Inteligencia Artificial 16(52) (2013), 52-64

INTELIGENCIA ARTIFICIAL

http://journal.iberamia.org/

An Approach to Argumentation Schemes that Appeal to Expert Opinion

Paola D. Budán[2,3], Maximiliano C. D. Budán[1,2,3] and Guillermo R. Simari [2]

[1] Argentinean National Council of Scientific and Technical Research (CONICET), Argentina
[2] AI Research and Development Laboratory (LIDIA) – Universidad Nacional del Sur, Argentina
[3] Universidad Nacional de Santiago del Estero, Argentina
E-mail: pbudan@unse.edu.ar - {mcdb,grs} @cs.uns.edu.ar

Abstract Argumentation is a form of reasoning that deeply resembles the human mechanism for commonsense reasoning. An argumentation scheme is a representational tool for modeling common patterns of reasoning; in particular, it displays the form of an argument by showing how the argument is built using the inferential structures commonly used in everyday discourse. Argument schemes are very useful in contexts such as legal argumentation, scientific argumentation, and especially in Artificial Intelligence applications.

One type of argumentation scheme corresponds to *appeal to Expert Opinion* or *Position-to-Know* argumentation. *Position-to-know* reasoning is typically used in an information seeking type of dialogue where one has to depend on a source. Most of such argumentation frameworks are based on Dung's seminal work characterizing *Abstract Argumentation Frameworks.* In this work, we introduce a novel framework, called *Expert Argumentation Framework* (EAF), extending AF with the capability of modeling the quality of expert associated with the arguments that were proposed.

Resumen La argumentación es una forma de razonamiento que se relaciona profundamente con el mecanismo humano de razonamiento basado en el sentido común. Un esquema de argumentación es una herramienta de representación para modelar patrones comunes de razonamiento. En particular, estos esquemas muestran la forma de un argumento, es decir, cómo se construye el argumento utilizando estructuras inferenciales comúnmente utilizadas en el discurso cotidiano. Los esquemas de argumentación son muy utilizados en contextos como la argumentación legal, argumentación científica y, especialmente, en aplicaciones de Inteligencia Artificial.

Un tipo de esquema de argumentación es aquel que apela a la Opinión Experta o Posición de Conocer. El razonamiento basado en la Posición de Conocer es típicamente utilizado en aquellos diálogos de búsqueda de información donde se depende de una fuente calificada. La mayoría de los marcos de argumentación se basan en el trabajo seminal de Dung que caracteriza un Marco de Argumentación Abstracto (MA). En este trabajo, introduciremos un nuevo marco, llamado Marco de Argumentación Experta (MAE), extendiendo el MA con la capacidad de modelar la calidad del experto asociada con los argumentos que éste propone.

Keywords: Argumentation Schemes, Expert Opinion, Position-to-know, Argumentation Framework, Expert Argumentation Framework.

Palabras Clave: Esquema de Argumentación, Opinión Experta, Posición de Conocer, Marco de Argumentación, Marco de Argumentación Experta.

ISSN: 1988-3064(on-line)

1 Introduction

Argumentation research has contributed with a human-like mechanism to the formalization of commonsense reasoning. In the argumentation process, an agent provides conclusions from certain claims; however, not all agents offer the same conclusions because the evidence set or the reasons from which they depart may be different, and it becomes necessary to determine what conclusions are acceptable. Good examples of the use of this kind of reasoning can be found in the areas of recommender systems and multi-agent systems, among others, where interesting applications have been developed [4, 5, 14].

Argumentation schemes [16, 17] are patterns of thought and expression leading from premises to conclusions in a semi-formal way; these patterns or schemas are used in everyday life and in special contexts such as legal argumentation, scientific argumentation, and *AI* systems in general. This simple device allows to represent arguments in a form that is close to the natural language usually used to represent them in free text.

A particular type of argumentation scheme corresponds to *appeal to Expert Opinion* or *Position-to-Know* argumentation. This reasoning is typically used in a type of dialogue where it is necessary to depend on a source, and this source has recognized authority recognized for her knowledge on the subject under discussion; however, until now, no research have been sufficiently developed as to formalize the structure of these schemes. When experts propose their arguments on a particular topic, it is useful to have a formalism that allows not only formalize the arguments and the relations between them, but also represent the authority of the sources from which the arguments come.

Abstract argumentation frameworks (AF) were defined on Dung's seminal work characterizing this type of frameworks [6]. In such an abstract structure, an argument is considered as an abstract entity where its internal structure remains unspecified, and its role in the framework is solely determined by the attack relation it maintains with other arguments.

In our work, we present an extension of AF, called *Expert Argumentation Framework* (EAF), to allow the representation of three components: the opinion of an expert, the properties associated with it, and the association of a particular expert with an argument. For a proper characterization and formalization of expert's opinions, we will consider the six basic critical questions that support this argument scheme following Walton's formalization of the appeal to expert opinion.

The main contribution of this paper is an improvement of the ability to represent and model the quality of an expert associated with the arguments that were proposed; to that effect we will extend Dung´s framework appropriately. Below, in Section 2, we will present an intuitive example to motivate and illustrate the goals of our work, and the rest of the paper is organized as follows: in Section 3, we will introduce the elements of abstract argumentation; then, in Section 4, we will briefly present argument schemes; in Section 5, we will introduce our proposal and will model the example presented in Section 2. Finally, in Section 6 we discuss the related work, and in Section 7 we offer our conclusions.

2 Motivating Example

There are many fields of study which follow the opinion of different experts in the evaluation of their lines of thought, in finding controversial opinions, advancing research, and therefore, producing scientific and technological advances. With the explosion of information and the proliferation of knowledge sources, it has become necessary to develop criteria, and abstract devices capable of evaluating these sources. In this paper, we take a motivating example from a case study of medicine, and we show how through the analysis of the arguments proposed by different experts, significant progress was made in myocardial re-vascularization. In this part, where we describe the expertise of the researchers, we frequently will use their own words mentioning the sources.

2.1 Description of the Context of our Example

According to Picich(è) [13], the history of myocardial re-vascularization, as is often the case with medical progress, is full of stories of visionary research surgeons, and who were inured to failure, criticism, and skepticism. It may well be that earlier attempts to achieve myocardial re-vascularization constitute a fertile pool of ideas from which current and future researchers can draw to elaborate derivative strategies that employ the tools of modern technology. Myocardial re-vascularization strategies fell into three categories: extra-cardiac procedures, cardiac operations on non-coronary artery structures, and direct coronary artery surgery.

In the words of this expert: "Direct myocardial re-vascularization is the consequence of the monumental work that Mason Sones and collaborators carried out at the Cleveland Clinic beginning in 1958, when selective coronary angiography was introduced. On January, 1962, Effler and his team were able to repair a severe obstruction of the left main trunk coronary artery by the patch graft technique developed by Senning. The same month Sones demonstrated for the first time that Vineberg's concept was correct: by means of collateral circulation the implanted left internal mammary artery could ameliorate the myocardial perfusion deficit of the anterolateral wall of the left ventricle due to a severe obstruction of the left anterior descending branch of the left coronary artery". [7]

In 1966, Favaloro [7] was able to dissect the internal mammary artery through a midline anterior thoracotomy with the aid of a special self-retaining retractor. The author argued that this technique allowed dissecting both right and left internal mammary arteries, leading to the double Vineberg approach. Later, it contributed to the utilization of the mammary artery as an arterial conduit for direct myocardial re-vascularization. The midline anterior thoracotomy's use also allowed to perform combined simultaneous procedures, particularly in patients with abnormal ventricles (ventricular aneurysmectomy or scar tissue resection) or patients with valvular diseases, introducing new concepts based mainly on the overall analysis of patients with coronary arteriosclerosis [7].

2.2 The Experts and their Proposals

In this subsection, we consider three experts in the myocardial re-vascularization treatment and their position on the subject.

Expert René Favaloro ($\mathcal{RF}$):
René Favaloro was an Argentine cardiac surgeon best known for his pioneering work on coronary artery bypass surgery. Favaloro got interested in the developments on cardiovascular interventions, and developed an enthusiasm for thoracic surgery. In the beginning, the major part of his work revolved around valvular and congenital diseases; later on he became interested in other areas. At the beginning of 1967, Favaloro began to consider the possibility of using the saphenous vein in coronary surgery. He put his ideas in practice for the first time in May of that year. The basic principle was to bypass a diseased (obstructed) segment in a coronary artery in order to deliver blood flow distally. The standardization of this technique, called bypass or myocardial re-vascularization surgery, was the fundamental work of his career, which ensured that his prestige would transcend the limits of that country, as the procedure radically changed the history of coronary disease. In 1970 he published a book called Surgical Treatment on Coronary Arteriosclerosis, and published it in Spanish with the name *Tratamiento Quirúrgico de la Arteriosclerosis Coronaria.*

The Expert $\mathcal{RF}$ puts forward the following arguments:

A_1 The development of direct coronary artery surgery by the saphenous vein graft technique for the first time provides a method that immediately increases the supply of oxygen to the myocardium.

A_2 The main indication for saphenous vein graft repear is the presence of total or subtotal obstruction in a dominant right coronary artery. The right coronary artery is dominant when its distal portion perfuses the diaphragmatic wall of both right and left ventricles.

A_3 Saphenous vein graft is applicable to subtotal obstruction, but also permits restoration of the right coronary circulation in patient with total obstruction.

Expert Vasiliy Kolessov ($\mathcal{VK}$):
Vasiliy Kolessov studied general surgery between 1934 and 1938 at the surgery department, headed by Professor Vasiliy Parin. Retiring in 1953, Kolessov headed surgery department of First Leningrad

Medical Institute and held that position until 1976. In mid-fifties of 20th century, Kolessov learned about an experiment of Demikhov, who successfully used vascular stapler to make end-to-side anastomosis between internal mammary artery (IMA) and coronary artery (CA). On February 25, 1964, Vasiliy Kolessov made the first successful coronary artery bypass grafting on a human being in the world. Through a left-side off-pump thoracotomy, the left IMA of a working heart was anastomosed with a left circumflex coronary artery. The surgeon used special scissors and optical instruments. That was the beginning of modern coronary surgery. Kolessov published his first results and the book on direct myocardium re-vascularization "Surgical Treatment of Ischemic Heart Disease". However, despite excellent the results of Kolessov's experimental surgery, his innovations were not an easy pill to swallow to medical community of those times. Medical community understood the benefits of arterial grafts over autovein-grafts since they preserved permeability longer. Another advantage of Kolessov's techniques was that patients after mammary-coronary bypass grafting survived more often.

The Expert $\mathcal{VK}$ advocates the following argument:

B_1 The use the saphenous vein is not the best alternative because it presents similar blockages to the coronary arteries. So mammary arteries are used.

Expert Andreas Grüntzig ($\mathcal{AG}$):
Andreas Grüntzig's first successful coronary angioplasty treatment on an awake human was performed in 1977, in Zurich, Switzerland. He expanded a short, about 3 mm, non-branching section of the Left Anterior Descending (LAD) artery (the front branch of the left coronary artery) which supplies the front wall and tip of the heart which had a high grade stenosis. Dr. Grüntzig presented the results of his first four angioplasty cases at the 1977 American Heart Association (AHA) meeting, which led to widespread acknowledgement of his pioneering work. The excellent results of this initial and subsequent patients were critical to the rapid development and growing acceptance of the angioplasty treatment option. Dr. Grüntzig recognized multiple important issues early: (a) the treatment would not be readily accepted by most physicians, especially bypass surgeons, (b) it could easily lead to bad outcomes without great care in selection of which patients/lesions to treat and of the treating physicians, and (c) it required careful teaching of the technique and its potential difficulties and pitfalls to other physicians, so as to proactively reduce the occurrence of poor results. Understanding these issues and tireless effort on his part are widely recognized in cardiology for being of fundamental importance to the ultimate success of the technique. [9, 12]

The Expert $\mathcal{AG}$ affirms that:

C_1 Coronary angioplasty is the treatment of choice for myocardial re-vascularization. Coronary angioplasty is the treatment of choice for myocardial re-vascularization. It is a non surgical treatment that allows for faster patient recovery.

In the next section we will introduce a form of representing the relation between arguments where their interplay can be better understood. This representation is an abstract form of depicting that relation over what it is called an attack graph.

3 A Framework for Abstract Argumentation

Dung [6] introduced the notion of *Abstract Argumentation Framework* (AF) as a convenient abstraction for studying certain properties in defeasible argumentation systems [15, 8]. In an AF, an argument is regarded as an abstract entity with unspecified internal structure, and its role in the framework is completely determined by the relation of attack it maintains with other arguments; this attack relation means that both arguments cannot be accepted simultaneously. Although the only representational components in an AF are a set of arguments and the attack relation defined between them, the structure's theoretical richness has produced a vast number of results in the form of different semantics; *i.e.*, ways to describe which arguments in the original set can be accepted together. The following definition captures the elements in this abstract entity.

Definition 1 (Argumentation Framework [6]) *An argumentation framework (AF) is a pair described as $\langle AR, Attacks \rangle$, where AR is a set of arguments, and Attacks is a binary relation on AR, i.e., the relation Attacks is such that $Attacks \subseteq AR \times AR$.*

The relation *Attacks* is such that if $(A, B) \in Attacks$ then we say that A attacks B, or that B is attacked by A. In a similar manner, extending the relation of attack, we will say that the set S attacks X when there exists at least an argument $A \in S$, such that $(A, X) \in Attacks$. It is also of interest to study sets of arguments that satisfy the following property.

Definition 2 (Conflict-freeness) *Let AF= $\langle AR, Attacks \rangle$ be an argumentation framework. A set of arguments $S \subseteq AR$ is called* conflict-free *if there are no arguments $A, B \in S$ such that $(A, B) \in Attacks$.*

Informally, given an AF, an argument A is considered *acceptable* if it can be defended, possibly using arguments in AR, from all the arguments in AR that attack it (also called *attackers*). This intuition is formalized in the following definitions, originally presented in [6].

Definition 3 (Acceptability Semantics) *Let AF= $\langle AR, Attacks \rangle$ be an argumentation framework.*

- *An argument $A \in AR$ is* acceptable *with respect to a set $S \subseteq AR$ iff for each $B \in AR$, if B attacks A then there is $C \in S$ such that $(C, B) \in Attacks$; in such case it is said that B is attacked by S and that A is defended by S.*

- *A conflict-free set S is* admissible *iff each argument in S is acceptable with respect to S.*

- *An admissible set $S \subseteq AR$ is a* complete extension *of AF iff S contains each argument that is acceptable with respect to S.*

- *An admissible set $S \subseteq AR$ is a* preferred extension *of AF iff S is maximal with respect to set inclusion..*

- *An admissible set $S \subseteq AR$ is the* grounded extension *of AF iff S is a complete extension that is minimal with respect to set inclusion.*

- *A conflict free set $S \subseteq AR$ is a* stable extension *iff S attacks each argument which does not belong to S.*

There exist characterizations of other sets that are admissible and satisfy different properties. To calculate these sets is to find the argumentative semantics corresponding to a given argument framework AR. Some of them are complete, grounded, preferred, stable, semi-stable, ideal, SCC, *etc.* There is a method for finding these semantics by using a labeling procedure. For further information see [2], where an excellent survey can be found.

Grounded semantics is important because it presents the characteristic property of having at most one extension. Dung presented in [6] a fixed-point characterization of the grounded semantics based on the characteristic function F defined below.

Definition 4 *Let $\langle AR, Attacks \rangle$ be an AF. The associated characteristic function $F : 2^{AR} \rightarrow 2^{AR}$, is $F(S) =_{def} \{A \in AR \mid A \text{ is acceptable w.r.t. } S\}$.*

The following proposition suggests a way to compute the grounded extension associated with a *finitary* AF, *i.e.*, such that each argument $A \in AR$ is attacked by at most a finite number of arguments, by iteratively applying the characteristic function starting from $\emptyset$. See [3, 11] for more details on argumentative semantics.

Proposition 1 ([6]) *Let $AF = \langle AR, Attacks \rangle$ be a finitary argument framework. Let $i \in N \cup \{0\}$ such that $F^i(\emptyset) = F^{i+1}(\emptyset)$. Then $F^i(\emptyset)$ is the least fixed point of F, and corresponds to the grounded extension associated with the AF.*

Example 1 *In this example, we represent as an abstract argumentation framework the scenario introduced in Section 2, showing the argumentation graph in Figure 1.*

$AR = \{A_1; A_2; A_3; B_1; C_1\}$

$Attacks = \{(B_1, A_1); (B_1, A_2); (B_1, A_3); (C_1, A_1); (C_1, A_2); (C_1, A_3); (C_1, B_1)\}$

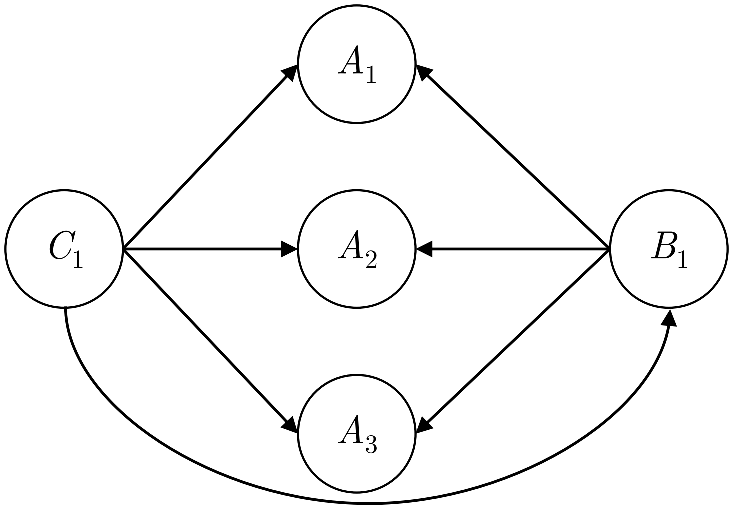

Figure 1: Argumentation Framework (AF)

The set $S = \{C_1\}$ is admissible, because it defends all the arguments it contains, and it is also a complete extension due the fact that it contains all the arguments in AR it defends. Finally, it can be verified that S is the minimal set satisfying the previous conditions, and therefore it corresponds to the grounded extension of AR. Below, we show how to calculate the grounded extension by applying the fixed point characterization from Prop. 1.

$F^0(\emptyset) = \emptyset$

$F^1(\emptyset) = F(\emptyset) = \{C_1\}$

$F^2(\emptyset) = F(\{C_1\}) = F^1(\emptyset)$

4 Argumentation Schemes

Argumentation schemes [16, 17] are argumental forms that facilitate the representation of the inferential structures corresponding to arguments that are usually used in everyday discourse; in particular, they are of much interest in special contexts that require their representational capability like in the area of legal argumentation, the structuring of scientific and philosophical argumentation, and especially in the many uses found in Artificial Intelligence.

Although deductive or inductive forms of inference are very usual, from an argument scheme a different alternative it is offered, from which it is possible to obtain defeasible arguments; this means that this arguments can receive rebuttals other agents. Defeasible argumentation gives rise to certain argumentation schemes in which an agent tries to convince another agent of accepting a particular position; but this position, which is represented by a set of arguments, can be criticized, attacked and defeated. Thus, the resulting scheme itself can be considered defeasible and presumptive.

Argument schemes reveal a way of thinking, therefore, a way of arguing. They determine a pattern of thought that answers to certain questions that are considered as decisive, or as is common refer to them, as critical. So, an argument scheme demonstrates a sensible approach for who presents the arguments, and for the listener as well, who can either accept or attack them. The balance of the reasons for or against a certain argument is made in response to the aforementioned critical questions.

One type of argumentation scheme corresponds to *appeal to Expert Opinion or Position-to-Know* argumentation. *Position-to-know* reasoning is typically used in an information seeking type of dialogue where one has to depend on a source. Where a is a source of information, the following argumentation schema represents the form of *position-to-know* argumentation (see Figure 2):

– Is a in a position to know whether A is true (false)?

– Is a an honest (trustworthy, reliable) source?

– Did a assert that A is true (false)?

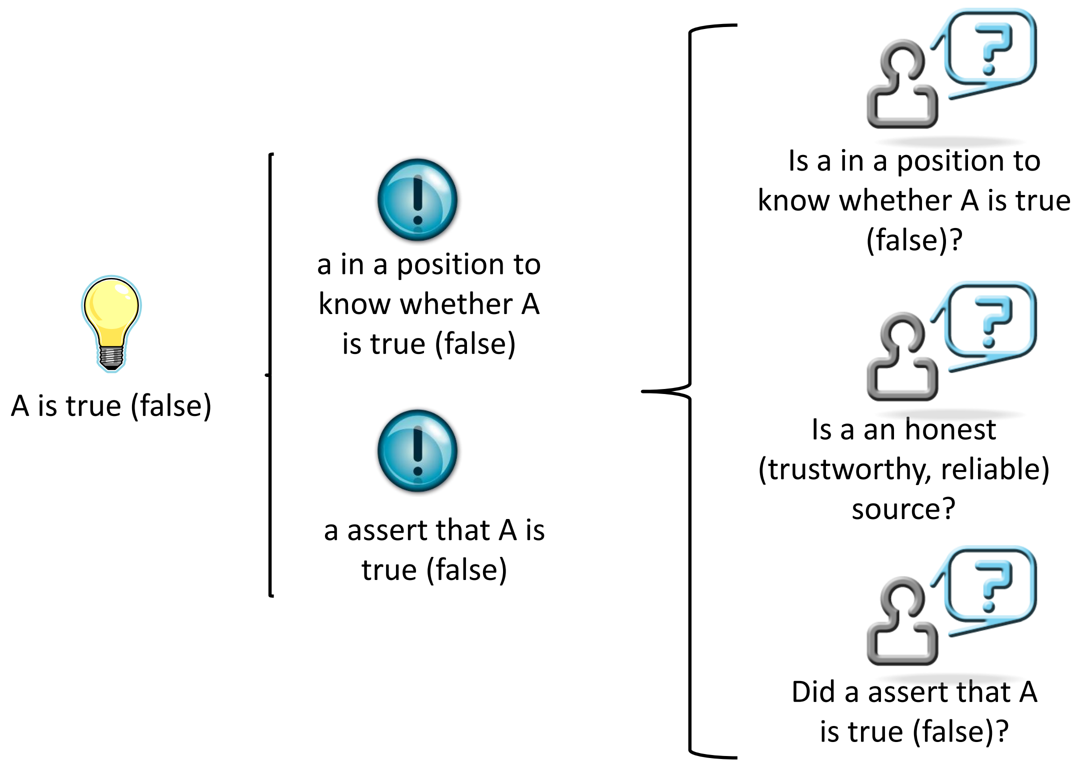

Figure 2: Argumentation Scheme - Position-to-Know Argumentation

According to Walton [16], the form of argument may appear as plausible, but also as defeasible. Therefore, it can be critically questioned in a dialogue by raising doubts about the truth of either a premise or by asking whether a is an honest (trustworthy) source of information. The second critical question concerns the credibility of the source.

The appeal to expert opinion, sometimes also called *argument from expert opinion*, is an important subclass of *position-to-know* reasoning. It is based on the assumption that the source is alleged to be in a position to know about a subject because he or she has expert knowledge of that subject.

Appeal to expert opinion should, in most typical cases, be seen as a plausible but defeasible form of argumentation. The six critical basic questions matching the appeal to expert opinion are listed below [16]:

1. Expertise Question: How credible is $\mathcal{E}$ as an expert source?

2. Field Question: Is $\mathcal{E}$ an expert in the field that A is in?

3. Opinion Question: What did $\mathcal{E}$ assert that implies A?

4. Trustworthiness Question: Is $\mathcal{E}$ personally reliable as a source?

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

6. Backup Evidence Question: Is $\mathcal{E}$ assertion based on evidence?

The idea behind using critical questions to evaluate appeals to expert opinion is dialectical. The assumption is that the issue to be settled by argumentation in a dialogue hangs on a balance of considerations. One can critically question an appeal to expert opinion by raising doubts about any of the premises and the critical questions represent a guide for the process.

5 Argumentation Framework of an Argumentation Scheme that appeals to Expert Opinion

Recently, the field of application of the argumentation has been expanded; additionally, there have been numerous studies that have demonstrated the value of argumentation schemes. However, there have been no investigations developed enough as to formalize the structures of these schemes. When different experts argue and counter-argue over a particular topic, it is useful to have a formalism that allows not only to formalize the arguments and the relations between them, but also to weight the expert that is providing them; it is important to note that the experts must belong to the same domain.

In this section, we will present an extension of AF called *Expert Argumentation Framework* (EAF), that takes in consideration the quality of expert that proposes the arguments.

Definition 5 *An* Expert Argumentation Framework (EAF) *is a 4-tuple* $\langle AR, EXP, Asserts, Attacks\rangle$ *where:*

- *AR is a set of arguments.*

- *Let E be a set of experts, and Υ a relevance measure, then $EXP \subseteq E \times \Upsilon$ is the set of graded experts represented as a pair $(\mathcal{X}, \alpha)$, where $\mathcal{X} \in E$ represents the expert introducing the argument and $\alpha \in \Upsilon$ is the relevance measure corresponding to the expert $\mathcal{X}$.*

- *$Asserts$ is a binary relation defined as part of $EXP \times AR$, that determines which expert claims or wields what argument, i.e., $Asserts \subseteq EXP \times AR$.*

- *$Attacks$ is a binary relation between the elements of $Asserts$, i.e., $Attacks \subseteq Asserts \times Asserts$, where $\big(((\mathcal{X}, \alpha), A), ((\mathcal{Y}, \beta), B)\big) \in Attacks$ iff $\alpha \geq \beta$.*

Note that, in the definition of *Attacks* the relevance measure of the expert who attacks an argument must be greater than or equal to the relevance measure of the expert who introduces the argument; furthermore, the definition of *Asserts* allows to model and to differentiate those arguments that can be put forward by different experts. To obtain the relevance measure associated to the expert, we analyze the features of the expert based on the scheme proposed by Walton [16, 17, 18].

Definition 6 *Let $(\mathcal{X}, \alpha)$ be a graded expert of* EXP*. The component $\mathcal{X}$ is an expert in E and $\alpha \in \Upsilon = \mathbb{N} \cup \{0\}$ is the relevance measure of $\mathcal{X}$, such that α is obtained as $\alpha = E + T + R + C + V$ where:*

– E *denotes that the argument comes from a credible expert in the subject.*

– T *denotes that the argument comes from a trusted expert in the field.*

– R *the expert is personally reliable as a source.*

– C *the argument is consistent with the arguments from another experts.*

– V *the assertions are based on evidence.*

Thus, given a property in the list E, T, R, C *and* V*, we will assign a 1 when the property is fulfilled and a 0 when it is not, obtaining a range from 0 to 5 for an expert.*

We will refer to graded experts just as experts when no confusion can arise. The following example exercises the definitions just introduced.

Example 2 *In this example, we present a formalization and characterization of the experts according to Definition 6, based on the description thereof presented in the Section 2.*

We can characterize the Expert Favaloro as $(\mathcal{RF}, 4)$ *from the following assessments:*

- *The argument relating to bypass or myocardial re-vascularization surgery comes from a credible expert in the subject* (E=1).
- *The argument relating to bypass or myocardial re-vascularization surgery comes from a trusted expert* (T=1).
- *Favaloro is reliable as a source in this matter* (R=1).
- *It is not possible to ensure that the arguments introduced by Favaloro are totally consistent with the arguments coming from other experts* (C=0).
- *Favaloro's assertions are based on evidence* (V=1).

We can characterize Expert Kolessov as $(\mathcal{VK}, 4)$ *given that:*

- *The argument relating to anastomosis between internal mammary artery and coronary artery comes from a credible expert in the subject* (E=1).
- *The argument relating to anastomosis between internal mammary artery and coronary artery comes from the trusted expert* (T=1).
- *Kolessov is reliable as a source* (R=1).
- *It is not possible to ensure that the arguments introduced by Kolessov are totally consistent with the arguments from other experts* (C=0).
- *Kolessov's assertions are based on evidence* (V=1).

We can characterize the Expert Grüntzig as $(\mathcal{AG}, 3)$ *given that:*

- *The argument put forward by Grüntzig comes from a credible expert in the subject* (E=1).
- *The argument claim for Grüntzig comes from the trusted expert* (T=1).
- *Grüntzig is not completely reliable as a source, because he died young and the technique proposed is still being tested* (R=0).
- *It is not possible to ensure that the arguments introduced by Grüntzig are totally consistent with the arguments from other experts* (C=0).
- *Grüntzig's assertions are based on evidence* (V=1).

The admissible, complete and grounded extensions of an EAF are now defined following the ones introduced for Dung's frameworks [6]:

Definition 7 *Let* $\Theta = \langle AR, EXP, Asserts, Attacks\rangle$ *be an expert argumentation framework.*

- *A set* $S \subseteq Asserts$ *is called* e-conflict-free *if there is no pair of arguments* $\big((\mathcal{X},\alpha),A\big), \big((\mathcal{Y},\beta),B\big)$ *in* S *such that* $\Big(\big((\mathcal{X},\alpha),A\big),\big((\mathcal{Y},\beta),B\big)\Big) \in Attacks$.

- *A pair* $\big((\mathcal{X},\alpha),A\big) \in Asserts$ *is* e-acceptable *with respect to a set* $S \subseteq Asserts$ *iff for each* $\big((\mathcal{Y},\beta),B\big)$ *in Asserts, if* $\big((\mathcal{Y},\beta),B\big)$ *attacks* $\big((\mathcal{X},\alpha),A\big)$ *then there is an argument* $\big((\mathcal{Z},\gamma),C\big) \in S$ *such that* $\Big(\big((\mathcal{Z},\gamma),C\big),\big((\mathcal{Y},\beta),B\big)\Big) \in Attacks$*; in such case it is said that* $\big((\mathcal{Y},\beta),B\big)$ *is attacked by* S.

- *An e-conflict-free set* S *is* e-admissible *iff each argument in* S *is e-acceptable with respect to* S.

- *An e-admissible set* $S \subseteq Asserts$ *is an* e-complete extension *of EAF iff* S *contains each argument that is e-acceptable with respect to* S.

- *A set* $S \subseteq Asserts$ *is the* e-grounded extension *of EAF iff* S *is a e-complete extension that is minimal with respect to set inclusion.*

Furthermore, we adapt the fixed-point characterization of the grounded semantics based on the characteristic function F presented by Dung [6].

Definition 8 *Let* Θ *be an EAF. The associated characteristic function* $F : 2^{Asserts} \to 2^{Asserts}$*, is* $F(S) =_{def} \{\big((\mathcal{X},\alpha),A\big) \in Asserts | \big((\mathcal{X},\alpha),A\big)$ *is acceptable w.r.t.* $S\}$.

Example 3 *As this example shows, attacks that come from relevant experts whose measure is less than that of the expert who wields the attacked argument are disregarded (as the attacks of* C *to the other arguments do). In the proposed framework, when we consider that an argument attacks another, we take into account the characteristics of the expert who is introducing it; in contrast, in Dung´s framework the attack means defeat without cosidering the characteristics of the expert who supports that argument. Below is the formal characterization of the situation in our running example.*

$AR = \{A_1; A_2; A_3; B_1; C_1\}$

$EXP = \{(\mathcal{RF}, 4); (\mathcal{VK}, 4); (\mathcal{AG}, 3)\}$

$Asserts = \{\big((\mathcal{RF},4),A_1\big); \big((\mathcal{RF},4),A_2\big); \big((\mathcal{RF},4),A_3\big); \big((\mathcal{VK},4),B_1\big); \big((\mathcal{AG},3),C_1\big)\}$

$Attacks = \{\Big(\big((\mathcal{VK},4),B_1\big),\big((\mathcal{RF},4),A_1\big)\Big); \Big(\big((\mathcal{VK},4),B_1\big),\big((\mathcal{RF},4),A_2\big)\Big); \Big(\big((\mathcal{VK},4),B_1\big),\big((\mathcal{RF},4),A_3\big)\Big)\}$

The set $S = \{\big((\mathcal{AG},3),C_1\big); \big((\mathcal{VK},4),B_1\big)\}$ *is e-admissible, since it defends all the arguments contained in it. The set* S *is also e-complete since it contains all the arguments in* AR *being defended by* S*. Finally, it can be verified that* S *is the minimal set satisfying the previous conditions, and therefore it corresponds to the e-grounded extension of* AR*. Next, we show how to obtain the grounded extension by applying the fixed point characterization from Prop. 1.*

$$F^0(\emptyset) = \emptyset$$

$$F^1(\emptyset) = F(\emptyset) = \{\big((\mathcal{AG},3),C_1\big)\}$$

$$F^2(\emptyset) = F(\{\big((\mathcal{AG},3),C_1\big)\}) = \{\big((\mathcal{AG},3),C_1\big); \big((\mathcal{VK},4),B_1\big)\}$$

$$F^3(\emptyset) = F(\{\big((\mathcal{AG},3),C_1\big); \big((\mathcal{VK},4),B_1\big)\}) = F^2(\emptyset)$$

6 Related Work

In 2008, Hunter [10] presented a framework for meta-reasoning about object-level arguments that allows for the presentation of richer criteria for determining whether an object-level argument is warranted.

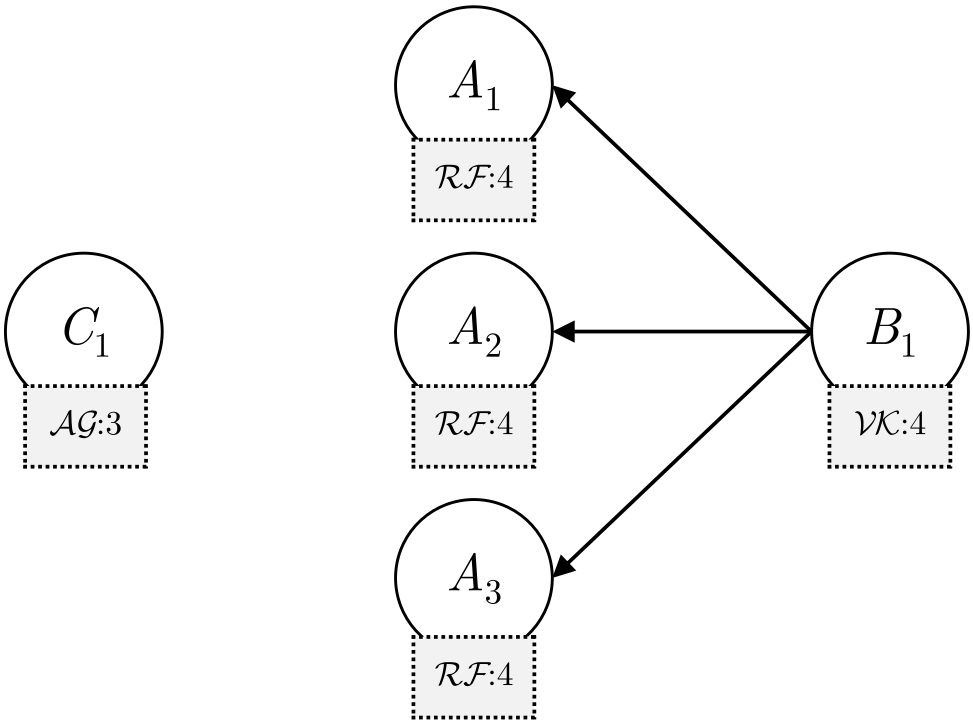

Figure 3: Expert Argumentation Framework (EAF)

These criteria can use meta-information corresponding to the arguments, including the proponents and provenance of the arguments; and an axiomatization using this framework for reasoning about the appropriated conduct of the experts that introduce the arguments. It shows how it can conform to some proposed properties for expert-based argumentation.

Hunter describes a formal approach to modelling argumentation providing ways to present arguments and counterarguments, and evaluating which arguments are, in a formal sense, warranted. He proposed a way to augment representation and reasoning with arguments at the object-level with a meta-level system for reasoning about the object-level arguments and their proponents. The meta-level system incorporates axioms for raising the object-level argumentation to the meta-level (an important case is to capture when an argument is a counterargument for another argument), and meta-level axioms that specify when proponents are appropriated for arguments. The meta-level system is an argumentation system to the extent that it supports the construction and comparison of meta-level arguments and counterarguments.

The implementation of our form of attack using preferences was introduced by Amgoud and Carol work [1]. In this work, they presented the acceptability of arguments in preference-based argumentation (PAF), taking into account preference relations between arguments in order to select the most acceptable arguments. The use of preferences enables to model a notion of individual defense. This investigation was based on acceptability by taking into account individual and joint acceptability, and by combining purely logical criteria and preference orderings for comparing arguments. Our combination with argument schemas was not mentioned in any of these two approaches.

7 Conclusions and Future Work

Argumentation has contributed to the study and formalization of commonsense reasoning with a human-like mechanism. In a general sense, argumentation can be associated with the interaction of arguments for and against conclusions, with the purpose of determining which conclusions are acceptable. One form of advancing in the representation of arguments is called Argumentation Schemes.

In this paper we presented a novel formalism for the schemas corresponding to *Position-to-Know* *argumentation* or *appeal to Expert Opinion* proposed by Walton [16, 17], formalism is understood as an extension of Dung's frameworks [6]. The focus of our extension is to consider as part of the formalism the characteristics required for an expert, and the relationship between an expert and the arguments put forward by him; for this we have proposed EAF as a 4-tuple $\langle AR, EXP, Asserts, Attacks\rangle$ which contains a set of arguments, a set of experts or proponents that support arguments, a relation that determines who puts forward the argument, and an attacks relation between arguments that depend on the relevance measure of experts that claim the arguments.

The expert hability is described by the use of the relevance measure, which is obtained by considering the expert's characteristics as proposed by Walton[16]. These features refer to the qualities of the experts in the domain on a specific topic, and the evidence on which they base their arguments, and they can take the value 0 or 1.

As lines of future research, firstly it is necessary to refine the definition of the 5-tuple containing the properties of the expert, so as not to consider just a binary value giving the possibility that these properties can be weighed; secondly, we need to analyze and study the extensions to the classical semantics proposed by Dung within the proposed framework. Moreover, it seems necessary to formalize other argumentation schemes that were also proposed by Walton [16], since little research has been done over such formalization of their structures; that will open the possibility of an implementation using for example Defeasible Logic Programming [8].

References

[1] Leila Amgoud and Claudette Cayrol. On the acceptability of arguments in preference-based argumentation. In *Proceedings of the Fourteenth conference on Uncertainty in artificial intelligence*, pages 1–7. Morgan Kaufmann Publishers Inc., 1998.

[2] Pietro Baroni, Martin Caminada, and Massimiliano Giacomin. An introduction to argumentation semantics. *Knowledge Engineering Review*, 26(4):365–410, 2011.

[3] Pietro Baroni and Massimiliano Giacomin. Semantics of abstract argument systems. In *Argumentation in Artificial Intelligence*, pages 25–44. Springer, 2009.

[4] Trevor J.M. Bench-Capon and Paul E. Dunne. Argumentation in artificial intelligence. *Artificial Intelligence*, 171(10):619–641, 2007.

[5] Philippe Besnard and Anthony Hunter. *Elements of argumentation*, volume 47. MIT press Cambridge, 2008.

[6] Phan Minh Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and¡ i¿ n¡/i¿-person games. *Artificial intelligence*, 77(2):321–357, 1995.

[7] René G. Favaloro. Critical analysis of coronary artery bypass graft surgery: a 30-year journey. *Journal of the American College of Cardiology*, 31(4s2):1B–63B, 1998.

[8] Alejandro J. García and Guillermo R. Simari. Defeasible Logic Programming: An Argumentative Approach. *Theory and Practice of Logic Programming*, 4(1):95–138, 2004.

[9] Andreas Grüntzig. The unlocking of the coronary arteries: origins of angioplasty. *European Heart Journal*, 30:1421–1428, 2009.

[10] Anthony Hunter. Reasoning about the appropriateness of proponents for arguments. In *Proceedings of the 23rd AAAI Conference on Artificial Intelligence, Chicago, Illinois*, 2008.

[11] Sanjay Modgil and Martin Caminada. Proof theories and algorithms for abstract argumentation frameworks. In *Argumentation in artificial intelligence*, pages 105–129. Springer, 2009.

[12] Richard L. Mueller and Timothy A. Sanborn. The history of interventional cardiology: cardiac catheterization, angioplasty, and related interventions. *American heart journal*, 129(1):146–172, 1995.

[13] Marco Picichè. The history of myocardial revascularization before the advent of cardiopulmonary bypass. In *Dawn and Evolution of Cardiac Procedures*, pages 65–77. Springer, 2013.

[14] Iyad Rahwan and Guillermo R. Simari. *Argumentation in artificial intelligence.* Springer, 2009.

[15] Guillermo R. Simari and Ronald P. Loui. A Mathematical Treatment of Defeasible Reasoning and its Implementation. *Artificial Intelligence*, 53(1–2):125–157, 1992.

[16] Douglas Walton. Justification of argumentation schemes. *Australasian journal of logic*, 3:1–13, 2005.

[17] Douglas Walton. *Fundamentals of critical argumentation.* Cambridge University Press, 2006.

[18] Douglas Walton. Visualization tools, argumentation schemes and expert opinion evidence in law. *Law, Probability and Risk*, 6(1-4):119–140, 2007.