1

Introducing Some Basic Concepts and Tools

Argumentation, which can be abstractly defined as the interaction of different arguments for and against some conclusion, is an important skill to learn for everyday life, law, science, politics and business. It is a rich, interdisciplinary area of research straddling philosophy, communication studies, linguistics, psychology and artificial intelligence that has developed context-sensitive practical methods to help a user identify, analyze and evaluate arguments.

Recently, the field of computing has embraced argumentation as a paradigm for research in artificial intelligence and multi-agent systems. Artificial intelligence in particular has seen a prolific growth in uses of argumentation. Argumentation has proved helpful to computing because it has provided concepts and methods used to build software tools for designing, implementing and analyzing sophisticated forms of reasoning and interaction among rational agents (Reed and Grasso, 2007). Recent successes include argumentation-based models of evidential relations and legal processes of examination and evaluation of evidence. Argument mapping has proved to be a useful tool for designing better products and services and for improving the quality of communication in social media by making deliberation dialogues more efficient. There now exist formal systems of argumentation to model many aspects of reasoning and argument that were formerly studied only by less structured methods of informal logic.

Now there has been the starting of a feedback loop. The formal argumentation methods and concepts that were developed in artificial intelligence are themselves being used to refine informal argumentation methods. In the past the argumentation methods have come from the humanities and social sciences. Now the tools that have been developed to model the features and problems of argumentation in natural language discourse, and other special contexts such as legal reasoning, are computationally precise. One benefit of this reverse transfer to and from computer science has been the refinement of argumentation theory itself through

mathematically precise modeling of its core concepts and methods. The purpose of this book is to present and refine these tools from computing to help build a better set of methods that can be used by all argumentation scholars. This project is carried forward by showing how the new methods can already be applied with some success to some of the leading problems of argumentation.

The book gives a clear idea of what the methods are and how they work as tools that can be used to study arguments. To distinguish itself from other views of argumentation, the book calls its approach "logical argumentation", suggesting a joining of informal logic with the formal argumentation technology of computer science. Each chapter of the book applies these methods to a leading problem of argumentation studies. The problems studied in the book include the problems of defining the notions of critical questioning, undercutting, rebuttal and refutation, (2) the problem of representing critical questions on an argument diagram, (3) the pervasive problem of finding the missing premises (or conclusions) in an argument, (4) the problem of applying argumentation schemes to real arguments in natural language discourse, (5) the problem of modeling how argument from precedent in our system of law is based on a form of argument from analogy that can represent the notion of similarity between cases, (6) the problem of reasoning backward from external data to a hypothesis about an agent's presumed internal state of mind, for example, its motive, (7) the problem of understanding how scientific inquiry begins from a discovery phase, and (8) the problem of how an arguer's position can be adequately and fairly represented in order to properly criticize or refute it. The substantial progress made in the book on solving these problems demonstrates how useful the methods of logical argumentation can be.

1. Logical Argumentation as a Distinctive Theory

The roots of logical argumentation are in informal logic, a discipline that has the goal of providing criteria and methods to help students identify, analyze and evaluate arguments found in a natural language text of discourse. Logical argumentation originally came out of forty years of experience in teaching critical thinking skills to university students and research studying informal fallacies, and is now being widely used and tested in many fields. It was originally based on collecting many examples of arguments from everyday conversational discourse and from law, analyzing them, visualizing them and evaluating them as case studies, and solving common problems posed by features of the arguments in the case studies. As the simple argument maps presented below show, logical argumentation arises from the practical task of assisting users to analyze and critically evaluate arguments of the kind found in everyday conversational discourse and in other contexts such as legal and scientific argumentation.

However, logical argumentation as a theory is wider than the traditional focus of informal logic, because of its integration with artificial intelligence and because of its aim of providing assistance with the task of argument invention, as well as the tasks of argument identification, analysis and evaluation. Logical argumentation is a theory that can be applied to many fields, including informal logic, speech communication, artificial intelligence and linguistics. It is interdisciplinary, even though it has central affiliations with the field of informal logic, because it has connections in communication studies and is increasingly being applied in computer science, especially in artificial intelligence and multi-agent systems.

The author has written many books on specific topics in argumentation studies and informal logic, and also textbooks meant to explain to students how the methods built and refined in these books can be learned and applied to examples of arguments in everyday conversational discourse. However, there has been no single book that attempts to put all these results together in a unified approach to logical argumentation. This book binds the research results of the findings in computer science together by distilling out of them a distinctive theory underlying an accompanying set of methods for the identification, analysis and evaluation of arguments. It is easy to explain the theory in general outline. But to understand how the theory works, you need to see how it applies to real examples and how it is used to solve significant problems of argumentation. The chapters of this book show the theory being applied to a series of real examples and problems of argumentation. The chapters present examples representing specific instances that give rise to problems to which the theory is applied. The attempts to solve the problems show the methods at work, and cumulatively show how the methods give rise to a general theory that fits them together.

This theory has three broad characteristics as an approach to rational cognition. First, it is procedural, meaning that proving something is taken to be a sequence with a start point, an end point, and an interval in between representing a sequence of orderly steps. The second characteristic is that it does not aim to prove something is true as knowledge that must be accepted beyond all doubt, but recognizes the bounds of human rationality required by the need to make decisions under conditions of uncertainty and lack of knowledge. This second characteristic is called bounded rationality. The third characteristic is the viewing of intelligence as a social process that is not located exclusively in our individual brains. This characteristic holds that two heads are better than one, implying that even when a single agent reasons by deliberating about what to do or what claim to accept based on evidence, it does this best by examining the evidence on both sides, pro and contra. Thus whether one agent is involved or a group of agents is engaged in deciding what to do or to accept based on the evidence, rational thinking is best seen as a dialogue process in

which arguments are put forward by one side and critically questioned by the other side.

2. The Methods and the Theory

Logical argumentation is a distinctive philosophical viewpoint built around a set of practical methods to help a user identify, analyze and evaluate arguments in specialized areas such as law and science, as well as arguments of the kind used in everyday conversational discourse. The method of logical argumentation has twelve defining characteristics.

1. The procedure for examining and criticizing the arguments on both sides forms a dialogue structure in which two sides take turns putting forward speech acts (e.g., making assertions or asking questions).
2. The dialogue has rules for incurring and retracting commitments that are activated by speech acts. For example, when a participant makes an assertion, he or she becomes committed to the proposition contained in the assertion.
3. The method uses the notion of commitment (or acceptance; Freeman, 2005) as the fundamental tool for the analysis and evaluation of argumentation rather than the notion of belief. The reason is that belief is a psychological notion internal to an agent (Walton, 2010a).
4. The method assumes a database of commonly accepted knowledge that, along with other commitments, provides premises for arguments. The knowledge base is set in place at the opening stage, but can be revised as new relevant information needs to be collected and considered.
5. The procedure is dynamic, meaning that it continually updates its database as new information comes in that is relevant to an argument being considered.
6. The arguments advanced are (for the most part) defeasible, meaning that they are subject to defeat as new relevant evidence comes in that refutes the argument.
7. Conclusions are accepted on a presumptive basis, meaning that in the absence of evidence sufficient to defeat it, a claim that is the conclusion of an argument can be tentatively accepted, even though it may be subject to later defeat as new knowledge comes in.
8. The method analyzes and evaluates argumentation concerning a claim where there is evidence for it as well as against it. Thus any argument is subject to critical questioning until closure of the dialogue.
9. The dialogue uses critical questioning as a way of testing plausible explanations and finding weak points in an argument that raise doubt concerning the acceptability of the argument.

10. The method uses standards of proof. Criteria for acceptance are held to depend on standards that require the removal of specifiable degrees of reasonable doubt.
11. The methods applied include defeasible argumentation schemes, deductive arguments, inductive arguments, presumptive arguments and argument visualization software tools.
12. The method comprises the study of explanations as well as arguments, including the form of argument called inference to the best explanation, or abductive reasoning.

There are two (often opposed) models of rational thinking and acting in the literature on cognitive science, and logical argumentation theory has a preference for one of these models as an approach to be taken in applying its methods, even though it acknowledges the need for both of them. The belief-desire-intention (BDI) model is based on the concept of an agent that carries out practical reasoning based on goals that represent its intentions and incoming perceptions that update its set of beliefs. According to the account of rational thinking of the BDI model, an agent has a set of beliefs that are constantly being updated by sensory input from its environment, and a set of desires (wants) that are then evaluated (by desirability and achievability) to form intentions. For example, on Bratman's (1987) version of the BDI model, forming an intention is described as part of adopting a plan that includes the agent's desires (wants) and beliefs.

According to the commitment model, agents interact with each other in a dialogue in which each contributes speech acts. Commitments are statements that the agent has expressed or formulated, either alone or as part of a group deliberation, and has pledged to carry out or has publicly asserted. Each agent has a commitment set, and as the one asks questions that the other answers, commitments are inserted into or retracted from each set, depending on the move, which takes the form of a speech act, that each speaker makes. A commitment is essentially a proposition that an agent has gone on record as accepting as indicated by a transcript or some other evidence that can be used to pin down exactly what the speaker said (Hamblin, 1970; 1971). One highly significant difference between the two models is that desires and beliefs are private psychological notions internal to an agent, while commitments are statements externally accepted by an agent and recorded in an external memory that is transparent to all parties.

The logical argumentation model and its accompanying set of methods take a view of proof and justification different from that taken in current epistemology in analytical philosophy, which is based on a true belief framework. On this approach, knowledge is taken to be true belief plus some third component, usually called justification. On the logical argumentation approach, knowledge is seen as a form of belief firmly fixed by an argumentation procedure that has examined the evidence on both sides, and uses standards of proof to conclude that the proposition in question

can be proved. The justification of proof is that the evidence supporting the proposition is so much stronger than the evidence against it, or doubts that have been raised against it, that the proposition can be accepted as knowledge. However, on this evidentialist approach, knowledge, especially scientific knowledge, must be seen as defeasible. There are two especially important consequences of the view. One is that falsifiability is taken to be a criterion of genuine scientific knowledge. The other is that knowledge does not deductively imply truth.

To sum up, there are four main components of the methods used in logical argumentation theory: argumentation schemes, dialectical structure, argument mapping, and modeling in a computational argumentation system. These four components are described in the next four sections.

3. Argumentation Schemes

Logical argumentation is based on argumentation schemes, such as argument from expert opinion, that represent commonly used types of arguments that are defeasible. The schemes connect arguments together into sequences, often called chaining, by taking the conclusion of one argument as a premise in a subsequent argument. Schemes identify patterns of reasoning linking premises to a conclusion that can be challenged by raising critical questions. The names of some easy to recognize argumentation schemes are listed in Table 1.1.

A more complete list of twenty-nine such schemes will be given in Chapter 4. Some of these schemes appear to be subtypes of others. For example, argument from threat is a species of argument from negative consequences. It has the additional implication that the proponent is stating a readiness to carry out the negative consequences for the respondent.

As an easy example to appreciate, we can give the scheme for argument from expert opinion. It has two premises and a conclusion.

Major Premise: Source *E* is an expert in subject domain *S* containing proposition *A*.

Minor Premise: *E* asserts that proposition *A* is true (false).

Conclusion: *A* is true (false).

The following critical questions represent standard ways of casting the argument into doubt.

CQ_1: *Expertise Question.* How credible is *E* as an expert source?

CQ_2: *Field Question.* Is *E* an expert in the field that *A* is in?

CQ_3: *Opinion Question.* What did *E* assert that implies *A*?

CQ_4: *Trustworthiness Question.* Is *E* personally reliable as a source?

CQ_5: *Consistency Question.* Is *A* consistent with what other experts assert?

CQ_6: *Backup Evidence Question.* Is *E*'s assertion based on evidence?

TABLE 1.1 *Some common argumentation schemes*

Argument from Witness Testimony	Argument from Verbal Classification	Argument from Rule
Argument from Expert Opinion	Argument from Appearances (Perception)	Argument from Threat
Argument from Analogy	Argument from Positive Consequences	Argument from Popular Opinion
Argument from Precedent	Argument from Negative Consequences	Direct *Ad Hominem* Argument (Personal Attack)
Practical Reasoning (Goal-Directed Reasoning to Act)	Circumstantial *Ad Hominem* Argument	Argument from Correlation to Cause
Argument from Evidence to a Hypothesis	Abductive Reasoning	Argument from Commitment
Argument from Ignorance (Negative Evidence)	Argument from Sunk Costs	Slippery Slope Argument

This form of argument is defeasible. If an expert says that a proposition is true, there may be a good reason for accepting it is true, but there may also be good reason for doubting whether it is true once it is pointed out that the expert is biased, for example, by evidence showing that he or she will gain financially from his or her claim. Defeasibility of arguments is very important in the logical argumentation model. The ideal arguer retracts his or her claim if it can be shown to be insufficiently supported by evidence that meets the appropriate standard of proof for accepting it. An ideal arguer is not only one who backs up his or her claims by supporting evidence, but also one who is open-minded. The ideal arguer probes into the reasons behind and those of his or her speech partner, formulating criticisms of his or her arguments. How this process works can be illustrated briefly with some examples.

4. Dialectical Structure

As noted in Section 2, logical argumentation reaches a decision on whether or not to accept a claim based on the arguments both for and against the claim; therefore on the logical argumentation point of view, an argument always has two sides, the pro and contra. They take turns making moves that contain speech acts. Some of the most common speech acts are identified in Table 1.2.

Speech acts are put forward by each participant at each move in the dialogue, and the structure of the dialogue is defined by rules (protocols) that set preconditions and post-conditions for the speech acts used in that type of dialogue.

TABLE 1.2 *Some common types of speech acts*

Speech Act	Dialogue Form	Function
***Question* (yes-no type)**	*S*?	Speaker asks whether *S* is the case
***Assertion* (claim)**	Assert *S*	Speaker asserts that *S* is the case
***Concession* (acceptance)**	Accept *S*	Speaker incurs commitment to *S*
***Retraction* (withdrawal)**	No commitment *S*	Speaker removes commitment to *S*
***Challenge* (demand for proof of claim)**	Why *S*?	Speaker requests that hearer give an argument to support *S*
Put Argument Forward	$P_1, P_2, \ldots, P_n$ therefore *S*	$P_1, P_2, \ldots, P_n$ is a set of premises that give a reason to support *S*

TABLE 1.3 *Example of a profile of dialogue*

Move	Proponent	Respondent
1.	Video games do not lead to violence	Why do you think so?
2.	Dr. Smith says so, and he is an expert	Do you think he could be biased?
3.	What evidence do you have for saying that?	His research is funded by the video game industry
4.	What evidence do you have for saying that?	It was shown by a 2001 investigation of the Parents' Defense League

In the small example dialogue shown in Table 1.3, the proponent begins at move 1 by making a claim. The respondent then puts forward a challenge demanding proof for this claim. At move 2, the proponent takes his turn by putting forward an argument from expert opinion. The respondent then asks a critical question. The proponent then asks for evidence to support the question, and the respondent offers some. However, the proponent asks for further evidence and the respondent offers it.

This small dialogue represents what is called a profile of dialogue, a short sequence of moves that could be part of a much longer sequence of argumentation. These small examples of dialogues need to be put into a wider perspective, viewed as a dialectical process by Freeman (1991, xiii): "We see arguments generated through a challenge-response dialogue where the proponent of some thesis answers critical questions posed by a challenger". So viewed, the structure of arguments takes the form of a procedure that has a start point and an end point.

A dialogue is defined as a 3-tuple $\{O, A, C\}$ where O is the opening stage, A is the argumentation stage, and C is the closing stage. Dialogue rules define what types of moves are allowed. At the opening stage, the participants

TABLE 1.4 *Seven types of dialogue*

Type of Dialogue	Initial Situation	Participant's Goal	Goal of Dialogue
Persuasion	Conflict of Opinions	Persuade Other Party	Resolve Issue
Inquiry	Need to Have Proof	Verify Evidence	Prove Hypothesis
Discovery	Need an Explanation	Find a Hypothesis	Support Hypothesis
Negotiation	Conflict of Interests	Get What You Want	Settle Issue
Information	Need Information	Acquire Information	Exchange Information
Deliberation	Practical Choice	Fit Goals and Actions	Decide What to Do
Eristic	Personal Conflict	Hit Out at Opponent	Reveal Deep Conflict

agree to take part in some type of dialogue that has a collective goal. Each party has an individual goal and the dialogue itself has a collective goal. The initial situation is framed at the opening stage, and the dialogue moves through the opening stage toward the closing stage. In Table 1.4, the type of dialogue is identified in the left column and its main properties are identified in the three matching columns on the right.

In a persuasion dialogue the proponent has a thesis to be proved, his ultimate *probandum*, and the respondent can either have (1) the role of casting doubt on the proponent's attempts to prove his thesis or (2) the role of arguing for the opposite thesis. A rational arguer is one who follows the protocols for the type of dialogue appropriate for the argumentation in which he is engaged and whose arguments conform to the requirements of argumentation schemes. The goal of a persuasion dialogue is to reveal the strongest arguments on both sides by pitting one against the other to resolve the initial conflict posed at the opening stage. Each side tries to carry out its task of proving its ultimate thesis to the standard required to produce an argument stronger than the one produced by the other side. This burden of persuasion is set at the opening stage. Meeting one's burden of persuasion is determined by coming up with a strong enough argument using a chain of argumentation in which individual arguments in the chain are of the proper sort. To say that they are of the proper sort means that they fit argumentation schemes appropriate for the dialogue. 'Winning' means producing an argument that is strong enough to discharge the burden of persuasion set at the opening stage.

In deliberation dialogues decisions are also made, but the starting point of the dialogue is an issue about which action to take to achieve some goal, not an issue about whether a proposition is true or false. The party who raises the issue does not have a burden of persuasion. Indeed, even once positions (proposals for resolving the issue about which action to take) have been put forward in a deliberation dialogue, the parties who put forward the

positions do not necessarily have a burden of persuasion. The proposals may have been put forward during a brainstorming phase of the deliberation, and a party may actually prefer some proposal put forward by some other party, after arguments about the pros and cons have been exchanged.

During the same sequence of argumentation an argument may shift from one type of dialogue to another. In some cases the shifts are based on an underlying embedding from the one dialogue into the other. In that case, the move to the second dialogue can support the chain of argumentation coming from the first type of dialogue. This kind of shift can be a good thing, from an argumentation point of view. For example, in a deliberation, the argumentation may shift to an information-seeking phase where facts relevant to the deliberation are brought into play. In other cases, the shift to the second dialogue can block the argumentation in the first dialogue, in some instances leading to fallacies. The analysis and evaluation of arguments in dialogues is based on procedural rules for the dialogue, as well as notions such as burden of proof and standard of proof, that set requirements for how strong an argument needs to be in order to be judged successful.

The logical argumentation model is normative because it sets standards for logical inference based on argumentation schemes and procedural standards that give requirements for how to take part in a dialogue with a speech partner. These standards can be structured in formal models of dialogue. However, the model is also partly empirical in that its purpose is to study real arguments used in everyday conversational discourse and other special contexts such as legal and scientific reasoning. For this reason, the logical argumentation model is based on the study of real examples of arguments. As well as identifying, analyzing and evaluating arguments used in a given case, logical argumentation also has the capability for constructing arguments. This technology is based on the application of argumentation schemes, with their capability to represent implicit parts of the text, especially implicit premises and conclusions in a chain of reasoning. The given arguments in a knowledge base can be chained forward toward the ultimate conclusion to be proved.

5. Rationale and Araucaria

In its simplest form, an argument diagram, or argument map as it is equivalently called, is composed of two elements: a set of propositions representing premises or conclusions of arguments and a set of arrows representing inferences from some propositions to others. For this reason an argument map is often called a box and arrow diagram, a visual representation of an argument formed by drawing arrows leading text boxes to other text boxes. An argument diagram takes the form of a tree structure in which there is a single proposition representing the ultimate claim or thesis to be proved at the root of the tree. All the other propositions are premises or conclusions that lead along branches of the tree to this root proposition.