Argumentation and Dialogue in Artificial Intelligence

Syllabus for Tutorial T12, IJCAI 2005

Trevor J.M. Bench-Capon and Paul E. Dunne
Department of Computer Science, University of Liverpool
Liverpool L69 7ZF, U.K.
{tbc,ped}@csc.liv.ac.uk

1. **Introduction and Overview**
   Distinguishing the notions of "proof" and "argument"; practical reasoning examples; concepts of argument status; argument frameworks.

2. **Modelling Sets of Arguments**
   Formal definition of "Argument System"; arguments and attacks; concept of "acceptable argument"; defining "admissible" sets of arguments; overview of assumption based argumentation frameworks.

3. **Strengths of Arguments and Audiences**
   Refining the concept of "successful attack"; Preference-based argument frameworks; Value-based argument frameworks.

4. **Dialogue Based on Argumentation Frameworks**
   Introduction to dialogue in argumentation; dialogue types and protocols; two-party immediate response disputes (TPI) and properties.

5. **Structure of Arguments**
   Argument Schema and their motivation; Toulmin's argument schema and developments of this; problems with argument schema.

6. **Example Studies**
   Analysis of some selected legal cases couched in terms of Value-based argument frameworks.

7. **Summary**

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Introduction to Tutorial T12

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Trevor J.M. Bench-Capon and Paul E. Dunne
Department of Computer Science
University of Liverpool
Liverpool L69 7ZF, U.K.
{tbc,ped}@csc.liv.ac.uk

1 Argument and Proof

In Artificial Intelligence reasoning is often modelled on the presentation of a proof. In some domains and for some topics this is entirely appropriate, but if we look at the justifications of reasoning offered in practice, they often fall short of the standards required by proof.

Whereas a proof compels us to accept the conclusion if we accept the premises, natural language justifications tend to be open to objections: they may persuade, but they rarely compel. Such justifications are always defeasible: they succeed if the objections that are made are met, but the process of objection is complete only when the party to whom the justification is presented is content. Such defeasible justifications may be termed arguments.

Objections can arise from a number of sources:

- arguments tend to leave some premises implicit, presupposing that the audience will agree with the information. But it may be necessary to make such premises explicit if these presuppositions are not satisfied.
- arguments tend to use vague, imprecise and open textured terms. All of these need to be given precise definitions if they are to form part of a proof.

- arguments tend to be "open world": they typically admit of objections arising from exceptional cases.
- arguments may be made even when we are uncertain of particular facts.

So in domains where we have incomplete, uncertain, or imprecise information, or where too much background is presupposed to allow everything to be explicit we must use arguments rather than proofs.

Arguments can be seen as *prima facie* justifications, which are acceptable so long as there is no objection which cannot be met satisfactorily.

These objections themselves take the form of arguments and may attack a number of points in the original justification:

- we may have an argument for the negation of the conclusion
- we may have an argument for negation of one of the premises
- we may have an argument that the rule is inapplicable.

These attacks apply to an argument with a *modus ponens* like structure. There are other structures for arguments each of which have their own characteristic ways of being attacked.

Practical reasoning – reasoning about action – provides an important area of reasoning in which proof is not possible, and we must rely on arguments. Whereas we cannot choose what we believe, we can choose what we will try to make the case. Given the scope for choice, there is room for rational disagreement, and demonstration that an action is correct is not possible.

Practical reasoning comes with its own distinctive form of argument, which can be expressed as:

- I wish to bring about some state of affairs S
- I can bring about S by performing A
- Therefore, I should perform A

This can be attacked by arguments which

- show that S is not desirable
- show that A will not bring about S
- declare that S can be brought about in other ways

- point to undesirable side effects of A

To use arguments to justify a belief or an action, we must propose an argument, and then defend it against other arguments which attack it. Arguments must therefore be considered in the context of other related arguments.

This issue can be explored using the notion on argumentation framework, which consists of a set of arguments and the attack relations between them. Given such a framework, we can then attempt to determine the status of the arguments within it.

2 Argumentation Frameworks

Dung [25] defines an argumentation framework as follows.

Definition 1 *An* argumentation framework *is a pair* $\langle \mathcal{X}, \mathcal{A} \rangle$ *where* $\mathcal{X}$ *is a set of* arguments *and* $\mathcal{A}$ *is a binary relation on* $\mathcal{X}$*, i.e.* $\mathcal{A} \subseteq \mathcal{X} \times \mathcal{X}$.

For two arguments x and y, the meaning of $\langle x, y \rangle \in \mathcal{A}$ is that x represents an attack on y. We also say that a *set of arguments* S attacks an argument y if y is attacked by an argument in S. An argumentation framework is conveniently represented as a directed graph $\mathcal{H}(\mathcal{X}, \mathcal{A})$ in which the arguments are vertices and edges represent attacks between arguments. This picture of underlies much of our discussion.

The key question to ask about such a framework is whether a given argument, $x \in \mathcal{X}$, should be accepted. One reasonable view is that an argument should be accepted only if every attack on it is rebutted by an accepted argument. This notion produces the following definitions:

Definition 2 *An argument* $x \in \mathcal{X}$ *is* acceptable *with respect to the set of arguments* S*, if:*

$$\forall y \in \mathcal{X} \ \langle y, x \rangle \in \mathcal{A} \ \Rightarrow \ \exists z \in S \textit{ such that } \langle z, y \rangle \in \mathcal{A}$$

Here we can say that z *defends* x, and that S defends x, since an element of S defends x.

Definition 3 *A set* S *of arguments is* conflict-free *if*

$$\forall \ x, \ y \in S \ \langle x, y \rangle \notin \mathcal{A} \textit{ and } \langle y, x \rangle \notin \mathcal{A}$$

A conflict-free set of arguments S *is* admissible *if for each* x *in* S*,* x *is acceptable with respect to* S*. A set of arguments* S *in an argumentation framework* $\mathcal{H}(\mathcal{X}, \mathcal{A})$ *is a* preferred extension *if it is a maximal (with respect to set inclusion) admissible subset of* $\mathcal{X}$*.*

The notion of a preferred extension is interesting because it represents a consistent position which can defend itself against all attacks and which cannot be further extended without introducing a conflict. We can now view a credulous reasoner as one who accepts an argument if it is in at least one preferred extension, and a sceptical reasoner as one who accepts an argument only if it is in all preferred extensions.

From Dung [25] we know that a preferred extension always exists, (this, however, could be the empty set) and that it is not generally true that there is a *unique* preferred extension. In the special case where there is a unique preferred extension we say the dispute is *resoluble*, since there is only one set of arguments capable of rational acceptance.

Alternative definitions of acceptability are also possible: instead of the preferred extension we may use the grounded extension, or the stable extension.

Within such a framework, we can classify the complexity of a number of problems as has been summarised in Table 1.

Problem	Description	Complexity
ADM$(\mathcal{H}, S)$	Is S admissible?	P
PREF-EXT$(\mathcal{H}, S)$	Is S preferred?	CO-NP–complete
STAB-EXT$(\mathcal{H}, S)$	Is S stable?	P
HAS-STAB$(\mathcal{H})$	Does $\mathcal{H}$ have a stable ext.	NP–complete
CA$(\mathcal{H}, x)$	Is x accepted credulously	NP–complete
SA$(\mathcal{H}, x)$	Is x accepted sceptically	Π_2^p–complete
COHERENT$(\mathcal{H})$	Is $\mathcal{H}$ coherent	Π_2^p–complete

Table 1: Complexity of Problems Relating to Argumentation Frameworks

An accessible introduction to complexity classes such as Π_2^p is given in Papadimitriou [51].

To conclude we briefly mention the important *assumption-based* framework of Bondarenko *et.al* [13] with which there are close links with Dung's formalism. A central idea of the former is to treat "arguments" and "attacks" not as primitive, atomic elements (as they are within [25]), but rather as constructs derived from a set of *assumptions*. This view provides a powerful general technique with which *default reasoning* and various non-monotonic logics can be modelled.

An assumption-based framework is defined with respect to some formal deductive system $\langle \mathcal{L}, \mathcal{R} \rangle$ with $\mathcal{L}$ the well-formed sentences of some formal language, e.g. the set of propositional formulae; and $\mathcal{R}$ a set of *inference* *rules* defining how "new" sentences in $\mathcal{L}$ may be derived. Given such a system an assumption-based framework is defined as a triple $\langle T, Ab, \overline{} \rangle$ with T a subset of $\mathcal{L}$ describing a given collection of *beliefs* and $Ab \subset \mathcal{L}$ a *non-empty* set of *assumptions* that are to be used to "extend" T. The component $\overline{}$ maps assumptions α into sentences, $\overline{\alpha}$ of $\mathcal{L}$ called the *contrary* (of α). The concepts of "conflict-free" and various admissibility semantics are defined with respect to whether a subset, Δ of assumptions can extend the starting belief set T in such a way that the resulting theory $T \cup \Delta$ does not allow the derivation of both an assumption α *and* its contrary $\overline{\alpha}$.

The formal deductive system is a significant element in such frameworks: in particular, as has been shown in Dimopoulos, Nebel, and Toni [19, 20, 21] the complexity of problems analogous to those given in Table 1 is linked to the complexity of the "derivability" problem in the supporting logic.

3 Strengths of Arguments and Audiences

In Dung's framework, an attack of one argument on another is assumed to succeed. But this is not always appropriate: sometimes we may choose which argument to accept.

Choice arises in particular when the argument is justifying an action: then choice may be determined by how we rank social values, attitude to risk, or other factors. Different people may make different choices: this means that an argument which is persuasive to one audience may fail to persuade another audience which makes different choices. The notion of an audience is explored in the writings of Perelman, e.g. [55].

To accommodate the notion of audience we may extend the standard argument framework of Dung to include audiences. Two approaches that have been considered are the *Preference Based* argumentation frameworks of Amgoud and Cayrol [2] and the *Value Based* argumentation frameworks of Bench-Capon [10].

The preference based scheme of [2] captures a concept of "audience" through a relationship over *arguments*. Formally,

Definition 4 *A* Preference Based argumentation framework *(PAF) is a triple $\langle \mathcal{X}, \mathcal{A}, Pref \rangle$ where $\langle \mathcal{X}, \mathcal{A} \rangle$ is an argument framework and $Pref \subset \mathcal{X} \times \mathcal{X}$ is a* preference *relation that is transitive and asymmetric.*

Thus $\langle x, y \rangle \in Pref$ is interpreted as "the *argument* x is preferred to the *argument* y". The key idea is that an attack $\langle x, y \rangle \in \mathcal{A}$ may fail not only because of the presence of a defender for y but also because $\langle y, x \rangle \in Pref$, i.e. $\langle x, y\rangle \in \mathcal{A}$ is a *successful attack* (in the terminology of [2] x *defeats* y) only if $\langle y, x\rangle \notin Pref$. In such terms the concepts of "conflict-free", "acceptable", and "admissible" are enriched via,

Definition 5 *For a PAF $\langle \mathcal{X}, \mathcal{A}, Pref\rangle$, and x, $y \in \mathcal{X}$, x* defeats *y if $\langle x, y\rangle \in \mathcal{A}$ and $\langle y, x\rangle \notin Pref$. A subset S is* conflict-free *if for each x, y in S if $\langle x, y\rangle \in \mathcal{A}$ then $\langle y, x\rangle \in Pref$. An argument x is* acceptable *to S if for every $y \in \mathcal{X}$ if y defeats x then there is some $z \in S$ such that z defeats y. A conflict-free set, S, is* admissible *if every $x \in S$ is acceptable to S. Finally, S, is a preferred extension if it is a maximal (with respect to set containment) admissible set.*

Any preference relation $Pref$ induces a standard argumentation framework by including *only* those $\langle x, y\rangle \in \mathcal{A}$ for which $\langle y, x\rangle \notin Pref$, i.e. such that x defeats y. Now, since $Pref$ is *asymmetric* this induced framework is acyclic and its preferred extension (which corresponded to the *grounded extension*) is unique, non-empty, and efficiently computable.

While these properties are compelling indicators of the practical efficacy of "audience related" enhancements to Dung's schema, there are, however, a number of issues that PAFs do not address. Thus, Bench-Capon [10] promotes the view of audiences being captured in the observation that advancing an argument x is not only a statement of "belief" in the argument itself *but also* of any "values" endorsed by x.

To record the values associated with arguments we need to add to the standard argumentation framework a set of values, and a function to map arguments on to these values.

Definition 6 *A* value-based argumentation framework *(VAF) is a 5-tuple: $VAF = \langle \mathcal{X}, \mathcal{A}, V, \eta, P\rangle$, where $\langle \mathcal{X}, \mathcal{A}\rangle$ is an argument framework, V is a non-empty set of* values*, η is a function which maps from elements of $\mathcal{X}$ to elements of V and P is the set of* possible audiences*. We say that an argument x* relates *to value v if accepting x promotes or defends v: the value in question is given by $\eta(x)$. For every $x \in \mathcal{X}$, $\eta(x) \in V$.*

The set P of audiences is introduced because, following Perelman, we want to be able to make use of the notion of an audience. Audiences are individuated by their preferences between values. We therefore have potentially as many audiences as there are orderings on V. We can therefore see the elements of P as being names for the possible orderings on V. Any given argumentation will be assessed by an audience in accordance with its preferred values. We therefore next define an *audience specific* value based argumentation framework, AVAF:

Definition 7 *An* audience specific value-based argumentation framework *(AVAF) is a 5-tuple:* $VAF(\alpha) = \langle \mathcal{X}, \mathcal{A}, V, \eta, \succ_\alpha \rangle$*, where* $\mathcal{X}$*,* $\mathcal{A}$*,* V *and* η *are as for a VAF,* α *is an audience, and* $\succ_\alpha$ *is a* value-preference relation *(transitive, irreflexive and asymmetric) over* $V \times V$ *reflecting the value preferences of audience* α*. We write* v_1 *is preferred to* v_2 *as* $v_1 \succ_\alpha v_2$*. The AVAF relates to the VAF in that* $\mathcal{X}$*,* $\mathcal{A}$*,* V *and* η *are identical,* $\alpha \in P$ *and* $\succ_\alpha$ *is the set of preferences derivable from the ordering* α *in the VAF.*

Our purpose in extending argumentation frameworks was to allow us to distinguish between one argument attacking another, and that attack succeeding, so that the attacked argument is defeated. We therefore define the notion of defeat for an audience:

Definition 8 *An argument* x defeats *an argument* y *for audience* α *if and only if both* $\langle x, y \rangle \in \mathcal{A}$ *and* $\neg(\eta(y) \succ_\alpha \eta(x))$*.*

It is useful to note the difference between the notion of defeat in PAFs and that in VAFs. For $\langle x, y \rangle \in \mathcal{A}$, "$x$ defeats y" in PAFs means "the *argument* y is not preferred to the *argument* x"; in VAFs, however, "x defeats y" means "the *value* promoted by the argument y is not superior (in the view of the audience α) to the *value* promoted by the argument x"

Note that an attack succeeds if both arguments relate to the same value, or if no preference between the values has been defined. If V contains a single value, or no preferences are expressed, the AVAF becomes a standard AF. If each argument can map to a different value, we have a Preference Based Argument Framework in the sense of Amgoud and Cayrol [2]. In practice we expect the number of values to be small relative to the number of arguments. Many disputes can be naturally modelled using only two values. Note that defeat is only applicable to an AVAF: defeat is always relative to a particular audience.

Dung [25] introduces the important notions, described in section 2, of acceptability, conflict free set, admissible set, and preferred extension for AFs. We next need to define these notions for an AVAF.

Definition 9 *An argument* x *is* acceptable to audience α *with respect to a set of arguments* S*, if: for each* $y \in \mathcal{X}$ *if* y *defeats* x *for* α *then there is some* $z \in S$ *that defeats* y *for* α*.*

A set S *is* conflict-free for audience α *if*

$$\forall x, y \in S \quad \langle x, y \rangle \in \mathcal{A} \;\Rightarrow\; \eta(y) \succ_\alpha \eta(x)$$

A conflict-free for audience α *set* S *is* admissible for an audience α *if every* $x \in S$ *is acceptable to audience* α *with respect to* S*.*

A set of arguments S in a value-based argumentation framework is a preferred extension for audience α *if it is a maximal (with respect to set inclusion) admissible for audience α subset of $\mathcal{X}$.*

Now for a given choice of value preferences $\succ_\alpha$ we are able to construct an argument framework equivalent to the AVAF, by removing from the set of attacks $\mathcal{A}$ those attacks which fail because faced with a superior value.

Thus for any AVAF, $VAF(\alpha) = \langle \mathcal{X}, \mathcal{A}, V, \eta, \succ_\alpha \rangle$ there is a corresponding argument framework, $AF(\alpha) = \langle \mathcal{X}, \mathcal{D} \rangle$, such that an element $\langle x, y \rangle \in \mathcal{A}$ is an element of $\mathcal{D}$ if and only if x defeats y for α. The preferred extension of $AF(\alpha)$ will contain the same arguments as $VAF(\alpha)$, the preferred extension for audience α of the VAF. Note that if $VAF(\alpha)$ does not contain any cycles in which all arguments pertain to the same value, $AF(\alpha)$ will contain no cycles, since the cycle will be broken at the point at which the attack is from an inferior value to a superior one. Hence both $AF(\alpha)$ and $VAF(\alpha)$ will have a unique, non-empty, preferred extension for such cases.

When we consider a range of audience, we may identify three new categories of acceptability for arguments, according to whether they are acceptable to all audiences (*objective acceptance*), some audiences (*subjective acceptance*) or no audiences (*indefensible*):

Definition 10 *Given a VAF, $\langle \mathcal{X}, \mathcal{A}, V, \eta, P \rangle$, an argument $x \in \mathcal{X}$ is* objectively acceptable *if and only if for all $\alpha \in P$, x is in the preferred extension for audience α.*

An argument $x \in \mathcal{X}$ is subjectively acceptable *if and only if for some $\alpha \in P$, x is in the preferred extension for audience α.*

An argument which is neither objectively nor subjectively acceptable (such as one attacked by an objectively acceptable argument with the same value) is said to be indefensible.

Deciding into which of these categories a given argument falls is hard:

- Subjective Acceptance is NP-complete.
- Objective Acceptance CO-NP-complete
- Deciding if a value ordering is critical is harder than either of these.

None the less there are some positive results. For example

- For a given audience, there is a unique, non-empty preferred extension, and an efficient algorithm to determine it.
- Given S there is an efficient algorithm to discover the class of audiences for which S is the preferred extension.

4 Dialogue

Because argumentation, with its notions of attack and counterattack, is intuitively adversarial in nature, it is natural to relate argumentation to a dialogue in which two parties attempt to persuade one another. Dialogue games have been used for sometime (e.g. MacKenzie [46], who used them to characterise logical fallacies and Gordon [36] who used them to identify the points of disagreement between parties to a legal case). Dialogue games have been related to argumentation frameworks also, such as Bench-Capon *et al.* [12], which bases the game on the Argument Schema of Toulmin [67] and Dunne and Bench-Capon [29] in which the game uses Dung's argumentation framework. Kowalski *et al.* [42] observe that procedures such as the TPI dialogue games introduced in Vreeswijk and Prakken [70] and analysed in [29], as well as variants of this, e.g. Cayrol *et al.* [15], Doutre and Mengin [23], may be viewed as "forward-reasoning" proof search mechanisms: they propose an alternative "backward-reasoning" technique within the assumption-based framework, proving its soundness and completeness with respect to the credulous admissibility semantics. Other recent work includes the concept of "graduality" in Cayrol and Lagasquie-Schiex [16]; the dialogue scheme outlined in Doutre *et al.* [24] for "position analysis" in Value-based frameworks; and the preliminary study of so-called "Examination Dialogues" (modelling, among other ideas, one of the classical techniques of Socratic dialogue) presented in Dunne *et al.* [33].

Typically a dialogue will begin with one party making a claim and proceed with the other party attacking that claim and the original party defending it. The moves available to attack and defend claims will vary according to the particular dialogue game, and different games will offer more or less rich sets of moves. Typically the dialogue will terminate with a winner when one of the parties has no move available to continue the dialogue.

Casting the argument as a formally constrained dialogue allows a number of issues to be explored, such as: the complexity of the dispute; strategies for dispute; and the procedures under which disputes may be conducted.

5 Structure of Arguments

So far we have considered arguments as entirely abstract. There are, however, situations in which it is helpful to consider the structure of arguments, for example if we wish to automate the generation of arguments, or to explore the attack relation in more detail.

The most general way to structure arguments is as deductions. Here an argument will be seen as a sequence of rule applications leading from known premises or assumptions to a conclusion.

This approach has a number of advantages:

1. It is uniform
2. Any desired logic may be used to guide the inference
3. Generation of arguments is straightforward
4. The notion of derivation is well defined and understood

There are, however, disadvantages. Not all arguments can be put into this form without some distortion, and the uniformity of the approach can obscure some subtle differences between arguments. To meet these difficulties a variety of argument schemes have been proposed.

One popular scheme is that proposed by Toulmin [67]. This scheme decomposes arguments into a number of components: *claims* whose truth we seek to establish by the argument, *data* that we appeal to as the grounds for the claim, and *warrants* which provide the rules of inference that connect the data and the claim. Warrants can, in Toulmin's scheme, bestow varying degrees of support for the claim, and these degrees of support are indicated by the use of a modal *qualifier*, such as "necessarily" or "possibly". There may also be exceptional conditions which prevent the claim from being established: these are indicated by the *rebuttal* which contains circumstances acknowledged as requiring the authority of the warrant to be put aside. Warrants also require some justification: this is the role of the *backing*.

This scheme, although entirely general, has proved popular, and has some intuitive appeal in that it is able to distinguish different roles played by various premises, and embodies ideas of defeasibility. It has been used as the basis of dialogue games in Bench-Capon *et al.* [12] and Bench-Capon [7].

In addition a number of more specific, special purpose, arguments schemes have been proposed, by e.g. Perelman and Olbrech-Tyteca [54] and Walton [72]. One classic example is the Argument From Authority:

- X says that P
- X is an authority on matters relating to P
- Therefore, P

Such argument schemes have their attractions, in that it is clear that, as a matter of fact, such arguments are advanced in practice. But there are problems

- argument schemes often embody fallacious patterns of reasoning
- argument schemes are often ill-defined

For these reasons it is hard to formalise such schemes and to determine what arguments represent acceptable uses of the schemes.

Despite these difficulties, argument schemes are widely employed in the analysis of natural argument, and it appears that their understanding is crucial to realizing the full potential of argument based approaches. We may therefore expect argument schemes to be receive an increasing degree of attention in the future.

6 Examples

We conclude with two examples.

One small example is the moral dilemma of a diabetic who loses his insulin and considers taking the insulin of another diabetic in order to preserve his life. Can he take the insulin? And if he does take the insulin, must he provide compensation?

The more extended example concerns of body of legal case law. The particular cases form an example widely used in training law students.

The facts of the chosen cases are:

Keeble v Hickergill (1707). This was an English case in which Keeble owned a duck pond, to which he lured ducks, which he shot and sold for consumption. Hickergill, out of malice, scared the ducks away by firing guns. The court found for Keeble.

Pierson v Post (1805). In this New York case, Post was hunting a fox with hounds. Pierson intercepted, killed and carried off the fox. The court found for Pierson.

Young v Hitchens (1844). In this English case, Young was a commercial fisherman who spread a net of 140 fathoms in open water. When the net was almost closed, Hitchens went through the gap, spread his net and caught the trapped fish. The case was decided for Hitchens.

Ghen v Rich (1881). In this Massachusetts case, Ghen was a whale hunter who harpooned a whale which subsequently was not reeled in, but was washed ashore. It was found by a man called Ellis, who sold it to Rich. According to local custom, Ellis should have reported his find, whereupon

Ghen would have identified his lance and paid Ellis a fee. The court found for Ghen.

Conti v ASPCA (1974). In this New York case, Chester, a parrot owned by the ASPCA, escaped and was recaptured by Conti. The ASPCA found this out and reclaimed Chester from Conti. The court found that they were within their rights to do so.

New Mexico vs Morton (1975) and Kleepe vs New Mexico (1976). These cases concerned the ownership of unbranded burros normally present on public lands, which had temporarily strayed off them.

These have been represented as a Dung style argumentation framework in Bench-Capon [8]. In addition the arguments can be associated with their purposes to instantiate a value based argument framework. The arguments identified and their associated values are shown in Table 2.

This example shows both how case law can be described as an argumentation framework and how the use of values can explain

- different intuitions and dissenting opinions
- different decisions in different jurisdictions
- different decisions as culture changes

7 Summary

We may summarise as follows:

- Arguments are important when modelling reason, since proof is not possible in a variety of domains.
- Arguments are defeasible: they are attacked by other arguments and must defend themselves if they are to be acceptable.
- In consequences, arguments must be considered in the context of related and conflicting arguments.
- Argumentation frameworks give us a means of analysing sets of arguments to determine their status.
- Arguments relating to action often offer a choice between alternatives, which the audience is free to resolve according to their preferences.
- Argumentation frameworks can be extended to accommodate the notion of audiences.

ID	Argument	Attacks	Values
A	Pursuer had right to animal		Claim
B	Pursuer not in possession	A,T	Clear law
C	Owns the land so possesses animals	C	Property
D	Animals not confined by owner	C	Clear law
E	Effort promising success made by pursuer to secure animal	B,D	Clear law
F	Pursuer has right to pursue livelihood	B	Livelihood
G	Interferer was trespassing	S	Property
H	Pursuer was trespassing	F	Property
I	Pursuit not enough (JUSTINIAN)	E	Clear law
J	Animal was taken (JUSTINIAN)	I	Clear law
K	Animal was mortally wounded (Puffendorf)	I	Clear law
L	Bodily seizure is not necessary (Barbeyrac), interpreted as animal was brought within certain control (TOMPKINS)	I	Clear law
M	Mere pursuit is not enough(TOMPKINS)	E,O	Clear law
N	Justinian is too old an authority (LIVINGSTON)	J	
O	Bodily seizure is not necessary (Barbeyrac) interpreted as reasonable prospect of capture is enough (LIVINGSTON)	I,M	Useful Activity
Q	The land was open	G,H,C	Property
S	Defendant in competition with the plaintiff	E,F	Livelihood
T	Competition was unfair	S	Livelihood
U	Not for courts to regulate competition	T	Role of Court
V	The iron holds the whale is an established convention of whaling.	B,U	Common Practice
W	Owners of domesticated animals have a right to regain possession	B	Property
X	Unbranded animals living on land belong to owner of land	D	Property
Y	Branding establishes title	B	Property
Z	Physical presence (straying) insufficient to confer title on owner	C	Clear law

Table 2: Arguments in the Example Cases

- Dialogue provides a natural way of modelling the process of argument between disputing parties.
- We can analyse the structure of arguments using argumentation schemes, which may range from the entirely general to the very specific.
- We can apply the above notions to quite extensive disputes, such as an evolving body of legal case law.

Annotated Selected Bibliography

It is noted that there is an extensive literature covering topics that are relevant to the overview presented in this tutorial: reasons of space preclude presentation of a more detailed survey. A number of the articles and monographs discussed below present excellent comparative surveys of related work, thus providing a valuable source of further reading. Omission of specific items should not be interpreted as a comment on their merits.

References

[1] A. Aleven. *Teaching Case Based Argumentation Through an Example and Models.* PhD Thesis, The University of Pittsburgh. (1997)

This describes CATO, a program designed to teach case based argumentation to law students. It is based in the domain of US Trade Secrets law, extends the ideas of [3], and represents the factor based approach to reasoning with legal cases.

[2] L. Amgoud and C. Cayrol. A reasoning model based on the production of acceptable arguments, *Annals of Math. and Artificial Intelligence*, **34**, 197–215, (2002)

Introduces the model of *Preference-Based Argumentation Frameworks* (PAF). These together with the VAF model of [9, 10] are one of the main mechanisms which seek to extend [25] by accounting for concepts of attacks which only succeed if the position promoted is not outranked by the position attacked.

[3] K. Ashley. *Modeling Legal Argument: Reasoning with Cases and Hypotheticals.* Cambridge, MA: MIT Press, (1990)

Describes the influential HYPO system, developed with Edwina Rissland, which models reasoning with legal cases in the domain of US Trade Secrets Law. It introduces several important notions, including dimensions for the representation of cases, the three-ply argument scheme for legal argument, and argument moves using legal cases such as citation, distinguishing and counter examples.

[4] K. Atkinson, T. Bench-Capon, and P. McBurney. Computational Representation of Persuasive Argument. Technical Report ULCS-04-006, Department of Computer Science, Univ. of Liverpool, (2004) (submitted)

Provides an account of persuasive action over argumentation based on a argument scheme and associated critical questions.

[5] K. Atkinson, T. Bench-Capon, and P. McBurney. A Dialogue Game Protocol for Multi-Agent Argument Over Proposals for Action. *First International Workshop on Argumentation in Multi-Agent Systems (ArgMAS2004)*, LNAI 3366, Springer-Verlag, pages 149–161, (2004) (extended version, in press *Jnl. of Autonomous Agents and Multi-Agent Systems*

Provides denotational semantics for the account of persuasive argument given in [4]

[6] T. J. M. Bench-Capon. Argument in Artificial Intelligence and Law *Artificial Intelligence and Law*, **5**(4):249–61, (1997)

A survey of the uses made of argument in Artificial Intelligence in Law up to 1996.

[7] T. J. M. Bench-Capon. Specification and Implementation of Toulmin Dialogue Game. In: J. C. Hage *et al.* (ed.): *Legal Knowledge Based Systems*, pages 5–20. (1998)

A further extension of ideas initiated in [12]. This gives a complete set of moves for a game based on Toulmin's schema, together with an operational semantics for them, and describes an implementation of the game in Prolog.

[8] T.J.M. Bench-Capon. Representation of Case Law as an Argumentation Framework. In T. Bench-Capon, Daskalopoulu, A., and Winkels, R., (eds) *Legal Knowledge and Information Systems, Proceedings of Jurix 2002.* IOS Press: Amsterdam. pages 103–112. (2002).

This paper formalises the wild animals cases discussed in the tutorial as an Argumentation Framework in the style of [25]

[9] T. J. M. Bench-Capon. Agreeing to differ: modelling persuasive dialogue between parties with different values, *Informal Logic*, **22**(3):231–45 (2003).

Augments the Value Based Argumentation Framework described in [10], by describing a dialogue game based on the TPI game of [29].

[10] T. J. M. Bench-Capon. Persuasion in Practical Argument Using Value Based Argumentation Frameworks, *Journal of Logic and Computation*, **13**(3):429–48 (2003).

Introduces *Value-based Argumentation Frameworks* establishing uniqueness of preferred extension, efficient computational properties, and defining the ideas of Subjective and Objective Acceptance.

[11] T.J.M. Bench-Capon. Try To See It My Way: Modelling Persuasion in Legal Discourse. *Artificial Intelligence and Law*, **11**(4):271–87 (2003)

Gives a full account of the wild animals cases discussed in the tutorial.

[12] T. J. M. Bench-Capon, P. E. Dunne, and P. H. Leng. A dialogue game for dialectical interaction with expert systems. In *Proc. 12th Annual Conf. Expert Systems and their Applications*, pages 105–113, (1992).

One of the first formalisations combining dialogue style techniques with a precisely defined argument scheme - that of Toulmin [67].

[13] A. Bondarenko, P. M. Dung, R. A. Kowalski, and F. Toni. An abstract, argumentation-theoretic approach to default reasoning, *Artificial Intelligence*, **93**(1–2):63–101, (1997).

Dung's argument systems described in [25] have concepts of "argument" and "attack" as atomic concepts. This article takes "assumptions" as atomic illustrating various approaches to deriving arguments and attacks (in the sense of [25]) from sets of these.

[14] C. Cayrol, S. Doutre, and J. Mengin. Dialectical proof theories for the credulous preferred semantics of argumentation frameworks. In *Sixth European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty (ECSQARU-2001)*, pages 668–679. LNAI, 2143, Springer-Verlag, (2001).

[15] C. Cayrol, S. Doutre, and J. Mengin. On decision problems related to the preferred semantics for argumentation frameworks. *Journal of Logic and Computation*, **13**(3):377–403 (2003).

These articles (and [23]) address algorithms for computing preferred extensions via a dialogue game. This game is couched in terms of the general classification presented in [41].

[16] C. Cayrol and M.C. Lagasquie-Schiex. Graduality in Argumentation. *Jnl. of A.I. Research*, **23**:245-297, (2005)

Describes a view of argumentation as based on the exchange and valuation of interacting arguments followed by the selection of the most acceptable. Introduces "graduality" in the selection of the best arguments to partition the set of the arguments into more than the two usual subsets of "selected" and "non-selected" arguments. Proposes new acceptability classes and a refinement of existing classes taking advantage of an available "gradual" valuation.

[17] G. Christie. *The Notion of an Ideal Audience in Legal Argument.* Kluwer Academic, Dordrecht, (2000).

This applies the idea of an audience proposed in [54] to law, and in particular provides an account of how and why there are differences between jurisdictions.

[18] F. Dignum (Editor). *Advances in Agent Communication.* LNAI, 2922, Springer-Verlag, 2004

Section IV includes a number of recent papers on dialogue in the setting of multi-agent system applications. For other multi-agent system based analyses of dialogue, the articles [47, 48, 49, 50, 52, 53, 61] provide a good overview of current approaches.

[19] Y. Dimopoulos, B. Nebel, and F. Toni. Preferred arguments are harder to compute than stable extensions. In *Proceedings of the 16th International Joint Conference on Artificial Intelligence (IJCAI99)*, (Ed., T. Dean), pages 36–43, San Francisco, Morgan Kaufmann (1999)

See [21].

[20] Y. Dimopoulos, B. Nebel, and F. Toni. Finding admissible and preferred arguments can be very hard. In *KR2000: Principles of Knowledge Representation and Reasoning*, eds., A. G. Cohn, F. Giunchiglia, and B. Selman, pp. 53–61, San Francisco, (2000). Morgan Kaufmann.

See [21].

[21] Y. Dimopoulos, B. Nebel, and F. Toni. On the compuational complexity of assumption-based argumentation by default reasoning. *Artificial Intelligence*, **141**, 57–78, (2002).

The basis provided in [13] allows concepts of credulous and sceptical reasoning, preferred and stable extensions to be developed for a number of non-classical logics. In studying the complexity of these problems a significant element is shown to be the complexity of "derivability" in the associated logic. One consequence is that sceptical reasoning under some logics can be shown complete for rather higher levels of the polynomial-time hierarchy.

[22] Y. Dimopoulos and A. Torres. Graph theoretical structures in logic programs and default theories. *Theoretical Computer Science*, **170**, 209–244, (1996).

The results for the decision problems CA, PREF-EXT, HAS-STAB given in Table 1 above, all derive from this paper. The terminology differs quite noticeably from that of [25], however, these are not difficult to relate. A more detailed discussion of the contribution of [22] expressed in the terminology of [25] may be found in [28].

[23] S. Doutre and J. Mengin. Preferred extensions of argumentation frameworks: Query answering and computation. In *First Intern. Joint Conf. Automated Reasoning (IJCAR 2001)*, pages 272–288. LNAI, 2083, Springer-Verlag, June 2001.

See [15]

[24] S. Doutre, T.J.M. Bench-Capon, and P.E. Dunne Explaining preferences with argument positions. *Proc. IJCAI05*, (to appear)

Presents a "TPI-style" dialogue game for validating that a subset of arguments within a value-based argument framework has (at least) one audience for which this set is admissible.

[25] P. M. Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming, and N-person games. *Artificial Intelligence*, **77**, 321–357, (1995).

Seminal article introducing the concept of argument framework and acceptability semantics that underpin the ideas and developments presented in this tutorial.

[26] P. E. Dunne. On Concise Encodings of Preferred Extensions. *Proc. 9th Non-monotonic Reasoning Workshop (NMR'2002)*, Toulouse, April 2002, pages 393-398

Complexity-based consideration of whether the set of all preferred extensions of an argument system can be represented by a description which is both length efficient and admits efficient testing as to whether a set of arguments *is* a preferred extension: motivation is to determine to what extent precomputation of all preferred extensions *once* is a feasible approach.

[27] P.E. Dunne. Prevarication in dispute protocols. In *Proc. Ninth International Conference on A.I. and Law (ICAIL'03)*, Edinburgh, June 2003, ACM Press, pages 12–21

Examines to what extent the "loser" of a dispute can exploit dialogue rules and their opponent's strategy in order to delay having to concede defeat.

[28] P.E. Dunne and T.J.M. Bench-Capon. Coherence in finite argument systems. *Artificial Intelligence*, **141**, 187–203, (2002).

Technical complexity classification proving the problem of deciding if $\mathcal{H}$ is coherent, i.e. every preferred extension is also stable, to be Π_2^p-complete. A similar classification of SA follows from this result.

[29] P.E. Dunne and T.J.M. Bench-Capon. Two party immediate response disputes: properties and efficiency. *Artificial Intelligence*, **149**, 221–250, (2003).

Detailed study and formalisation of the TPI-dispute protocol introduced in [70]. Introduces the concept of *dispute complexity* as the number of moves needed to win an argument. Main technical contribution shows TPI dialogues establishing an argument is *not* credulously accepted can be viewed as a very weak propositional proof calculus and thus may require exponentially many (in the number of arguments) rounds to reach a conclusion.

[30] P.E. Dunne and T.J.M. Bench-Capon. Complexity in value-based argument systems. *Proc. 9th European Conf. on Logics in Artificial Intelligence. (JELIA'04)*, LNAI, 3229, Springer-Verlag, pages 360–371, 2004

Classifies the complexity of deciding Subjective and Objective Acceptance that were left open in [10]. Also introduces the problem "*critical pair*" concerned with deciding whether a given argument is subjectively accepted with one specific ordering of a pair of values but indefensible when this order is reversed. This problem being demonstrated to be "harder" than deciding Subjective or Objective Acceptance.

[31] P.E. Dunne and T.J.M. Bench-Capon. Identifying Audience Preferences in Legal and Social Domains. *Proc. DEXA'04*, LNCS 3180, Springer-Verlag, pages 518–527, 2004

Presents an efficient algorithm by which the set of audiences consistent with a given S being a preferred extension in a VAF can be recovered.

[32] P.E. Dunne and T.J.M. Bench-Capon (Editors) *Argumentation in Artificial Intelligence and Law.* Wolf Legal Publishing, (2005), (in press)

Collection of papers presenting recent developments in the specific field of argumentation techniques as applied in legal contexts.

[33] P.E. Dunne, S. Doutre, and T.J.M. Bench-Capon. Discovering inconsistency through examination dialogues. *Proc. IJCAI05* (to appear)

Introduces a class of dialogue scheme aimed at modelling question processes seeking to expose inconsistencies in argument.

[34] P.E. Dunne and P.J. McBurney. Optimal Utterances in Dialogue Protocols. *Proc. Second International joint Conference on Autonomous Agents and Multiagent Systems (AAMAS'03)*, July 2003, ACM Press, pages 608-615

Considers the question of "move selection" for participants in a dialogue, reviewing notions of what can be said to consitute a "best" move. Extended version appears in the collection [18].

[35] J. Glazer and A. Rubinstein. Debates and decisions: on a rationale of argumentation rules. *Games and Economic Behavior*, **36**(2):158–173, 2001.

Good representative article presenting argument and dialogue from the game-theoretic perspective favoured within economics.

[36] T. F. Gordon. *The Pleadings Game: An Artificial Intelligence Model of Procedural Justice*. Dordrecht: Kluwer Academic Publishers. (1995)

An account of how dialogue and argumentation can be used to model legal process. The idea is that parties use a dialectical exchange to identify the points of agreement and disagreement between them so that the issues which need to be decided before a judge can be agreed.

[37] K. Greenwood, T. Bench-Capon, and P. McBurney. Towards a Computational Account of Persuasion in Law. In *Proc. of the Ninth International Conf. on AI and Law (ICAIL'03)*, ACM press, New York, pages 22–31, 2003

An application of the theory of persuasive argument of [4] to legal case based reasoning, illustrated from the domain of US Trade Secrets Law.

[38] J.C. Hage. *Reasoning With Rules*. Kluwer Academic Publishers; Dordrecht (1997).

A book describing Hage's Rule Based Logic, a logic targeted at explaining defeasible argument in Law.

[39] A. Hunter. Making argumentation more believable. *Proc. of the 19th American National Conference on Artificial Intelligence (AAAI'2004)*, pages 269–274, MIT Press, 2004

[40] A. Hunter. Towards higher impact argumentation. *Proc. of the 19th American National Conference on Artificial Intelligence (AAAI'2004)*, pages 275-280, MIT Press, 2004

These two papers give a formal account of audiences, to explain how different perspectives can affect what people believe.

[41] H. Jakobovits and D. Vermeir. Dialectic semantics for argumentation frameworks. In *Proceedings of the Seventh International Conference on Artificial Intelligence and Law (ICAIL'99)*, pages 53–62, N.Y., (June 1999). ACM Press.

Describes a uniform approach to defining dialogue games within argument systems. The schemes presented in [14, 15] are couched in terms of this approach.

[42] R. Kowalski, P.M. Dung and F. Toni. Dialectic proof procedures for assumption-based, admissible argumentation (to appear *Artificial Intelligence*, 2005)

Presents dialogue style proof procedures for credulous reasoning in assumption-based frameworks, introducing backward reasoning as a mechanism for guiding the dialogue development.

[43] A. R. Lodder. *Dialaw: On legal justification and Dialogue Games.* Ph.D. thesis, Univ.of Maastricht. (1998)

Description of a simple dialogue game based on the Reason Based Logic of [38].

[44] P. Lorenzen and K. Lorenz. *Dialogische Logik.* Darmstadt: Wissenschaftliche Buchgesellschaft. 1978

A monograph presenting the view of propositional proof theory as a dialogue mechanism.

[45] R. P. Loui. Process and Policy: Resource-Bounded Nondemonstrative Reasoning. *COMPINT: Computational Intelligence: An International Journal* **14**, 1–38. 1998

This paper investigates the appropriateness of formal dialectics as a basis for nonmonotonic and defeasible reasoning that takes computational limits seriously. Dialectical protocols are shown to be appropriate for such deliberations when resources are bounded and search is serial.

[46] J. D. MacKenzie. Question-Begging in Non-Cumulative Systems. *Journal of Philosophical Logic* **8**(1), 117–133. 1978

One of the first dialogue games, introducing important notions such as commitment stores. Based on standard propositional logic, it is particularly intended to explain certain fallacies, especially begging the question.

[47] P. McBurney and S. Parsons. Representing epistemic uncertainty by means of dialectical argumentation. *Annals of Mathematics and AI*, **32**(1–4):125–169, 2001.

See comments following Dignum [18].

[48] P. McBurney and S. Parsons. Games that agents play: A formal framework for dialogues between autonomous agents. *J. Logic, Language and Information*, **11**:315–334, 2002.

See comments following Dignum [18].

[49] P. McBurney and S. Parsons. Chance Discovery using dialectical argumentation. In T. Terano *et al.*, editors, *New Frontiers in Artificial Intelligence*, pages 414–424. LNAI, 2253, Springer-Verlag, 2001.

See comments following Dignum [18].

[50] P. McBurney, S. Parsons, and M. J. Wooldridge. Desiderata for agent argumentation protocols. In *Proc. First Intern. Joint Conf. on Autonomous Agents and Multiagent Systems (AAMAS'02)*, pages 402–409. ACM Press, 2002.

See comments following Dignum [18].

[51] C. H. Papadimitriou. *Computational Complexity.* Addison-Wesley: Reading, MA, 1994.

[52] S. Parsons, C. A. Sierra, and N. R. Jennings. Agents that reason and negotiate by arguing. *J. Logic and Computation*, **8**(3):261–292, 1998.

See comments following Dignum [18].

[53] S. Parsons, M. J. Wooldridge, and L. Amgoud. An analysis of formal inter-agent dialogues. In *Proc. First Intern. Joint Conf. Autonomous Agents and Multiagent Systems*, pages 394–401. ACM Press, 2002.

See comments following Dignum [18].

[54] C. Perelman and L. Olbrechts-Tyteca. *The New Rhetoric: A Treatise on Argumentation*. University of Notre Dame Press, Notre Dame (1969).

The definitive presentation of Perelman's ideas relating to the role of audience and the role of values in determining the persuasiveness of arguments. It also contains a systematic exploration of a large number of argument schemes.

[55] C. Perelman. *Justice, Law and Argument*. Reidel: Dordrecht, 1980.

A collection of essays providing an accessible introduction to Perelman's ideas.

[56] J.L. Pollock. How to reason defeasibly. *Artificial Intelligence*, **57**(1):1–42. (1992)

This paper describes the construction of a general-purpose defeasible reasoner that is complete for first-order logic and provably adequate for Pollock's argument-based conception of defeasible reasoning.

[57] J.L. Pollock. Defeasible reasoning with variable degrees of justification. *Artificial Intelligence*, **133**(1–2):233–282. (2001).

Considers how the degree of justification of a belief is determined, where conclusions are supported by several different arguments, the arguments typically being defeasible, and there may also be arguments of varying strengths for defeaters for some of the supporting arguments.

[58] H. Prakken. *Logical Tools for Modelling Legal Argument*. Kluwer Academic Publishers, 1997.

This book surveys the use of logic in describing conflicts between legal norms, and discusses logical approaches to resolving such conflicts.

[59] H. Prakken and G. Sartor. A Dialectical Model of Assessing Conflicting Arguments in Legal Reasoning. *Artificial Intelligence and Law*, **4**(3–4):331–68 (1996).

Gives a formal description of arguments as deductions and provides a proof theory based on grounded semantics and expressed as a dialogue procedure.

[60] H. Prakken and G. Sartor. Argument-Based Extended Logic Programming with Defeasible Priorities. *Journal of Applied Non-classical Logics*, **7**:25–75. 1997

This paper discusses non-monotonic reasoning in terms of arguments represented as logic programs, and in particular offers a formalisation of how priorities between conflicting arguments can themselves be the subject of argument.

[61] C. Reed. Dialogue frames in agent communications. In: Y. Demazeau (ed.): *Proc. 3rd International Conference on Multi-agent systems (ICMAS-98)*, pages 246–253. 1998

See comments following Dignum [18].

[62] C. Reed and T. Norman. *Argumentation Machines.* Kluwer Academic Publishers: Dordrecht. (2003).

A book surveying argument in AI from a variety of perspectives, including multi-agent systems, decision support, persuasion, law and rhetoric.

[63] C.A. Reed and G.W.A Rowe. *Araucaria: Software for Puzzles in Argument Diagramming and XML.* Department of Applied Computing, University of Dundee, Technical Report. (2001).

Describes Araucaria, a program supporting the graphical analysis of arguments in terms of argument schemes.

[64] J.R. Searle. *Rationality in Action.* MIT Press, Cambridge Mass., 2001

A recent monograph giving an account of practical reasoning. In particular it addresses the problems with the practical syllogism, and argues that a deductive theory of practical reason is inappropriate.

[65] G.R. Simari and R.P. Loui. A mathematical treatment of defeasible reasoning and its implementation. *Artificial Intelligence*, **53**(2–3):125–157 (1992).

An early and influential presentation of a formal approach to defeasible reasoning based on argumentation.

[66] D.B. Skalak and E.L. Rissland. Arguments and cases: an inevitable intertwining. *Artificial Intelligence and Law* **1**:3–44 (1992).

Develops a number of strategies for argument and the moves to realise in the context of legal case based reasoning.

[67] S. Toulmin. *The uses of argument.* Cambridge University Press. 1959

This book introduces a popular scheme for the analysis of argument.

[68] H.B. Verheij. Automated argument assistance for lawyers. *Proceedings of the Seventh International Conference of Artificial Intelligence and Law.* New York: ACM Press, pages 43–52. (1999).

Describes Argu-Med, which provides a graphical interface to an argumentation framework based on the Reason Based Logic of [38]

[69] G. Vreeswijk. Abstract Argumentation Systems. *Artificial Intelligence*, **90**:225–279, 1997

Presents a theory of argumentation systems modelling these as collections of "defeasible proofs". The introduction, additionally, provides a useful comparative survey of formal argumentation systems up to and including [25].

[70] G. Vreeswijk and H. Prakken. Credulous and sceptical argument games for preferred semantics. In: *Proceedings of JELIA'2000, The 7th European Workshop on Logic for Artificial Intelligence*, Berlin, pages 224–238, 2000

Presents the elements of the *Two party immediate response* (TPI) dialgoue game studied and analysed in [29], showing this to be sound and complete for credulous reasoning in any system, and sound and complete for sceptical reasoning in coherent argument systems. Presents examples of where the sceptical reasoning method may fail in systems which are not coherent.

[71] D. N. Walton and E. C. W. Krabbe *Committment in Dialogue: Basic Concepts of Interpersonal Reasoning.* Univ. of New York Press. 1995

Presents one of the first systematic attempts to construct a taxonomy of dialogue types and aims.

[72] D.N. Walton, *Argumentation Schemes for Presumptive Reasoning.* Erbaum: Mahwah, NJ. 1996

An account of presumptive or defeasible argument in the informal logic tradition. Its approach makes use of argument schemes and critical questions. It describes some sixteen schemes for presumptive reasoning and their associated critical questions in detail.

Argumentation and Dialogue in Artificial Intelligence

Trevor J.M. Bench-Capon and
Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

Introduction

- Proofs and Arguments (TB-C)
- Modelling Sets of Arguments (PED)
- Strengths of Arguments and Audiences (TB-C/PED)
- Dialogues Based on Argumentation Frameworks (PED)
- Structure of Arguments (TB-C)
- Examples of Argumentation (TB-C)

Proof and Argument

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

Proof and Argument

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

Arguments don't compel – they persuade

Arguments are always defeasible

Proof and Argument

Arguments Leave Things Implicit

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

No need to state this

Presupposes John is a Man

Proof and Argument

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

Arguments May Use Open Texture

No need to specify a threshold

Proof and Argument

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

Arguments Are "Open World"

John is a Strruldbrug

Proof and Argument

- Proof
  - John is aged 79
  - John is a man
  - All men aged greater than 70 are old
  - 79 > 70
  - Therefore, John is old
- Argument
  - John is old because he is in his seventies

Arguments can contain uncertain information

We don't need to Know John's age

Proof is Sometimes Possible

- In some domains
  - Information is complete
  - Information is certain
  - Information is precise
  - Everything can be made explicit
- For example, Mathematics
- *But this is unusual – in natural domains we must deal with defeasible arguments*

Arguments give *Prima Facie* Justification

- An argument gives a rational justification for a conclusion
- But the argument can be challenged by another *argument*
- Challenges arise in a variety of ways

Challenges

- John is old because he is in his seventies
  - John must be young: I've seen him hang gliding
    - Argument for negation of conclusion (*defeater*)
  - John is in his fifties
    - Denies a premise
  - Age has got nothing to do with it – you are as young as you feel
    - Rule is not applicable (*undercutter*)

Challenges Depend on the Type of the Argument

- Example: Argument from Authority
  - Grapefruits are healthy because Jane Fonda says so
    - Authority did not say it
      - Jane was talking about grapes as a healthy fruit
    - Not an authority
      - Jane knows about exercise not diet
    - Competing authority
      - Carol Vorderman says grapefruit is not healthy

Legal Example

- John should get benefit because he is unfit for work
  - Facts: is there anything wrong with John?
  - Interpretation: John has a cold – does this make him unfit?
  - Law: Is there such a benefit?
  - Exceptions: John is not ordinarily resident

Practical Reasoning

- I want to be in London by 12.00, so I will catch the 9.30 train
  - Are the facts correct?
    - Is there a 9.30 train?
    - Will it reach London by 12.00?
  - Is the desire correct?
    - Do you really want to be in London?
    - Must you be there by 12.00?

Practical Reasoning

- I want to be in London by 12.00, so I will catch the 9.30 train
  - Alternatives
    - You could drive to London instead
  - Conflicts
    - You will miss my party if you go to London
  - Side effects
    - The 9.30 train costs more than the 10.00

Considering an Issue

- Put forward one or more arguments supplying prima facie justifications
- Challenge these arguments with other arguments
- Challenge these new arguments
- Result is a set of arguments, and a set of attack relations between them

Argument Status

- If we have a set of arguments, and attacks between them, we want to determine
  - Which arguments are acceptable
    - Must be accepted
    - Can be accepted
  - Which sets of arguments are acceptable together
  - Which arguments are indefensible

Argument Frameworks

- A method for systematically addressing questions of argument status is given by
- Argumentation Frameworks
  - Initially introduced by P.M. Dung
- We will discuss argument frameworks in the next section of the tutorial

Modelling Sets of Arguments

Trevor J.M. Bench-Capon and
Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

Overview

a. Definition of *Argument System*.
b. Concept of *Acceptable argument*.
c. Concept of *Admissible set*.
d. Different *extension* semantics.
e. Comparison of properties.

Argument Systems

- Defined by two sets:
- X: finite set of *arguments*

$$X=\{x_1,\ldots,x_n\}$$

- A: finite set of *attacks*

$$A\subset X\times X$$

- Modelled as a directed graph $H(X,A)$

Arguments and Attacks

- Arguments are viewed as *atomic*: no assumptions are made concerning their *internal structure*.
- The *attack relation* includes a notion of an argument *x* being "stronger" than an argument *y*:

  $<x,y> \in A$ read as "*x attacks y*"

Acceptable Arguments I

- *Acceptance* of a given argument, *x*, is defined with respect to sets *S*

  x is *acceptable* w.r.t. *S* if any attack *y* on *x* is itself attacked by some *z* in *S*, i.e.

  $<y,x> \in A \Rightarrow \exists\, z \in S \; <z,y> \in A$
- This view, however, ignores any other properties of *S*

Acceptable Arguments II

- *S* may be "inconsistent": it might contain arguments – *z* and *w* – with $<z,w> \in A$.
- *S* is 'useful' as a possible defence only if it is *conflict-free*

  $\forall z,w \in S \; <z,w> \notin A$ and $<w,z> \notin A$

Admissible Sets of Arguments

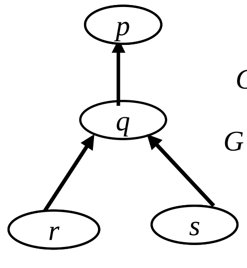
- A set of arguments, *S*, is *admissible* if it is *conflict-free* and each of its members is *acceptable* w.r.t. *S*.
- Admissible sets provide the basic context for examining ideas of “maximally consistent sets of beliefs”.
- There are 3 general forms:
  Grounded ; *Preferred* ; *Stable*

Grounded Extensions

Construct a maximal admissible set, *G*, by

1. $G := \emptyset$
2. $G := G \cup \{ y : y \text{ is acceptable w.r.t. } G \}$
3. *Iterate* (2) *until no change in G*

Grounded Extensions



$G := \emptyset$

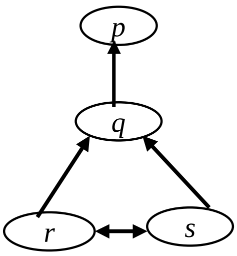
$G := \{r, s\}$

$G := \{r, s, p\}$

Pros and Cons

- Always some grounded extension
- But it might be the empty set.
- Grounded extension is unique
- But this rules out 'valid' alternatives.
- Can be computed efficiently.

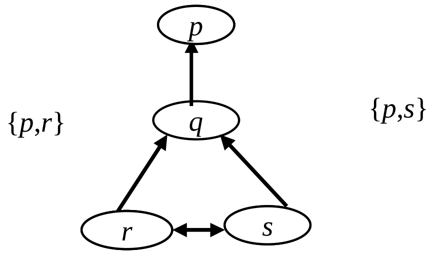
Empty Grounded Extension



Preferred Extensions

- A *preferred extension* is any *maximal admissible set w.r.t.* $\subseteq$.
- Every grounded extension is a preferred extension (but not *vice-versa*).
- An argument system may have more than one preferred extension.

Multiple Preferred Extensions



Classes of acceptance

a. *p* is in *every* preferred extension.
b. *r* is in some but not all.
c. *q* is in none.

- *p* is said to be *sceptically accepted*.
- *r* is said to be *credulously accepted*.
- *q* is said to be *inadmissible*.

Pros and Cons

- Preferred extension always exists.
- But this might still be empty.
- Multiple extensions give rise to richer acceptance classes.
- But this creates complications with interpretation.
- Algorithmic questions are non-trivial.

Complexity Issues

- Deciding if an argument is *credulously accepted* is NP-complete.
- Deciding if an argument is *sceptically accepted* is Π_2-complete.
- Deciding if a system has an *empty preferred extension* is coNP-complete.

Stable Extensions

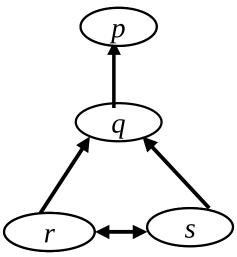
- A *stable extension* is a set *S* for which every argument, *y*, that is not in *S* is attacked by some argument, *z*, in *S*, i.e.

$$\forall y \notin S\ \exists z \in S : \langle z,y \rangle \in A$$

- Every stable extension is a preferred extension, (but not *vice-versa*).

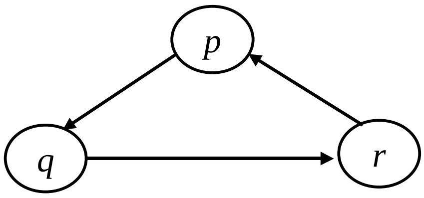
Stable Extensions

{*p*,*r*}



{*p*,*s*}

Case with no stable extension



Pros and Cons

- Stable extensions are never empty.
- But there could be *no stable extension.*
- Testing if a given *S* is stable is "easy".
- But deciding if any stable extension is present is NP-complete.

Coincident Conditions

- If *H*(*X*,*A*) contains no directed cycle then its grounded extension is stable.
- If *H*(*X*,*A*) contains no simple *odd length* directed cycle then each of its preferred extensions is stable.
- Systems in which every preferred extension is stable are called *coherent*.

More on coherence

- Coherent systems are important in connection with *Dialogue Games* to prove *sceptical acceptance*.
- These will be reviewed in Part 4.
- Testing system coherence, however, is extremely hard.

A related approach – assumption based frameworks

- In Dung "*arguments*" and "*attacks*" are atomic elements.
- Bondarenko *et al.* define a model in which these are derived from a set of "*assumptions*".
- This approach provides a powerful tool for describing defeasible reasoning under a number of non-monotonic logics.

Assumption Based Frameworks

- Start with a *deductive system* - $<L,R>$
- L – a formal language, e.g. propositional formulae.
- R – a set of inference rules.
- An *assumption based framework* is a triple $<T,Ab,con>$ with $T, Ab \subset L$ and con a mapping from Ab to L

Assumption Based Frameworks

- T is called the *belief set*.
- Ab the *assumption set*.
- con(α) the *contrary* of α.
- Aim is to identify subsets,Δ of Ab that can be used to *extend* T without contradiction.
- That is $T \cup \Delta$ does not allow both α and con(α) to be derived in $<L,R>$ for any $\alpha \in$ Ab

Assumption Based Frameworks

- Δ is *conflict-free* if it can extend T
- Δ is *maximal* if none of its supersets is conflict-free.
- Stable, admissible, and sceptical semantics can also be developed.
- Key aspect is that the complexity of decision problems is intimately linked to that of "derivability" in $<L,R>$

Development

- The algorithmic and interpretative issues with preferred extensions come about because of *cycles* in $H(X,A)$.
- An 'ideal' model might combine the merits of grounded extensions with the flexibility of *coherent* systems.
- Part 3, considers developments of the abstract system aiming at this 'ideal'.

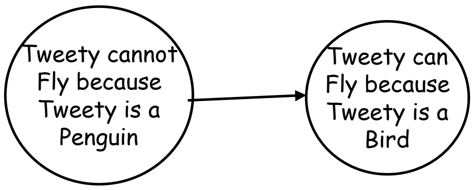
Strengths of Arguments and Audiences

Trevor J.M. Bench-Capon and Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

In Dung's Framework

- Attacks always succeed
- An argument can be defended only by attacking its attackers
- This is reasonable for questions of belief
  - We are seeking certainty
  - We cannot *choose* what is true

Standard defeasible belief



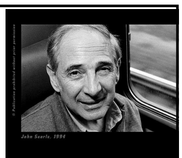
But This is not Appropriate For all Uses of Argument

- Sometimes we do have a choice
- So personal preference, temperament and context may lead us to ignore an attack
- Typical in
  - Practical reasoning
  - Politics
  - Law, etc

As Perelman says:

- If men oppose each other *concerning a decision to be taken*, it is not because they commit some error of logic or calculation. They discuss apropos the applicable rule, the ends to be considered, the meaning to be given to values, the interpretation and characterisation of facts.

John Searle



- Assume universally valid and accepted standards of rationality, assume perfectly rational agents operating with perfect information, and you will find that rational disagreement will still occur; because, for example, the rational agents are likely to have different and inconsistent values and interests, each of which may be rationally acceptable.

Perelman Again

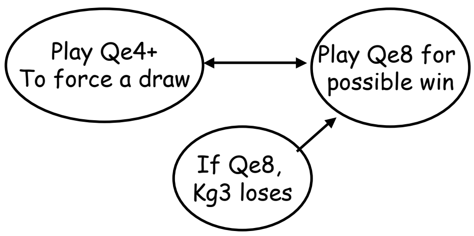
- "Logic underwent a brilliant development during the last century when, abandoning the old formulas, it set out to analyze the methods of proof used effectively by mathematicians. … One result of this development is to limit its domain, since everything ignored by mathematicians is foreign to it. Logicians owe it to themselves to complete the theory of demonstration obtained in this way by a theory of argumentation"

Chess Game

- Suppose I am playing Chess:
  - If I play Qe4+, then I can draw by perpetual check
  - If I play Qe8, then my opponent might play, Kf3, allowing me to win
  - If I play Qe8, then my opponent can win by Kg3

Chess Example

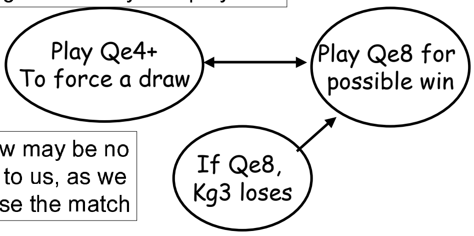
If all attacks succeed, we must play for the draw



Chess Example

But in practice we do have a choice:

We might feel lucky and play Qe8

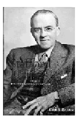


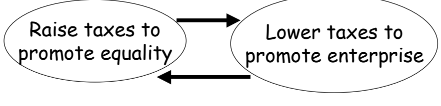
A draw may be no good to us, as we will lose the match

Chess Example

- Thus it may be rational – if a draw is unacceptable – to ignore the attack on moving to Qe8
- Compare game strategies:
  - choose the best outcome assuming best play by opponent
  - choose the best outcome possible, if opponent plays weakly

Taxation Debate





Brown sees force in both arguments
– but what Brown does depends on (reveals?) whether Brown prefers equality or enterprise at a given time

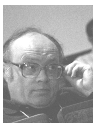
Note That:

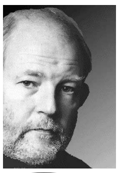
- In denying that the attack of an argument succeeds, we *do not reject* the argument
- Rather we accept the argument, but deny that it has *sufficient force* to *persuade* us to change our chosen course of action
  - That if our opponent replies Kf3, we will lose remains a valid argument against Qe8, but if we need to win we must play Qe8 anyway
  - Cutting taxes will increase enterprise, but the resulting inequality is unacceptable to us

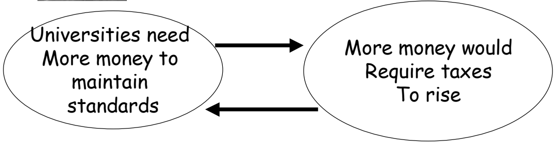
Values Have Different Weights for Different People

- We may both accept that both equal distribution AND enterprise are good,
- BUT I might sacrifice enterprise to equality and you might sacrifice equality to enterprise
- So we can agree that both arguments are valid, but disagree as to what should be done
- The strength of an argument (for an audience) depends on the strength that audience gives to the value accepting it promotes

Education Debate







Irreconcilable difference in values: educational standards versus whatever is served by inadequate taxation

Persuasiveness

- In decisions about actions we can *choose* what we prefer:
  - we are trying to fit the world to our desires, whereas in belief we must fit our beliefs to the world
- Whether an argument is persuasive depends on what the *audience* wants
  - The optimist plays Qe8, the pessimist Qe4+
  - The socialist raises taxes the conservative lowers them
  - The educationalist increases the budget, the politician cuts it

Argument Strength

- For such arguments we can accept an argument by *choosing to prefer* it to its attackers
- We need to distinguish between *attack* and *defeat* (successful attack)
- We need a way to represent the preferences
- To represent audiences we need a way to relate systematically preferences

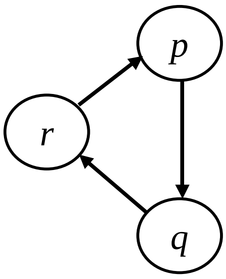
Approach

- Start from Dung's Argumentation Framework
  - Abstract enough to avoid questions of what counts as an argument or attack
- Extend this to include notions of value and audience
  - Preference Based Argumentation Frameworks
  - Value Based Argumentation Frameworks

Preference-Based Frameworks

- Extend from $<X,A>$ to $<X,A,Pref>$
- $Pref \subset X \times X$ is a *preference relation*
- $<x,y> \in Pref$ means
 "*argument x* is preferred to *argument y*"
- Preference relations must be *transitive* defining an *ordering* i.e. without *cycles.*

Example



$Pref=\{<p,q>,<q,r>\}$ (Valid)

$Pref=\{<p,q>,<q,r>,<r,p>\}$ (Not valid)

Conflict-free and admissible sets

- Adding preferences means that an attack by x on y may *sometimes fail* – to succeed $<y,x> \notin Pref$ must hold.
- This leads to notion of *successful attack* of x on y as $<x,y> \in A$ *and* $<y,x> \notin Pref$
- So obtain new definition of *conflict-free* and *admissible sets*, S

Alternative view

- Given $H(X,A)$ and $Pref \subset X \times X$ form the directed *sub-graph* of $H(X,A)$ that contains only *successful attacks*
- This graph contains no cycles.

$\therefore$ unique, non-empty preferred extension is its grounded extension.

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Problems

- Preference schemes are based on abstract relationship over *arguments*
- No assumptions of *where* preferences originate or *why* they may change.
- Each different preference relation must be seen "in isolation" even though there may be some underlying connections.

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Value-Based Frameworks I

- Extend from $<X,A>$ to $<X,A,V,\eta>$
- $V=\{v_1,\ldots,v_t\}$ finite set of *values*
- $\eta : X \rightarrow V$ maps arguments to values.
- A VAF is instantiated w.r.t. to *audiences*

α- an ordering of V

$v_i >_\alpha v_k$ – the *value* v_i is ranked above the *value* v_k by the audience α

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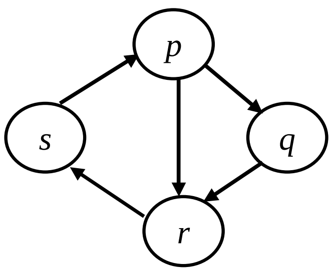
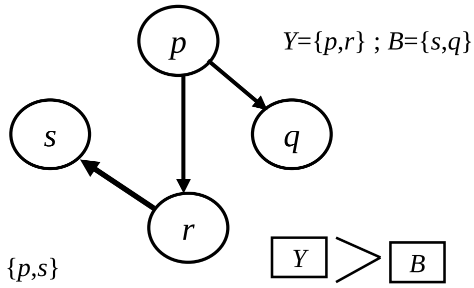
Value-Based Frameworks II

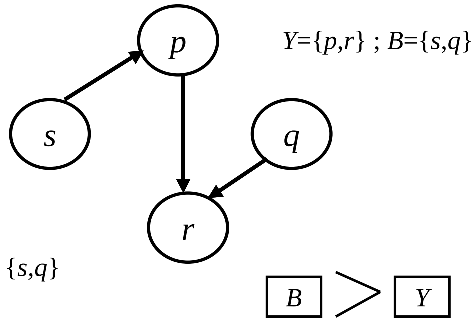
- One consistency condition: every cycle in $<X,A>$ contains at least 2 distinctly valued arguments.
- Attacks succeed relative to *audiences.*
- Concept of "successful attack" by x on y is now: $<x,y> \in A$ *and it is not the case that* $\eta(y) >_{\alpha} \eta(x)$

Value-Based Frameworks III

- The attack $<x,y>$ succeeds if "*the value promoted by y does not outrank the value promoted by x for the audience* α"
- The sub-graph of $H(X,A)$ that contains only successful attacks w.r.t. α has no cycles: unique, non-empty preferred extension $\equiv$ grounded extension.







Properties of audiences I

- Argument *values* do not change for different audiences
- The *ranking* of values does.
- An argument may be accepted by *every* audience (*Objective Acceptance*)
- or only by *some* audiences (*Subjective*)
- or by *no* audience (*Indefensible*)

Properties of audiences II

- Deciding into which of these categories a given argument falls is hard –
  Subjective Acceptance is NP-complete
  Objective Acceptance coNP-complete
- Deciding if a value ordering is *critical* is harder than either of these.

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Positive Results

- Given *S* there is an efficient algorithm to discover the class of audiences for which *S* is the preferred extension.
- The complexity classification may be misleading: the results use systems with a number of *values* comparable to the number of *arguments.*
- “real” cases tend to use few values.

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Summary

- Accounting for relations between arguments other than pure “attack” is needed practically to analyse persuasive argument.
- Preference-based and Value-based frameworks offer two different but related perspectives.
- Some concrete examples of value-based application will be presented later.

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Dialogue Based on Argumentation Frameworks

Trevor J.M. Bench-Capon and
Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

Overview

- What do we mean by dialogue?
- Types and aims of dialogue.
- Dialogue Protocols and their elements
- Desiderata for dialogue
- Dialogue Games in Argument Systems

What do we mean by dialogue?

- A formal procedure for two parties to reach a view about a topic of concern.
- Interest centres on:

  Concept of 'initial' belief state.

  Types of contribution parties make

  Semantics defining changes in beliefs

  'Soundness', 'completeness', termination

What do we mean by dialogue?

- We do not consider dialogue in the context of 'natural language'.
- While propositional proof theories can be cast as dialogue processes in the sense we use, this is just one of many domains in which such formalisms can be exploited.

Types of Dialogue I

- *Negotiation* – parties try to agree a division of a collection of resources.
- *Discovery* – parties try to find out information about a given domain.
- *Persuasion* – one party tries to convince others of the "truth" of some claim.
- This list is *not meant to be exhaustive*

Background

- Dialogue models have a long history prior to their use in Argument Systems, e.g.

a. McKenzie's DC system defined a mechanism directed at exposing a particular class of fallacious reasoning.
b. Lorenz investigated dialogue formulations of propositional proof calculi.
c. Both approaches date from the late 1970s

Types of Dialogue II

- We consider *Persuasion Dialogues* in the context of argument frameworks.
- Basic elements –

  Defender – promoting some claim *p*

  Challenger – disputing *p*

  Collection of atomic arguments
- The arguments structured as *H(X,A)*

Elements of Dialogue Protocols I

- 2 *players – Defender* and *Challenger*
- Set of *Discussion topics – L*
- Set of *Dialogue actions – R*
- A *legal move function* –– μ
- Initial and termination rules
- For a dialogue protocol in an argument system *H(X,A*) we use *L=X*

Elements of Dialogue Protocols II

- First: *D asserts p holds*
- Then: *C attacks p with q*
- Then: *D defends p attacking q with r*
- and so on until ?

a. Who ‘wins’ (and when and why)?
b. What attacks can players use?
c. What ‘properties’ are ‘desirable’?

Elements of Dialogue Protocols III

- General frameworks for considering such "*dialogue games*" on argument systems have been proposed.
- Related models have dealt with less abstract settings, e.g. Toulmin's argument schema.
- We will consider a particular instantiation: *TPI-disputes*

Context for Dialogue

- View persuasion dialogue as aimed at establishing some argument, *p*, is *credulously accepted* i.e. there is an admissible set containing it.
- Also consider *sceptical acceptance* noting that there are complications in this case.

Desiderata for dialogue games

- Completeness – if *p* accepted then there is a dialogue 'won' by *D*; if *p* not accepted there is a dialogue won by *C*
- Soundness – every dialogue produces the same result.
- Termination – every dialogue produces some result eventually.

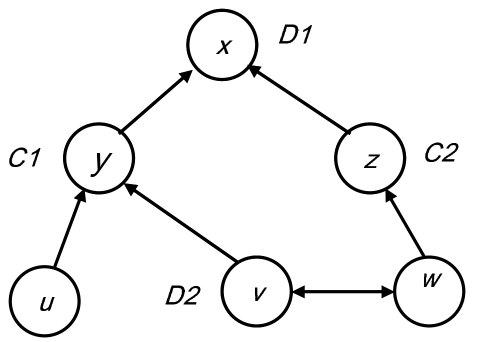
TPI-disputes - Rules and Moves

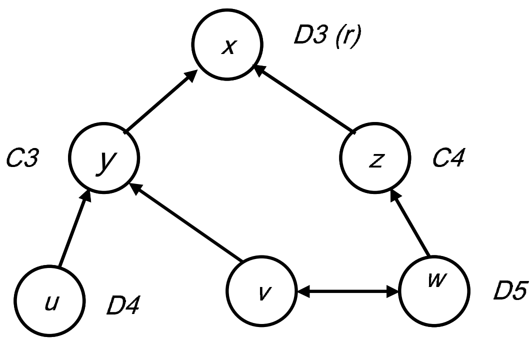
Game Instance: *H(X,A) ; x∈X*

counter: c(*y*) - <*y,z*>∈ *A* ; *z* 'last' argument

back: b(*y,z*) - *C* starts a 'new' attack on *y* using *z*, <*z,y*>∈ *A*

retract: r - *D* forced to adopt 'new' defence.





TPI-dispute properties I

- Typically several possible dialogues over an argument in any given system.
- Outcome is identical in every case: either *D* always wins or always loses.
- If *D* wins the set of arguments used in defending *p* is an admissible set.
- TPI-disputes are sound and complete for credulous reasoning.

TPI-dispute properties II

- TPI-disputes are *not* sound and complete for *sceptical reasoning* in general.
- If played on a *coherent argument system* then sceptical acceptance always follows by demonstrating that no attacker of *p* is credulously accepted.

Problems with TPI

- If *D* wins this can always be achieved with a "small" number of moves.
- Finding such a win is non-trivial.
- If *D* loses the number of moves in the "shortest" game demonstrating this can be very large – exponential in $|X|$
- TPI can be used as a very weak propositional proof theory equivalent to the CUT-free Gentzen calculus.

Algorithmic issues

- A number of algorithmic issues arise in attempting to automate dialogue processes of the type outlined:

  Move Selection

  Optimisation criteria

  being just two examples.

Other Issues

- The development of dialogue methods for VAFs is the object of current work.
- An important feature of this is to exploit techniques for recovering audiences that are consistent with a challenger not accepting a given argument.

Structure of Arguments

Trevor J.M. Bench-Capon and
Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

Structure of Arguments

- So far we have considered arguments in the abstract
- But the structure of arguments can be important
  - If we wish to generate arguments from a knowledge base
  - If we wish to enumerate the types of attack

Argument as Deduction

- Given a set of inference rules R
  - $a_1, \ldots, a_n \rightarrow a$
- A deduction from a theory T is a sequence $b_1, \ldots, b_m$ with $m \geq 0$ such that for all k = 1 … m
  - $b_k \in T$ or
  - there is a rule $a_1, \ldots, a_n \rightarrow b_k \in R$ such that each $a_1, \ldots, a_n \in \{b_1, \ldots, b_{k-1}\}$

Attacks

- An argument will comprise
  - A set of assumptions (where $b_k \in T$)
  - A set of conclusions (where b_k is derived)
  - A set of rules (those used to derive b_k)
- An attack is one of
  - A derivation of the negation of an assumption
  - A derivation of the negation of a conclusion
  - The denial of a rule

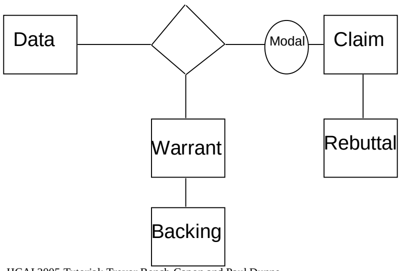
Arguments as Derivation

- This argument structure has a number of advantages
  - Any logic may be used
  - Generation of arguments is straightforward
  - The notion of derivation is well defined and understood
- It also has some disadvantages
  - Not all arguments are easily represented as deductions
  - We may wish to capture some further nuances

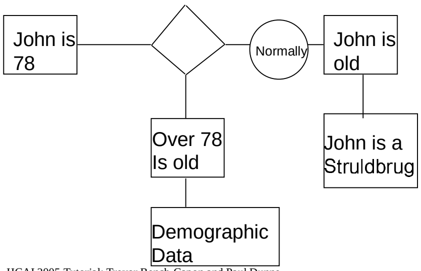
Toulmin's Argument Schema

- To capture some of these nuances, Stephen Toulmin proposed an argument schema that would distinguish different roles played by premises
- It has a nice graphical presentation
- It accommodates non-monotonicity
- It allows qualification of conclusions
- It has been used in AI

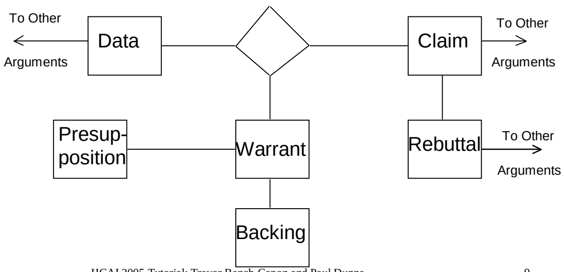
Toulmin's Argument Scheme



Toulmin Example



Modified Toulmin Scheme



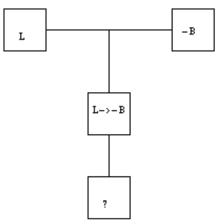
Dialogue Game Based on Toulmin's Argument Schema

- Various moves ask for, or supply, particular additions to the argument graph
- Targeted at explanation – information supplied as needed

Example Dialogue

A1: John should not get sickness benefit (-B)
This is the initial claim
B1: Why?
The first question simply seeks the grounds for the claim, the data in our schema
A2: He is a lazy person (L)
Some grounds are advanced
B2: OK, but so what?
Here two moves are made. The truth of the data is accepted, but its relevance to the argument is questioned
A3: Lazy people should not get sickness benefit (L -> -B)
A rule which would licence the conclusion is advanced
B3: Is there a law to that effect?
Here a justification for the rule is sought. Note that here we do not seek a justification in terms of a logical argument for the rule, but rather in terms the authority from which the rule derives - making use of the backing in our schema. Moreover we seek a legal, not a moral authority
A4: Not as such.

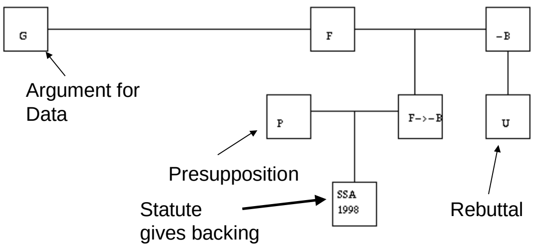
A1- A4: First argument fails



No backing can be supplied so the warrant must be withdrawn and the data does not support the claim

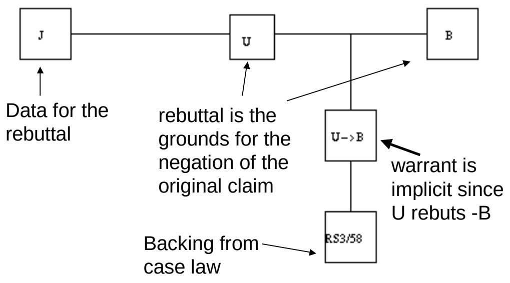
B4: So why do you think he should not get the benefit? (-B)
Now there is no reason to think that L is a reason for -B, a different reason is sought.
A5: He is fit for work (F)
Another reason is supplied.
B5: Suppose he is. Why should that matter?
Here player B does not immediately accept the truth of the data, but wishes to defer consideration of it, while exploring the connection between F and -B
A6: If someone is fit for work, they should not get sickness benefit.
The relevant rule is supplied
B6: Any work at all?
Player B suspects that the rule is not always applicable and seeks the elements of the context which make it applicable to this case
A7: Work that someone would pay to have done. (P)
The background assumption is given
B7: True, but what's your authority?
Player B accepts that P is true, but now wishes to know the authority for the rule
A8: Social Security Act 1984, section 32(1).
This time player A has an authority, in the form of a statutory provision
B8: Why do you say John is fit for work? (F)
Player B accepts the rule but questions the premise, asking for grounds that support it.
A9: I saw him gardening. (G)
A supplies the grounds
B9: I can accept that. But gardening is unsuitable work for John(G, U -> B)
B accepts the truth of the grounds, and that there is a rule entailing F. On the face of it this would establish -B. But Player B is aware of an exceptional circumstance which can defeat the argument.

B4-B9: An Argument With A Rebuttal



A10: What's that got to do with it?
Player A now wishes to know the authority for the rule implicit in B's rebuttal. Note that it is now B who is the proponent of the claim
B10: Fit for work means fit for suitable work. Toogood, Commisssioner, RS3/58.
B supplies an authority from case law
A11: Why do you say gardening is not suitable work?
Player A is forced to accept the rule, but can question the premise
B11: John is a University Lecturer. (J)
B supplies his data for U
A12: OK, OK. John should get the benefit. (B)
Player accepts the truth of J, and that J implies U, and so is constrained to accept that B

A10-A12: The accepted argument



Generation of Toulmin Structures

- Toulmin argument structures can be generated from annotated logic programs

```
old(X):-man(X,class),
        age(X,A,data),
        greater_than(A,70,cond),
        not struldbrug(A,qual),
        source(demographics).
```

presupposition
data
warrant
rebuttal
backing

Argument Schemes

- A great variety can be found in the informal logic literature
  - Perelman
  - Walton
- These have been used for analysis of natural argument
  - Some tools (e.g. Arucaria)
  - Not much automation at present

Problems with Argument Schemes

- They often look like logical fallacies
- Argument From Sign
  - The streets are wet
  - So, it is raining
- Fallacy of Affirmation of Antecedent
- So when are such arguments ok, and when are they simply fallacious?

Problems With Argument Schemes

- They are often not well defined
- Argument from Waste (Perelman)
  - We should go on with this, because it would be a waste to give up now
    - MACBETH: I am in blood
      Stepp'd in so far that, should I wade no more,
      Returning were as tedious as go o'er.
- Hard to see how to formalise this, or determine when it is appropriate

Future of Argument Schemes

- Arguments as deduction are attractive:
  - Simple, uniform
  - Well defined
  - Established semantics
  - Computable
- But such arguments have limitations
  - uses of argument schemes abound in natural argument
  - Argument schemes are required for the full range of persuasive capability

Summary of Argument Schemes

- Argument schemes need investigation
  - Identification of some canonical set
  - Precise definition
  - Conditions of acceptability (some equivalent of soundness)
  - Automatic generation
- We need to understand argument schemes if we are to exploit the full potential of an argumentation based view of reasoning

Examples

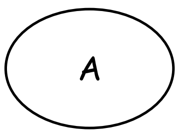
Trevor J.M. Bench-Capon and
Paul E. Dunne
Dept. of Computer Science
University of Liverpool
United Kingdom

An Example Moral Debate

- Hal is a diabetic
- Through no fault of his own Hal loses his insulin
- Carla is a diabetic who has insulin
- Hal enters Carla’s house
- Hal uses Carla’s insulin
- Did Hal act correctly?
- Must Hal replace Carla’s insulin?

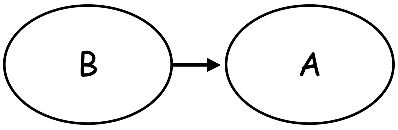
First Argument

- Hal should not take Carla’s insulin, as that would endanger her life (A)



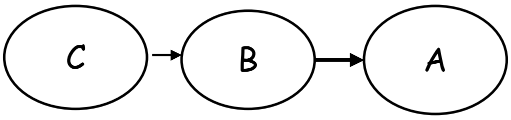
Second Argument

- Hal can take the insulin because the *actual* threat to his life overrides the *potential* threat to Carla (B)



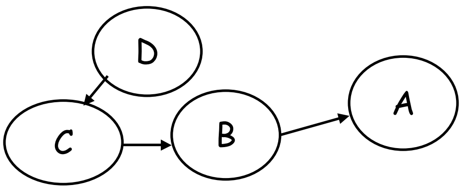
Third Argument

- But Hal can't take the insulin – it belongs to Carla (C)



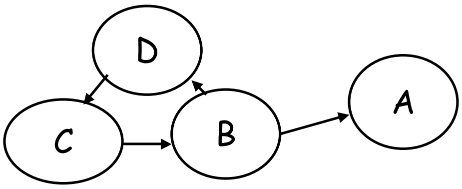
Fourth Argument

- Hal can discharge his obligations to Carla by replacing the insulin (D)



Fifth Argument

- Hal can do whatever is required to save his life (B)



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Status of the Arguments

- Now we have a three cycle, and so no preferred (or grounded) extension. None of the arguments are acceptable!
- We can resolve this by considering values
  - A and B relate to the importance of preserving life:
  - C and D relate to the importance of respecting property

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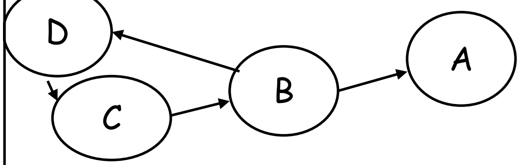
Fifth Argument

- If we prefer life, B and C are acceptable
- If we prefer property, B and D are acceptable
- So B is objectively acceptable, and Hal lives!



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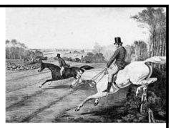
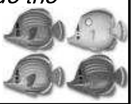
Example Set of Cases



- Pierson: *Plaintiff is hunting a fox on open land. Defendant kills the fox.*
- Keeble: *Plaintiff is a professional hunter. Lures ducks to his pond. Defendant scares the ducks away*

- Young: *Plaintiff is a professional fisherman. Spreads his nets. Defendant gets inside the nets and catches the fish.*



Ghen vs Rich:

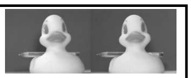
- Ghen harpooned a whale, lost it. Ellis found it, sold it to Rich, who processed it.
- Found for Ghen.
  - "the iron holds the whale"
- *Whaling is governed by conventions which the court respects*

Conti vs ASPCA

- Chester, a talking parrot used by ASPCA for educational purposes, escaped. Conti found it and kept it as a pet. ASPCA reclaimed it.
- Found for ASPCA
- Chester was domesticated, and so *ferae nauturae* did not apply

Burros Cases

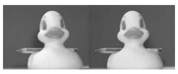
- New Mexico *vs* Morton
- Kleepe *vs* New Mexico
  - Unbranded burros straying from state lands
  - Showed that:
    - Branding established possession
    - Presence on land had to be more than accidental straying

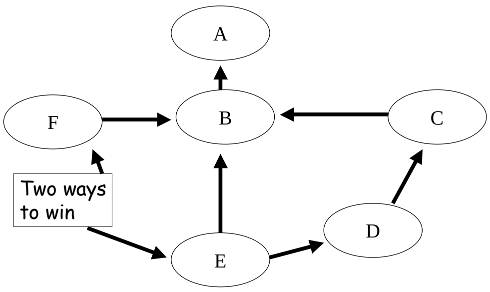


Representing Keeble

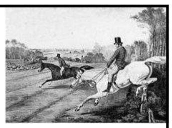
- A: Pursuer had a right to the animal
- B: Pursuer not in possession
- C: Owns the land (so owns the animals)
- D: Wild animals not confined
- E: Efforts made to secure animals
- F: Pursuer has right to pursue livelihood unmolested

Keeble as AF





Preferred extension is {A,C,E,F}

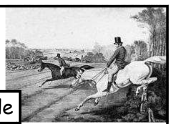


Pierson as AF

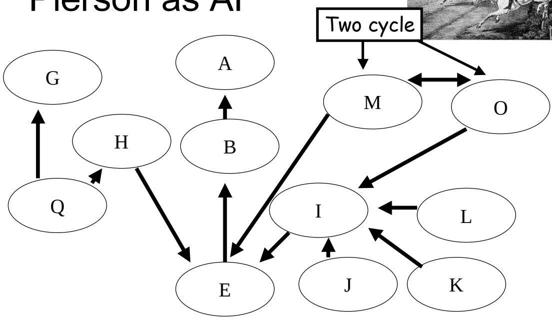
- {A, B,E} as in Keeble
- I, M: Pursuit is not enough
- J: Hypothetical: the animal was taken
- K: Hypothetical: animal was wounded
- L: Hypothetical Certain control is enough
- O: Reasonable prospect of capture
- G: Not relevant: Interferer was trespassing
- H: Not relevant: Pursuer was trespassing
- Q: The land was open

Situations which would establish right

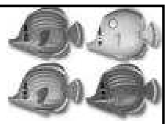
Excludes some past cases



Pierson as AF



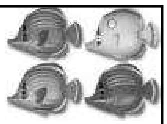
Preferred extensions are {B,I,M,P,Q} and {A,E,O,Q,R}

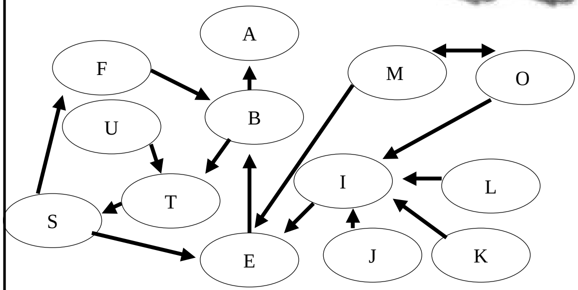


Young as AF

- Arguments in Pierson are all relevant– but now L is applicable and P is not
- F from Keeble is present
- S: Defendant was in competition with the plaintiff
- T: The competition was unfair
- U: Not for the court to rule on what is unfair competition.

Young as AF (Trespass omitted)



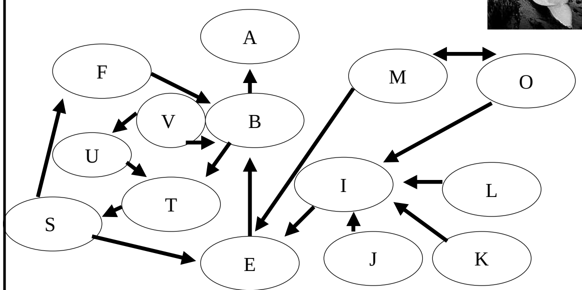


Preferred extension is {B,L,S,U} Argument U breaks the 4 cycles

Ghen Versus Rich

- New Argument V:
  - The iron holds the whale is a convention throughout the whaling industry
- Attacks U: establishes what is unfair competition is whaling
- Attacks B: Establishes what counts as possession in whaling

Ghen as AF (Trespass omitted)

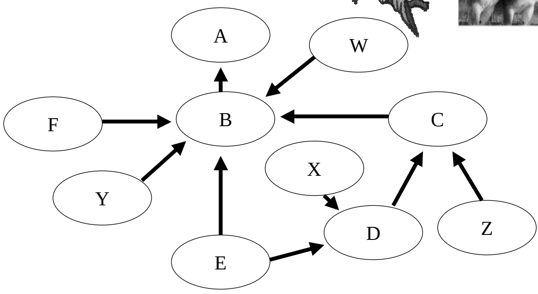


Preferred extension is {A,E,F,K,T,V}

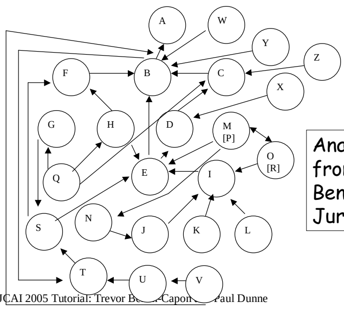
Conti and Burros Cases

- Add some special cases
  - W: Domestication sufficient
  - X: Unbranded animals go to the owner of the land
  - Y: Branding sufficient
  - Z: Animals must live on the land: straying on to someone's land does not affect title

Effect on AF

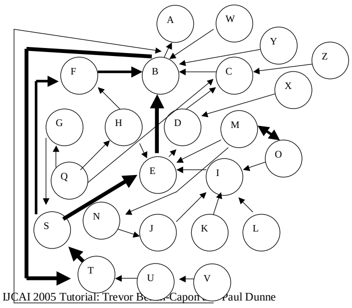


Argumentation Framework for Animals Cases



Analysis taken from
Bench-Capon 2002
Jurix 2002

Some cycles here



Blue: Need clear law

Orange: Encourage useful activity

Pierson

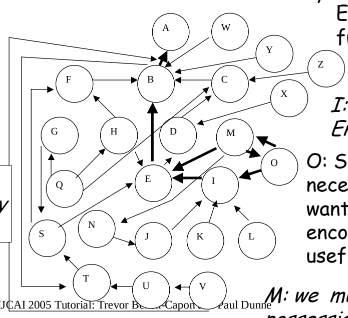
A: Pierson Had A Right To the Animal

B: Pierson had No possession

E: Pierson was in full pursuit

M and O form a 2-cycle: resolved by Value

So A is *Subjectively* acceptable



I: Pursuit not Enough

O: Seizure not necessary (we want to encourage socially useful activity)

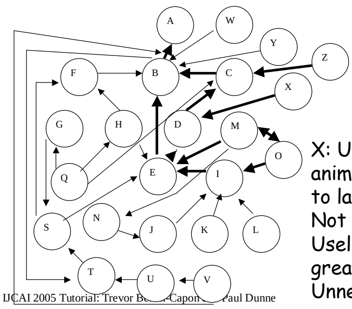
M: we must insist on possession for clear law

Green: Protect property rights

Keeble I

C: owns the land so possesses the animals

D: Animals not confined

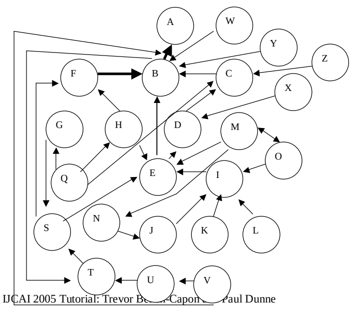


X: Unbranded animals belong to landowner. Not needed: Useless if blue greater than green Unnecessary else

Red: Promote economic activity

F: Keeble was pursuing his livelihood

Keeble II



Purple: Restrictive view of role of courts

S: Defendant in Competition

T: Competition was Unfair

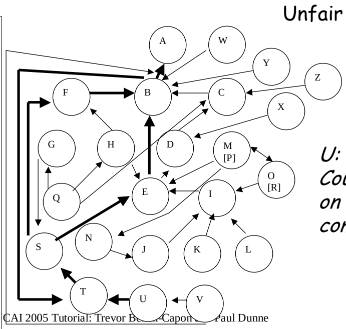
Young

U breaks the even cycle BTSEB

Without U B is defeated by its position in the even cycle

Note:
4 cycle BTSEB
TE objectively acceptable

U: Not for the Court to rule on what is unfair competition



Representation of Purpose and Audiences Can

- Account for different intuitions
- Explain different judgements in different jurisdictions
- Explain how interpretation can change over time as social attitudes change

Summary I

- Arguments are important when modelling reasoning, since proof is not possible in a variety of domains.
- Arguments are defeasible: they are attacked by other arguments and must defend themselves if they are to be acceptable. In consequences, arguments must be considered in the context of related and conflicting arguments.
- Argumentation frameworks give us a means of analysing sets of arguments to determine their status.

Summary II

- Arguments relating to action often offer a choice between alternatives, which the audience is free to resolve according to their preferences.
- Argumentation frameworks can be extended to accommodate the notion of audiences.
- Dialogue provides a natural way of modelling the process of argument between disputing parties.

Summary III

- We can analyse the structure of arguments using argumentation schemes, which may range from the entirely general to the very specific.
- We can apply the above notions to quite extensive disputes, such as an evolving body of legal case law.