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Douglas Walton

Argument Evaluation and Evidence

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For Karen, With Love.

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Contents

Chapter 1
Introduction to Argument and Explanation

Abstract This chapter defines the key notions of evidence and argument to prepare the way for the subsequent chapters. It uses a simple and intuitive example to motivate the reader and to explain how the modeling of the notions of evidence and argument in the subsequent chapters will progress. This chapter is built around the Sherlock Holmes case of the Study in Scarlet written by Sir Arthur Conan Doyle to illustrate Holmes' method of using evidence to arrive at a conclusion by a series of steps by which the evidence accumulates. It uses this example (1) to explain and show how both arguments and explanations contain reasoning, (2) to show how arguments and explanations are woven together in evidential reasoning, (3) to introduce the form of argument called inference to the best explanation, (4) and to show the importance of this form of reasoning for the study of evidential reasoning and argumentation.

This book shows through illustrative and instructive examples how evidence is used in pro and contra argumentation in natural language argumentation on controversial issues, and how the relationships between argument and evidence can be clarified using an argumentation model. In the first three chapters the book poses a series of key problems of evidential reasoning and argumentation. Each problem is posed in a clear and simple way so that anyone can understand the problem, and some argumentation-based tools are applied to the problems in a non-technical manner, paving the way to the solutions achieved in the remaining chapters by applying some recently developed computational models of argumentation made available in artificial intelligence. Hence the book progresses from confronting these problems to introducing argumentation-based tools needed to deal with them, and finally offering solutions to them, along the way building a useful and increasingly sophisticated general method for evaluating arguments.

Section 1.1 provides an outline of the argumentation in the book. Section 1.2 assembles some facts concerning the much disputed case of a cloth stored in a church in Italy that has been claimed by many to be the burial shroud of Jesus of Nazareth. The cloth has markings on it caused by bloodstains forming an image of what appears to be a man who has been crucified. Many books have been written on this case and a good deal of forensic evidence has been assembled by scientists who have tested the materials of the cloth. In Sect. 1.2, some of the basic pro and con

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arguments in the case are articulated and the structure of the evidential reasoning in the case is modeled using an argument diagram. An argument diagram, also called an argument map in artificial intelligence, is a visual structure representing the premises and conclusions in a sequence of argumentation along with the inferential links joining them together. The Turin shroud case is used in Sect. 1.1 to introduce the use of argumentation methods.

Section 1.3 introduces a basic type of reasoning that will be important in the rest of the book, abductive reasoning, often called inference to the best explanation (IBE). We will use these terms interchangeably in the book. Section 1.4 introduces a fictional case of evidential reasoning in which a clever piece of detective work was carried out by Sherlock Holmes, to the amazement of his associate Dr. Watson. This case concerned the first meeting between Holmes and Watson, described in the story *A Study in Scarlet.* Section 1.5 shows how the Study in Scarlet case combines argument and explanation. Section 1.6 presents an example of an explanation built by a group of students working together to learn about the Darwinian theory of evolution in a science class. Section 1.7 gives another example of an explanation of the same phenomenon by a different group of students. These examples are used to show how argument, explanation and evidence need to be combined in a unifying structure.

Section 1.8 shows how the argumentation in the Study in Scarlet case can also be modeled as showing Holmes partly also using a series of explanations to reason backward from conclusions to premises. Section 1.9 carries on with the same case modeled in a third way where the sequence of evidential reasoning contains an important part where one argument attacks another. Section 1.10 gives the reader some indications of how the methods, concepts and tools introduced will be applied to a series of other cases, and the problems they give rise to in the subsequent chapters. This section summarizes ten characteristics of the methods used to analyze the examples.

1.1 Outline of the Book

Schiappa (1995, 2002, 51) has advocated the centrality of argument evaluation "as a direction and purpose for argumentation studies", suggesting by implication that there currently exists no method of argument evaluation in this field. This book argues that there now is such a method that has been developed in artificial intelligence (a field of computer science) and proves it by applying the method with a convincing degree of success to many examples. The book also improves the method by showing how it can be extended to employ the concept of evidence as one of its main components.

Argumentation studies has emerged from several disciplines (including philosophy, speech communication, logic and artificial intelligence), and has led not only to considerable theoretical research but also to software systems for displaying argument structures that can be used to facilitate argumentation. Argument mapping

tools are becoming much more popular in recent years (Scheuer et al. 2010), helping a user to identify and analyze arguments using a visual interface that displays premises and conclusions and sequences of argumentation. The next main problem is to build practical methods of argument evaluation using mapping tools that can be applied to real cases where evidence is used to evaluate arguments used in personal decision-making, law, scientific inquiry and public debate. This book presents a formal and computational model of argumentation that has been developed by computer scientists (working with the author) showing how it can be used to evaluate real arguments. The book illustrates by examples how this tool can be applied to cases in the public domain where scientific evidence presented by experts has to be evaluated by an audience of non-experts. One example is a controversy about whether a painting can be attributed to Leonardo da Vinci, based on forensic evidence collected by experts who disagree. Another example concerns a statistical correlation found between weather patterns in the southern Pacific and flu pandemics, which raised the question of whether there might be a causal connection between these two events, such as migrating bird patterns.

A major problem that is at once theoretical and practical in nature in the field of argumentation studies is to clarify the relationship between the concepts of argument and evidence. This book shows how evidence is used in pro and contra argumentation on controversial issues, and how the relationships between argument and evidence can be clarified on an argumentation model. The book poses a series of key problems of evidential reasoning and argumentation, and offers solutions achieved by applying recently developed computational models of argumentation made available in artificial intelligence. Each problem is posed in a clear and simple way so that anyone can understand the solution, whether or not the reader is an expert in argumentation studies or artificial intelligence. The book progresses from confronting these problems and offering solutions to them, along the way building a general theoretical framework that shows how evidential reasoning and argumentation can be combined.

Using current argumentation methods, this book progresses from confronting these problems and offering solutions to building a general theoretical framework that shows how evidential reasoning and argumentation need to be combined. The book provides a hands-on survey explaining to the reader how to use methods and concepts of argumentation theory that are increasingly being developed in a more sophisticated way through being formalized in computational argumentation systems. Among the tools featured are argument diagrams (also called argument maps), explanation diagrams, methods of combining arguments with explanations, argumentation schemes, and formal computational models of dialogue. For example, argumentation schemes have been applied to collaborative argumentation in examples of arguing to learn (Nussbaum 2008; Nussbaum and Edwards 2011; Macagno and Konstantinidou 2013). It is shown how computational systems can not only be used to model arguments, but also explanations, as well as systematic inquiry procedures in which evidence is brought to bear in a sequence of argumentation used to prove an ultimate claim. It applies argument mapping tools for making argument diagrams that are useful for representing and summarizing arguments

visually. Such argument mapping tools are now used to structure educational interactions (Andriessen and Schwarz 2009). Argument mapping tools are designed to help a user visualize the premises and conclusions of arguments in a graphic structure, and display a sequence of connected argument chained together to support an ultimate conclusion. Empirical research has shown that argument mapping is a useful learning and teaching methodology (Dwyer et al. 2013). The book shows how the use of these tools and methods requires a new approach to the concepts of knowledge and explanation suitable for diverse settings, such as legal argumentation and science education. This book surveys the main methods and tools of argumentation theory that are so far showing promise as being the most useful ones for application to diverse fields, including natural language argumentation and argumentation in specialized domains such as law and science.

The book applies formal models of dialogue that take an argument to be an interaction between two or more parties and that represent different conversational settings of an argument. It is now well recognized that argumentative interactions play an important role in computer-supported collaborative learning (Baker 2003, 47; Nussbaum 2011). Two other notions that are fundamentally important for understanding teaching are the concepts of explanation and knowledge, assuming that education is the transmission of knowledge from the teacher to the students, and that much of what a teacher does can often better be described as explanation rather than argument. The book shows convincingly through a series of examples analyzed using argumentation methods that both arguments and explanations can only be properly understood if configured using formal models of dialogue. Moreover, the book concentrates on one especially important species of argumentation called inference to the best explanation (also often called abductive reasoning) and shows how it needs to be modeled by combining arguments and explanations in a hybrid dialogue structure.

It is widely acknowledged that there is a growing dependence on expert opinion evidence in important matters of public deliberation and in the way evidence is treated in the courts, so much so indeed that any study of evidential reasoning now needs to take this aspect of it into account. For this reason much of the book concerns arguments for and against expert opinions, in a framework in which expertise is defined both in the relationship of an expert to a body of knowledge and in the relationship of an argument from expert opinion to the audience to whom it was addressed as an argument presenting evidence. Through the use of case studies and computational tools from artificial intelligence, the book examines a series of examples of evidence being used in this way, arguing that it can be analyzed as a dialectical procedure with an opening stage, an argumentation stage and a closing stage. By applying these tools, the last chapter that puts forward a theory of evidential reasoning of the kind used in scientific inquiry that links evidential reasoning to arguments that pass through a sequence of argumentation that goes through several stages, typically from a problem formulation stage, to a discovery stage, to a stage where a claim to knowledge is based on a standard of proof.

A theme of the book is that evidential reasoning based on expert opinion testimony needs to be evaluated by basing this kind of argumentation on the

assumption that an expert possesses knowledge in a particular field or domain of expertise. What makes an expert "an expert", on this view, is possession of knowledge. The problem solved by the case study evidence put forward and analyzed in the book is that evidential reasoning can be modeled using resources from argumentation theory, especially argumentation schemes, argument mapping tools, formal dialectical models of evidential procedures, and the combining of these tools as applied to significant problem cases.

This chapter introduces the reader to the investigations in the other chapters of the book by explaining (1) how argumentation theory as a distinctive approach to evidential reasoning basically works, and (2) how some standard argumentation tools are applied to evidential reasoning. These twin aims are carried out by analyzing two simple but realistic examples. The chapter also provides definitions and explanations of key terms and concepts used in argumentation theory that are applied to cases of evidential reasoning in the rest of the book. However, by using such examples the chapter also introduces the reader to some main problems in this emerging field of study.

Chapter 2 analyzes two case studies of murder trials in which the evidential reasoning employed is based on inference to the best explanation and shows to how to model this kind of pro-con argumentation using argument diagramming tools, argumentation schemes, and explanatory story-based scripts. On this approach, one intelligent agent reconstructs the motive of another by drawing an inference from facts and commitments of the other agent using abductive reasoning. This chapter extends the theory of (Walton and Schafer 2006), which provided an argumentation framework for reasoning forward from motive to action, and reasoning backward from action to inferred motive. The use of argument diagrams and explanation diagrams in the chapter provides a way of dealing with the circularity in the use of IBE noticed by Pardo and Allen (2008, 233): a hypothesis explains the evidence, but the evidence helps to justify the hypothesis. This work provides a basis for moving forward to confronting the technical problem of combining argument and explanation in such cases, solved in Chap. 3.

Inference to the best explanation is a form of argumentation that combines argument and explanation, leading to the next three problems. The first problem is how to define the notion of explanation in a way that can make it useful for argumentation studies. The second problem is how to build a set of criteria that can be used to determine in a particular text of discourse whether something should be interpreted as an argument or an explanation. The third problem is how to evaluate explanations so that one explanation can properly be said to be better than another.

Chapters 1 and 2 show how common cases of evidential reasoning are based on abductive reasoning, or inference to the best explanation, and we have seen how inference to the best explanation can be evaluated as a form of argument by asking the appropriate critical questions matching the scheme for the abductive type of argument. Inference to the best explanation works by putting forward an explanation that purports to account for the facts in a given case. At this point we are confronted with three questions of high generality and importance in argumentation, in artificial intelligence and in philosophy: (1) What is an explanation? (2) How can

it be determined by objective criteria whether an explanation is successful (good)? (3) How can it be judged whether one explanation is better than another? These questions are answered in Chap. 3.

Many of the examples studied in this book involve scientific evidence presented by experts in a framework where an expert opinion needs to be used by people who are not themselves experts. Chapter 4 takes an argumentation approach to build a method for evaluating such arguments from expert opinion. The method uses the argumentation scheme for argument from expert opinion along with its matching set of critical questions. It shows how to use this scheme in three formal computational argumentation models that provide tools to analyze and evaluate instances of argument from expert opinion. This chapter offers solutions to key problems of how to apply argumentation tools to analyze and evaluate arguments from expert opinion. It is shown (1) how to use these tools to construct an argument diagram to represent pro and con arguments in a given argument from expert opinion, (2) how to evaluate the arguments and critical questions shown in the diagram, and (3) how to use this structure within a formal computational model to determine whether what the expert says is acceptable or not.

In Chap. 5 a formal and computational argumentation system is used to model the argumentation in a case of conflict among art experts on the attribution of an unsigned portrait of a young woman to Leonardo da Vinci. Forensic investigations were carried out by forensic experts and experts on art history. To begin with, the leading expert opinions were in direct conflict, but as technical investigations took place and new forensic evidence came in, the hypothesis that the painting was a genuine Leonardo[1] became more widely accepted. Chapter 5 presents an analysis of the structure of the interlocking argumentation in the case using a series of argument diagrams to track structure of the mass of evidence. It can be seen that the contested attribution of the painting takes the form of a series of conflicts among experts on art history and forensic evidence.

Chapter 6 extends the analysis of arguments from correlation to cause given in the current argumentation literature where the notion of a cause is analyzed as a set of conditions that are individually necessary for the occurrence of an event, and taken together are sufficient for the occurrence of that event (Walton et al. 2008, Chap. 5). A causal inference is dependent on what is called a *field*, meaning a constellation of factors that hold in an individual case, but where there are conditions of uncertainty, lack of knowledge and even inconsistency, because the situation is highly complex, and the state of the investigation into it can vary. Field-dependence means that argument from correlation to cause is analyzed in the examples as a defeasible form of argument that is subject to critical questioning and counter-arguments.

Chapter 6 is built around analyzing the arguments from correlation to cause in three illustrative examples. It is shown that arguments from correlation to cause are initially scientific arguments used to collect evidence and draw conclusions in

[1]According to Martin Kemp (private email), it is best not to call him ‘da Vinci’, which was not a stand-alone surname at this time.

an investigation, for example by experiments, but then they are also used both by scientists and non-scientists for all kinds of purposes. In Chap. 6 it is shown that argument from correlation to cause is inherently reasonable, and is indeed a common heuristic form of reasoning that we could not do without in scientific research, public policy formation, and most notably in clinical investigations and medical decision-making. But it is also shown that it is a form of argument that is highly variable in dependability, sometimes notoriously leading users to commit the *post hoc* fallacy.

The problems solved in the preceding chapters leads to an underlying problem of great theoretical generality – the problem of how evidential reasoning leads to knowledge. In Chap. 7, CAS is extended to build a procedural view of inquiry in which evidence is marshaled to support or defeat claims to knowledge. Through the use of this procedure, it is shown how the argumentation framework needs to be extended by an evidence-based theory of inquiry. This theory views the collection of evidence as a sequence of moves in a collaborative group inquiry in which agents evaluate what is known or not known.

A central problem of the book, to clarify the relationship between the concepts of argument and evidence, is posed in a pointed way throughout Chaps. 5 and 6. In these chapters the notion of evidence is prominent in the example of forensic evidential reasoning in the case of a da Vinci painting and in a series of examples of evaluating scientific arguments from correlation to causation. CAS defines the concept of an argument, but it is only in Chap. 7 that it is extended to provide some guidance on how to model the concept of evidence in an inquiry. The problem of clarifying how evidence is related to argument generally is reserved for Chap. 8, because it is an issue of such high generality, even though, as the book shows, it is also a central practical problem for argumentation studies as a field.

The book builds the exposition around engaging examples that anyone can understand and models the argumentation in the examples using visual displays. Building on the body of evidence provided by studying these examples, the book relates evidential reasoning in explanation to evidential reasoning in argumentation. Using argument visualization tools to display the structure of arguments and explanations in the examples, it shows how the four fundamental concepts of argumentation theory can be fitted together within a comprehensive and coherent argumentation theory. The four concepts are those of argument, explanation, evidence and knowledge.

1.2 The Shroud of Turin

The shroud of Turin is a long linen cloth kept in the Cathedral of St. John the Baptist in Turin Italy. It is believed by many to be the burial shroud of Jesus of Nazareth. It shows a striking image of a man's face and the whole front of his body as it might be laid out after crucifixion. There are marks on the face and body consistent with wounds of the kind that suggest the manner of Christ's crucifixion. When the image was photographed, its negative presented a much clearer and more impressive

picture that convinced many that what has been preserved is an image of Christ on his burial shroud. The image of the face itself is very impressive. It looks comparable to many images of the face of Jesus found in popular representations. The image of the man represented on the shroud has a mustache, beard, and long hair. The man appears to be muscular and tall. The image itself could be classified as presenting a visual argument (Birdsell and Groarke 1996), a so-called multimodal argument, but we will not try to analyze this aspect of it here.

The shroud is a rectangular cloth that is more than 4 ft long by more than 3 ft wide. Reddish-brown stains that look like bloodstains are found on the cloth showing what appear to be wounds on the body shown in the image on the cloth. One wrist on the cloth shows what appears to be a round wound that could have been from piercing. Other marks that appear on the body look like they could have been from wounds on the torso and legs. Proponents of the authenticity of the image argue that these markings on the shroud are blood drippings of the kind that could occur during crucifixion.

The presence of the shroud in Turin, Italy was attested to in the fourteenth century, but before that time there are no historical records indicating its whereabouts, before that time, or even if it existed previously. Although there are other reports of a shroud thought to be the burial shroud of Jesus before that time, there is no firm evidence that these reports to refer to the same one that is in Turin.

The issue of whether the image depicted on the shroud is a genuine representation of Christ has been a subject of intense debate. Some experts think that the shroud was a medieval forgery, while other writings have argued for authenticity. Forensic investigations included a radiocarbon dating of the shroud in 1980, when the Catholic Church finally agreed to make a small sample of the cloth available for scientific testing. A team of scientific experts on radiocarbon dating at the University of Oxford said that the date of the shroud is between 1260 and 1390. Tests conducted independently by teams of radiocarbon dating experts at the University of Arizona and the Swiss Federal Institute of technology corroborated this dating. This evidence suggested that the shroud is a medieval forgery. These dates match the first known appearance of the shroud recorded from the known facts of its provenance. However, others argued that the sample chosen for testing was introduced in the Middle Ages as a repair fragment.

The controversy suggested by the description of the shroud of Turin case given above has led to further scientific investigations and much writing and argumentation on the subject. But in order to provide the reader with an interesting case that can be used to introduce some basic tools, methods and approaches typical of argumentation, let's take the description of the argumentation presented in the paragraph above as a case study. It is a realistic enough case, despite its incompleteness, to give the reader some idea of how an argument diagram can be used to represent the structure of argumentation in any given text of discourse. Any text of discourse in natural language will contain vagueness, ambiguity, confused or unclear reasoning that is difficult to follow, much less to represent analytically as a logical sequence of reasoning. So there are always decisions to be made on how to model the argumentation in a given text of discourse, and in some cases the best way