

# **Argumentation in Artificial Intelligence**

# Argumentation in Artificial Intelligence

Edited by

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Springer

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*To Zoe, for her love and support.*

– I.R.

*To my family with love.*

– G.S.

# Foreword

Argumentation is all around us. Letters to the Editor often make points of consistency, and “Why” is one of the most frequent questions in language, asking for reasons behind behaviour. And argumentation is more than ‘reasoning’ in the recesses of single minds, since it crucially involves interaction. It cements the coordinated social behaviour that has allowed us, in small bands of not particularly physically impressive primates, to dominate the planet, from the mammoth hunt all the way up to organized science. This volume puts argumentation on the map in the field of Artificial Intelligence. This theme has been coming for a while, and some famous pioneers are chapter authors, but we can now see a broader systematic area emerging in the sum of topics and results.

As a logician, I find this intriguing, since I see AI as ‘logic continued by other means’, reminding us of broader views of what my discipline is about. Logic arose originally out of reflection on many-agent practices of disputation, in Greek Antiquity, but also in India and China. And logicians like me would like to return to this broader agenda of rational agency and intelligent interaction. Of course, Aristotle also gave us a formal systems methodology that deeply influenced the field, and eventually connected up happily with mathematical proof and foundations. Thus, I see two main paradigms from Antiquity that come together in the modern study of argumentation: Platos’ *Dialogues* as the paradigm of intelligent interaction, and Euclid’s *Elements* as the model of rigour. Of course, some people also think that formal mathematical proof is itself the ultimate ideal of reasoning - but you may want to change your mind about reasoning’s ‘peak experiences’ when you see top mathematicians argue interactively at a seminar.

But more themes went into the mixture of this Book. Leibniz and those after him, from Boole to Turing or McCarthy, added computation as a major category in understanding reasoning. Now, this is not necessarily congenial to argumentation: Leibniz’ famous ‘Calculus’ calls for replacing interactive disputation by mechanical computing. But modern computation itself is distributed and interactive, so we are in tune again.

Also relevant to understanding this Book is the emergence of ‘Argumentation Theory’ in the 20th century, partly in opposition to formal logic. In particular, Toulmin gave us a much richer view of actual inference than just a bleak jump from premises to conclusion, and placed it in a historical tradition of dynamic legal procedure (what he calls the ‘formalities’) rather than just the static mathematical form of statements. Indeed, Mathematics and Law seem two major pillars of our culture, with the latter often under-estimated as an intellectual force. This tandem seems significant to me, since it fits the Dynamic Turn I have long advocated toward logical studies of cognitive actions, and indeed multi-agent interaction. Strategic responses to others, and ‘logical empathy’ putting yourself in someone else’s place, are keys to rational behaviour. And argumentation is one of the major processes that make this interaction happen. Thus, *pace* Toulmin, logic and argumentation theory can form happy unions after all, witness the work of colleagues like van Eemeren, Krabbe & Walton, Gabbay & Woods, etc.

And even beyond these strands, the land of rational agency is populated by other tribes, many equipped with mathematical tools. Game theorists study social mechanisms, social scientists care about social choice and decisions, and philosophers, too, have long studied rational interaction. Think of Kant's categorical imperative of treating others as an end like yourself, not just a means. This only makes sense in a society of agents.

AI lets all these strands come together: logic, mathematics, computation, and human behaviour. It has long been a sanctuary for free-thinkers about reasoning and other intelligent activities, taking a fresh look at the practice of common sense all around us. Indeed, I see the above perspective as an appropriate extension of the very concept of 'common sense', which is not just 'sense' about how single agents represent the world and make inferences about it, but equally much 'common' about how they sensibly interact with others. And once more, argumentation is a major mechanism for doing so.

The content of this rich volume is definitely not exhausted by the above. It contains methods from computer science, mathematics, philosophy, law, and economics, merging artificial with natural intelligence. Its formal methods range from logic programs to abstract argumentation systems, and from non-monotonic default logics and belief revision to classical proof theory. It also highlights multi-agent dialogue and decision making, including connections with game theory - where our rich practices of argumentation and debate pose many unsolved challenges. Just try to understand how we successfully conduct meetings, and 'play' arguments of various strengths over time! Finally, I would mention an intriguing feature in many studies of argumentation, viz. attention to fallacies and errors. Once I was taken to task by a prominent medical researcher, who claimed that the most interesting information about the human body and mind is found with patients deviating from the norm, and coping with 'disturbance' in unexpected creative ways. He did not understand why logicians would wilfully ignore the corresponding rich evidence in the case of reasoning, concentrating just on angelic correctness. I agree, and linking up with empirical psychology and cognitive science seems an attractive next step, given the suggestive material collected here.

This volume tries to stake out a new field, and hence: papers, careers, tenure. But something broader is at stake. Original visions of AI tended to emphasize hugely uninspiring, if terrifying, goals like machines emulating humans. A Dutch book with 'vision statements' by leading scientists once revealed a disturbing uniformity: all described a technological end goal for their field of which all said they hoped to be dead long before it was achieved. I myself prefer goals that I could live with. Understanding argumentation means understanding a crucial feature of ourselves, perhaps using machines to improve our performance, helping us humans be better at what we are.

I am happy that books like this are happening and I congratulate the editors and authors.

# Preface

This book is about the common ground between two fields of inquiry: Argumentation Theory and Artificial Intelligence. On the one hand, formal models of argumentation are making significant and increasing contributions to Artificial Intelligence, from defining semantics of logic programs, to implementing persuasive medical diagnostic systems, to studying negotiation dialogues in multi-agent systems. On the other hand, Artificial Intelligence has also made an impact on Argumentation Theory and Practice, for example by providing formal tools for argument analysis, evaluation, and visualisation.

The field of Argumentation in Artificial Intelligence has grown significantly in the past few years resulting in a substantial body of work and well-established technical literature. A testimony to this is the appearance of several special issues in leading scientific journals in recent years, (*e.g.*, Springer's Journal of Autonomous Agents and Multiagent Systems 2006; Elsevier's Artificial Intelligence Journal 2007; IEEE Intelligent Systems 2007; Wiley's International Journal of Intelligent Systems 2007). Another evidence of the maturity of this area is the establishment of a new biannual international conference in 2006 (see [www.comma-conf.org](http://www.comma-conf.org)). In addition, two series of workshops have been co-located with major AI conferences: the Argumentation in Multi-Agent Systems (ArgMAS) workshop series running annually alongside AAMAS since 2004, and the Computational Models of Natural Argument (CMNA) workshop running series alongside IJCAI and ECAI since 2001. Yet, although valuable survey papers exist, there is no comprehensive presentation of the major achievements in the field. This volume is a response to a growing need for an in-depth presentation of this fast-expanding area. As such it can be seen as a confluence of deep exposition and comprehensive exploration of the underlying themes in the various areas, done by leading researchers. While no single volume on Argumentation and Artificial Intelligence could cover the entire scope of this dynamic area, these selected writings will give the reader an insightful view of a landscape of stimulating ideas that drive forward the fundamental research and the creation of applications.

This book is aimed at new and current researchers in Argumentation Theory and in Artificial Intelligence interested in exploring the rich terrain at the intersection between these two fields. In particular, the book presents an overview of key concepts in Argumentation Theory and of formal models of Argumentation in AI. After laying a strong foundation by covering the fundamentals of argumentation and formal argument modeling, the book expands its focus to more specialised topics, such as algorithmic issues, argumentation in multi-agent systems, and strategic aspects of argumentation. Finally, as a coda, the book presents some practical applications of argumentation in AI and applications of AI in argumentation.

Although the book is an edited collection, the chapters' topics and order was done carefully to produce a highly organised text containing a progressive development of intuitions, ideas and techniques, starting from philosophical backgrounds, to abstract argument systems, to computing arguments, to the appearance of applications presenting innovative results. Authors had the chance to review each others'

work at various stages of writing in order to coordinate content, ensuring unified notation (when possible) and natural progression.

Readers of this book will acquire an appreciation of a wide range of topics in Argumentation and Artificial Intelligence covering, for the first time, a breadth of hot topics. Throughout the chapters the authors have provided extensive examples to ensure that readers develop the right intuitions before they move from one topic to another.

The primary audience is composed of researchers and graduate students working in Autonomous Agents, AI and Law, Logic in Computer Science, Electronic Governance, Multi-agent Systems, and the growing research represented by the interdisciplinary inquiry carried out in many areas such as Decision Support Systems. Given the scope and depth of the chapters of this book, its content provides an excellent foundation for several different graduate courses.

The book begins with an “Introduction to Argumentation Theory” by Douglas Walton, who was one of the argumentation theorists who pioneered joint work with AI researchers. The rest of the book’s twenty three chapters have been organised into four parts: “Abstract Argument Systems”, “Arguments with Structure”, “Argumentation in Multi-Agent Systems”, and “Applications”. Chapters in this book have been written by researchers that have helped shape the field. As such, we are confident that this book will be an essential resource for graduate students and researchers coming to the area.

The value of this book is in the ideas it presents. Thus we gratefully acknowledge efforts by all authors who shared their ideas and deep insights of this fertile area of research in such a clear manner. Furthermore, they also acted as peer reviewers of other chapters and helped to significantly improve the quality and the flow of the book. We would also like to thank all the contributions made by the different organisations that supported the authors of this book as they individually recognise in each chapter.

We are grateful to the Springer team, and in particular Melissa Fearon and Valerie Schofield, for supporting the creation of this book from early discussions right through to final editorial work.

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Dubai, Edinburgh and Bahia Blanca,  
December 2008

*Iyad Rahwan*  
*Guillermo Simari*



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