Natural Language Texts

Katarzyna Budzynska (Polish National Academy of Sciences, PL, and University of Dundee, UK)

Joint work of Budzynska, Katarzyna; Villata, Serena

Discourse analysis and text mining is a promising approach to identify and extract real-life arguments, receiving attention from the natural language processing community (e.g., argument mining of legal documents, on-line debates, newspaper and scientific articles, etc). On the other hand, computational models of argumentation have made substantial progress in providing abstract and structured formal models to represent and reason over argumentation structures. Our work is aimed at the interaction between Computational Linguistics and Argumentation Theory. More precisely, it has the goal to combine the techniques and frameworks for analysing, aggregating, synthesizing, structuring, summarizing, and reasoning about arguments in natural language texts.

4 Working Groups

4.1 Results of Discussion Group I – Most Important Problems in Argumentation

Beishui Liao (Zhejiang University, CN)

- The role of numerical approaches
- Interaction and aggregation of arguments
- Formal representation of argument
- How to use argumentation to represent preference-based nonmonotonic reasoning
- What is the negation of argument

- Formal argumentation account of fallacies
- Analysing and modelling argumentation schemes
- Argumentation models of decision theory vs. other models of decision making
- Argumentation mining (e.g. large-scale applications)
- Argumentation and other networks
- Validity of arguments w.r.t. time/dynamics
- Balancing the different steps of argumentation

4.2 Results of Discussion Group II – Most Important Problems in Argumentation

Massimiliano Giacomin (University of Brescia, IT)

- How to do reasoning with strict and defeasible (non-strict) rules by satisfying qualitative postulates and in a way which is expressible dialectically in a natural way, without being overly skeptical?
- Identifying proper sets of qualitative postulates that should be satisfied in specific contexts.
- Alternatives to Dung's approach. Identifying an elegant formalism encompassing Dung's model and capturing also different ways of evaluating arguments, e.g. balancing considerations.
- Achieving a clarification on the "semantics of a semantics". When to adopt a specific semantics instead of another?
- How do we validate dialogue protocols? Do we need a semantic model?
- How to do sound and complete argument games when arguments become available dynamically from private knowledge bases?
- Identifying models to switch between different levels of reasoning, as happens in real argumentation.
- What is the nature of defeat? How to deal with preferences? Preference order between arguments is dynamic and may depend on the labelling of arguments, thus a recursive process may be needed.
- Further investigation on the notion of accrual and its management.
- How to manage numerical information in argumentation in a principled way?
- How to determine "who knows more" in a multi-agent argumentation context? What is knowledge? Relationships with other areas (e.g. belief revision and logic programming).
- Dealing with time in argumentation, e.g. arguments can be valid now but not in the future.

4.3 Results of Discussion Group III – Most Important Problems in Argumentation

Leendert van der Torre (University of Luxembourg, LU)

- What is the negation of an argument? Type theory. Define the operators, like negation of trust in distrust, negation of attack as support, negation of argument. What is the negation of an argumentation framework?
- Interaction of strict and non-strict rules in argumentation. Do we need strict rules? What are strict rules? How does it relate to work in general NMR? What is the role of specificity in this discussion? Relationship with the work by Frida Stolzenburg, last year at KR, David Poole's approach.
- Relationship between argumentation and natural language processing / machine learning / data mining. Output of many techniques are different from an argumentation framework. For example, argument mining, learning strategies, giving reasons for what it learned. Define more clearly the argument mining problem, extend the interdisciplinary
- Rhetorics and dialectics, debating game to beat politician
- Natural language interfaces to arguments.
- Integrating argumentation and computational social choice. The relation between voting and the semantics of argumentation. Show that semantics works better. Kind of democracy based on argumentation.
- Can argumentation contribute to Turing test, Winograd scheme, disambiguating sentences, giving reasons why one way or another . Is AI a sub field of machine learning? Relationship with the other Dagstuhl workshop. How do we convince Russell and Norvig that formal argumentation should be in the book?
- Alternatives to the three step approach, sometimes we are interested in only one argument, focus on explanation and justification
- Bringing argumentation to the U.S. (Kevin Ashley, Thorne MacCarthy)
- What is rationality and which is the role formal argumentation
- Efficient algorithms for abstract argumentation not based on SAT problem

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