ARGUMENTATION

The notion of argument and natural argumentation

Argumentation games

Legal argumentation

Arguing with priorities

WHAT IS AN ARGUMENT?

AN ARGUMENT IS

Ambiguous in natural language

- **Used as some sort of "reason"**
  a piece of evidence related to the case at stake
  (pure view as premises)
- **Move or sequence of moves in a dispute**
  (composition in context)
- **Stating relations between propositions**
  that are in some sense necessary (proof)
  (including logical relations)

WHAT IS NATURAL ARGUMENTATION?

AN EXAMPLE OF NATURAL ARGUMENTATION

P: I offer you my car for $20000.

O: Why should I pay $20000? Bob's car is similar and is only $17000.

P: $20000 is a good price since my car is safer.

O: Why is your car safer?

P: Since it has an airbag.

O: That doesn't make your car safer: the newspapers recently reported on exploding airbags.

P: But a scientific study has shown that cars with airbags are safer. And scientific studies are more reliable than newspapers.

O: OK, I admit that your car is safer. Still I cannot pay $20000; I offer $18000.

P: OK, I accept your offer.

SOME PROPERTIES OF NATURAL ARGUMENTATION

Raising pieces of evidence to strengthen or weaken a position at stake

The content of arguments (premises) may be of various sources

Strength of arguments may vary

Arguments may stand in conflict

Arguments are defeasible

Arguments are raised dynamically

Arguments need to be compared and evaluated

In some contrast with "logical" argumentation, e.g., deductive syllogisms

DEFEASIBILITY AND PROBABILITY

The lottery paradox

A fair lottery with 1 million tickets and 1 price

Probability that some ticket wins is 1

Probability that a given ticket wins is 0.000001

Is the conclusion that a given ticket will not win justified?

As a consequence, one could conclude that no ticket would win

Probability theory produces mere probabilities

Many plausible reasoning patterns are statistically invalid (e.g., chaining)

Non-monotonic logics ignore statistical dependencies between variables

NATURAL VERSUS LOGICAL ARGUMENTATION

	Logical Argumentation	*Natural Argumentation*
Truth of arguments	**required**	**debatable**
Completeness	**required**	**incomplete**
Strength	**equal**	**varying**
Reasoning pattern	**modus ponens**	**complex interrelations**

CRITIQUE ON DEDUCTIVE MODELS

Logical argument and reasoning centered around logical syllogisms

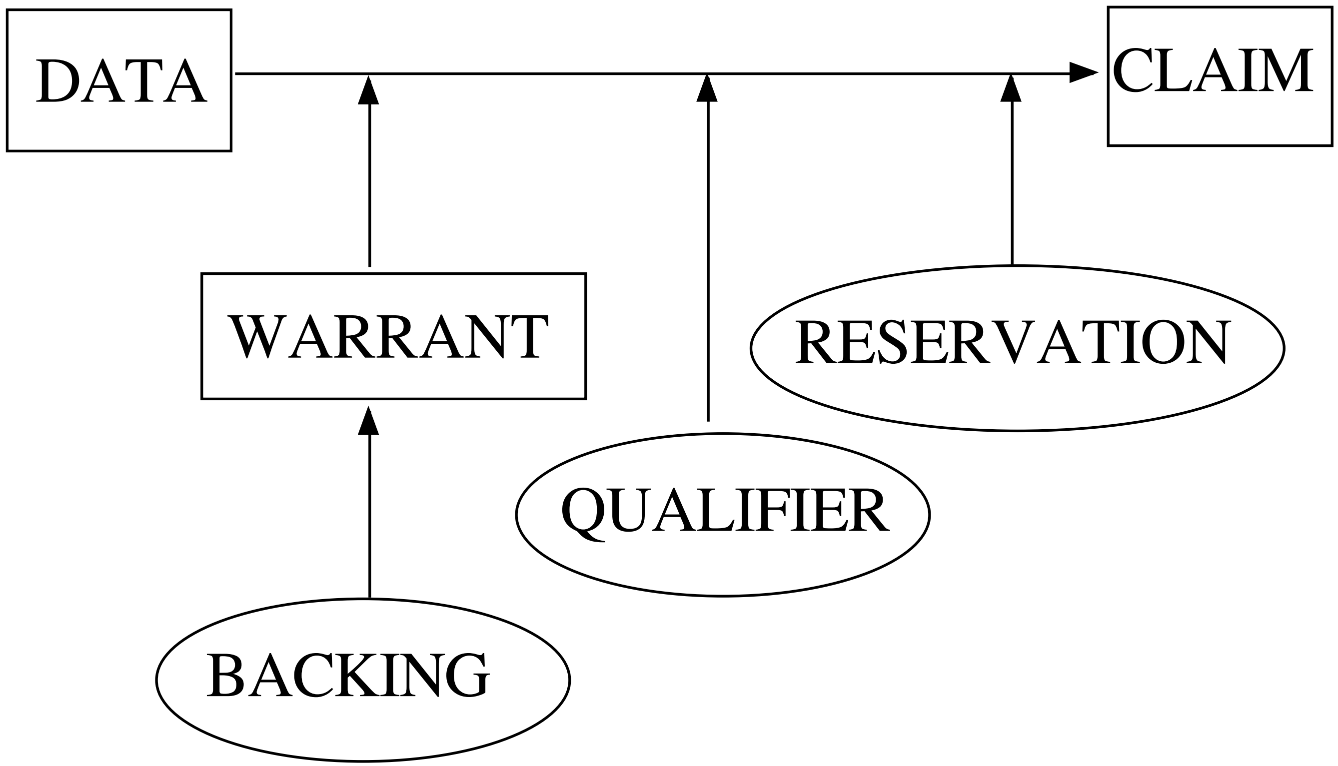
Public discourse, argument, speaking and debate does not follow these

How can we model natural argumentation?

Toulmin, a philosopher in the 1960s has developed an argumentation schema

Intended to analyse public argumentation

TOULMIN'S SCHEMATA



CENTRAL ELEMENTS

Data

Starting point of the argumentation

Types: Evidence, fact, example, opinion, experience, statistics

Claim

Purpose behind argumentation

Position to issue

JUSTIFICATION

Warrant

Logical connection between data and claim

Types:

Authority

Motivation (depends on audience)

Substantive (most similar to logic)

SUPPORTIVE ELEMENTS

Backing

Helps reasoning, enhances credability

Same types as data

Reservation

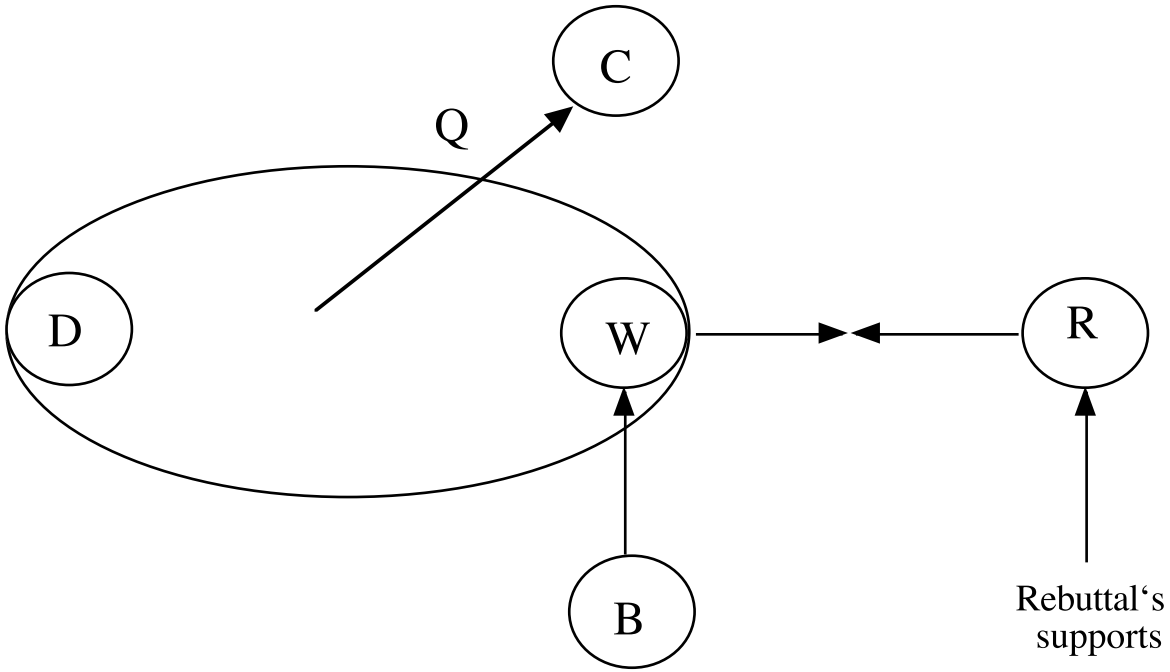
Exception, limitation

Same types as data

Qualifier

Relative strength

TOULMIN'S SCHEMATA - DATA STRUCTURE



KINDS OF REASONS

Distinction according to defeasibility

- ***indefeasible* reasons (deductive reasons):**
  conclusive reasons, that is, they logically entail the conclusion

- ***defeasible* reasons (prima facie reasons):**
  adding additional information may destroy the reason connection

Definition *prima facie reason (Pollock)*

P is a *prima facie* reason for S to believe Q if and only if P is a reason for S to believe Q and there is an R such that R is logically consistent with P but (P & R) is not a reason for S to believe Q

Examples: perception, memory, statistics, enumerative and statistical induction

DEFEATERS FOR PRIMA FACIE REASONS

Definition (Pollock)

R is a *defeater* for P as a prima facie reason for Q if and only if P is a reason for S to believe Q and R is logically consistent with P but (P & R) is not a reason for S to believe Q

Two kinds of defeaters

***Rebutting* defeaters – reasons for denying the conclusion**

***Undercutting* defeaters – attack the connection between the reason and the conclusion**

Definition *Rebutting* defeater *(Pollock)*

R is a *rebutting defeater* for P as a prima facie reason for Q if and only if R is a defeater and R is a reason for believing ¬Q

Definition *Undercutting* defeater *(Pollock)*

R is an *undercutting defeater* for P as a prima facie reason for Q if and only if R is a defeater and R is a reason for denying that P wouldn't be true unless Q were true (i.e., P → Q)

USES OF MODELS OF NATURAL ARGUMENTATION

Persuasion (in philosphy)

Argumentation structuring (e.g., for meetings)

Illustrating deductive argumentation

Legal reasoning (dispute resolution)

Collaboration and negociation (in multi-agent environments)

Argumentative dialog systems

ISSUES IN
MODELING NATURAL ARGUMENTATION

Support for finding relevant arguments

Structuring and visualizing arguments

Reasoning models to compare and assess arguments

Reasoning with arguments of varying strength

Argumentative discourse analysis

Argumentative dialog strategies

ARGUMENT SYSTEMS

Definition

An argument system is a pair <X,←> where

- **X is a set of arguments and**
- **← is a relation between pairs of arguments in X**

(a ← b means "b attacks a", "b is a counterargument of a")

Status of arguments and sets of arguments

An argument *a* is *acceptable* with respects to a set of arguments *C*, if every attacker of *a* is attacked by a member of *C*

A conflict-free set *S* of arguments is *admissible* if each argument in *S* is acceptable with respect to *S*

A set of arguments is a *preferred extension* if it is a ⊇-maximal admissible set

A conflict-free set of arguments is a *stable extension* if it attacks every argument outside it

SOME KNOWN RESULTS

(Dung, AI Journal)

Each admissible set is contained in a $\supseteq$-maximal admissible set

Every stable extension is preferred

Not every preferred extension is stable

Stable extensions do not always exist; preferred extensions always exist

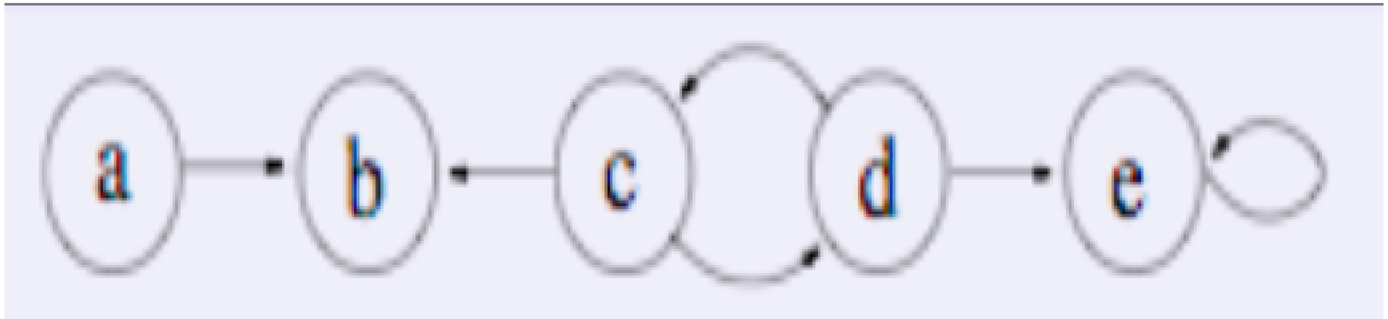
Stable and preferred extensions are generally not unique

EXAMPLES FOR DEFINITIONS (1)

Conflict-Free Set

Given an argumentation framework $F = (A, R)$.

A set $S \subseteq A$ is *conflict-free* in F, if, for each $a, b \in S$, $(a, b) \notin R$.



$cf(F) = \{\{a, c\}, \{a, d\}, \{b, \mathrm{d}\}, \{a\}, \{b\}, \{c\}, \{d\}, \emptyset\}$

EXAMPLES FOR DEFINITIONS (2)

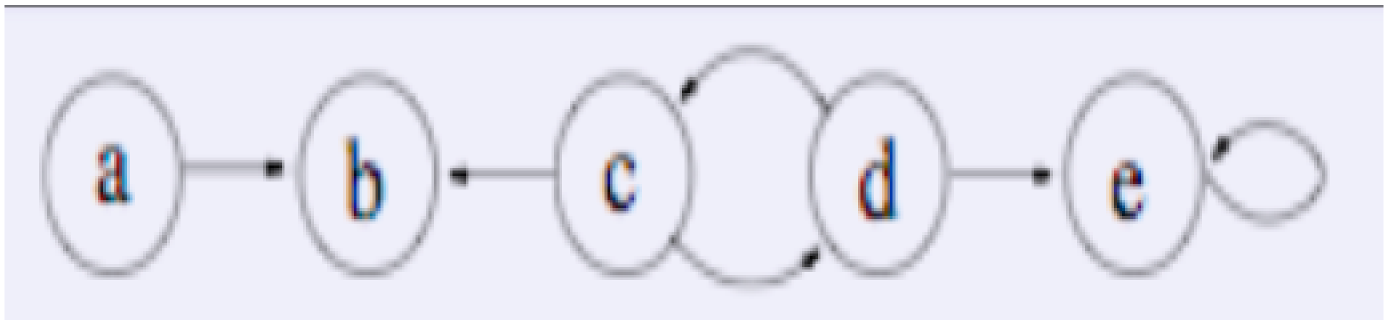
Admissible Set

Given an argumentation framework $F = (A, R)$.

A set $S \subseteq A$ is *admissible* in F, if, for each $a, b \in S$, $(a, b) \notin R$.

- **S is conflict-free in F**
- **each $a \in S$ is defended by S in F, ($a \in A$ is defended by S in F ,**

  if for each $b \in A$ with $(b, a) \in$ R, there exists a $c \in S$, such that $(c , b) \in R$)



$cf(F)$ = {{a, c}, {a, d}, ~~{b, d}~~, {a}, ~~{b}~~, {c}, {d}, Ø}

EXAMPLES FOR DEFINITIONS (3)

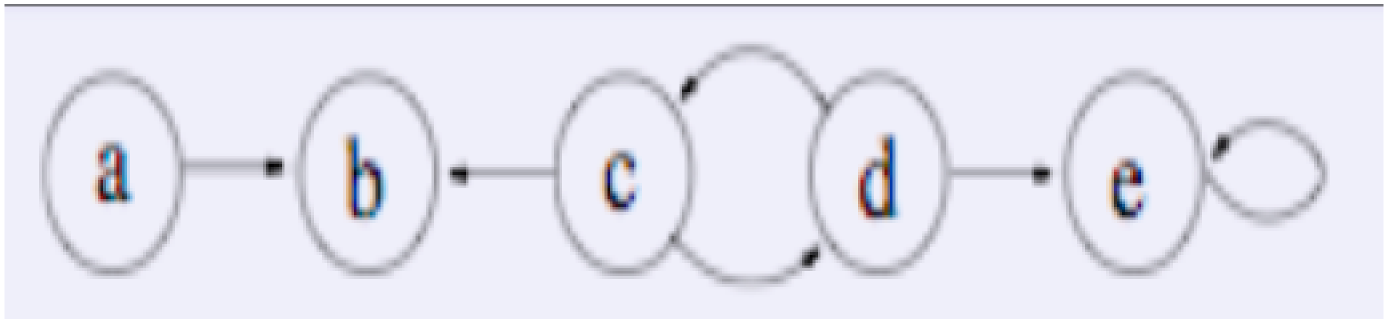
Grounded extension

Given an argumentation framework $F = (A, R)$.

The *grounded extension* of an argumentation framework $F = (A, R)$ is given by

the least fixpoint of the operator $\Gamma_F : 2^A \rightarrow 2^A$,

defined as $\Gamma_F(S) = \{a \in A \mid a$ is defined by S in $F\}$



***ground*(F) = {{a}}**

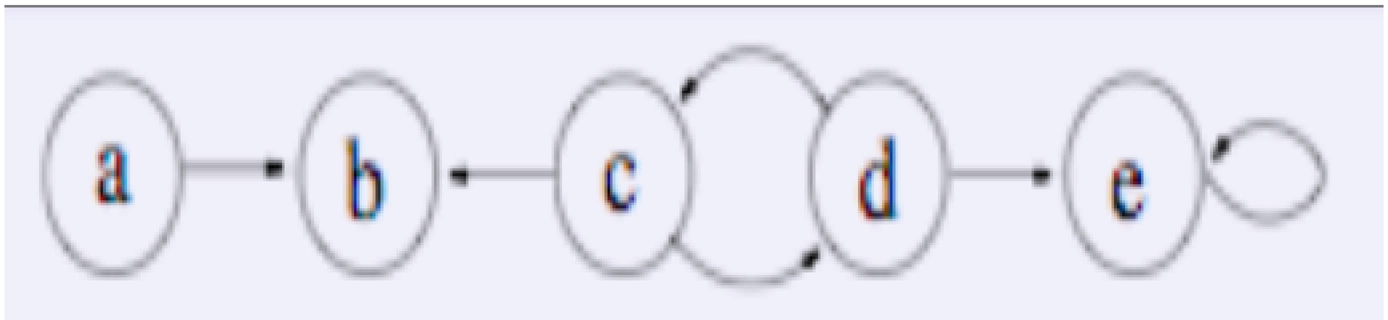
EXAMPLES FOR DEFINITIONS (4)

Preferred extension

Given an argumentation framework $F = (A, R)$.

A set $S \subseteq A$ is *preferred* in F, if

- **S is *admissible* in F**
- **each $T \subseteq A$ admissible in F, not $T \supset S$**



***pref(F)* = {{*a*, *c*}, {*a*, *d*}, ~~{*a*}, {*c*}, {*d*}, Ø~~}**

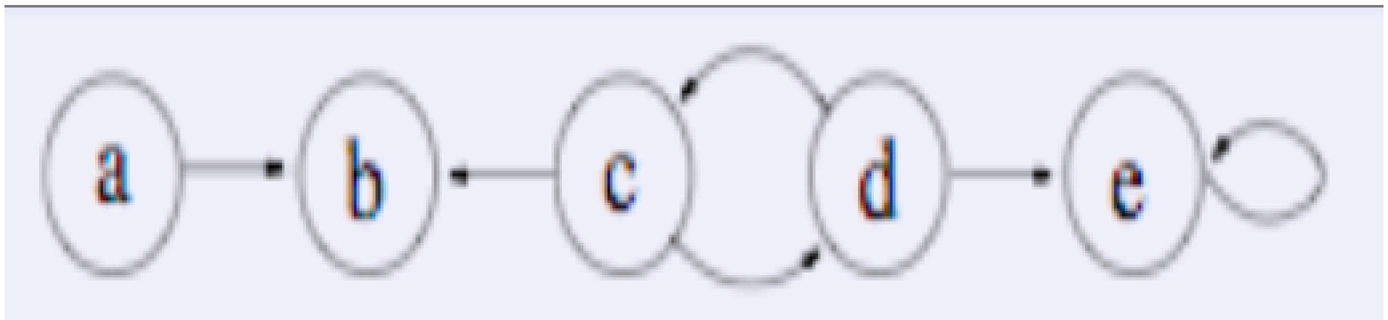
EXAMPLES FOR DEFINITIONS (5)

Stable extension

Given an argumentation framework *F* = (*A*, *R*).

A set *S* ⊆ *A* is *stable* in *F*, if

- ***S* is *conflict-free* in *F***
- **for each *a* ∈ *A* \ *S*, there exists a *b* ∈ *S*, such that (*b*, *a*) ∈ *R***



***stable*(*F*) = {~~{*a*, *c*}~~, {*a*, *d*}, ~~{*b*, d}, {*a*}, {*b*}, {*c*}, {*d*}, Ø~~}**

VALUE-BASED ARGUMENTATION FRAMEWORK

Definition

A *value-based argumentation framework* (*VAF*) is a 5-tuple:

$VAF = \langle AR, attacks, V, val, valpref \rangle$

AR and attacks are as for a standard argumentation framework

V is a non-empty set of values

val* is a function which maps from elements of *AR* to elements of *V

***valpref* is a preference relation (transitive, irreflexive and asymmetric) on *V* x *V*.**

We say that an argument *A* relates to value *v* if accepting *A* promotes or defends *v*:

the value in question is given by val(*A*). For $A \in AF$, $val(A) \in V$.

An argument $A \in AF$ defeats an argument $B \in AF$

if and only if both attacks(A,B) and not valpref(val(B),val(A)).

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, the *VAF* becomes a standard *AF*.

If each argument maps to a different value,

we have a Preference Based Argument Framework (Amgoud and Cayroll 1998)

IMPORTANT NOTIONS FOR VALUE-BASED ARGUMENTATION FRAMEWORK

An argument $A \in AR$ is *acceptable* with respect to set of arguments S,

(*acceptable*(A,S)) if:

$$(\forall x)((x \in AR \ \& \ defeats(x,A)) \rightarrow (\exists y)((y \in S) \ \& \ defeats(y,x))).$$

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

$$(\forall x)\ (\forall y)((x \in S \ \& \ y \in S) \rightarrow (\neg\, attacks(x,y) \vee valpref(val(y),val(x)))).$$

A conflict-free set of arguments S is *admissible* if

$$(\forall x)(x \in S \rightarrow acceptable(x,S)).$$

A set of arguments S in an argumentation framework AF is a *preferred extension* if it is a maximal (with respect to set inclusion) admissible set of AR.

A conflict-free set of arguments S is a *stable extension* if and only if S attacks each argument in AR which does not belong to S.

Given an order on values, a *polychromatic* cycle in a *VAF* has a unique, non-empty preferred extension.

ALGORITHM FOR COMPUTING EXTENSIONS

EXTEND(AR,attacks).

1) $S := \{s \in AR: (\forall y)(\text{not } defeats(y,s))\}$

2) $R := \{r \in AR: \exists s \in S \text{ for which } defeats(s,r)\}$

3) If $S = \emptyset$ then return S and Halt

4) $AR' := AR / (S \cup R)$

5) $attacks' := attacks / ((S \times R) \cup (R \times AR) \cup (AR \times R))$

6) Return $S \cup EXTEND(AR', attacks')$

PROPERTIES OF CYCLES (1)

In a dichromatic three cycle
the argument coloured differently from the other two will be objectively acceptable.

An argument chain in a VAF, *C* is a set of n arguments {a_1 ... a_n} such that:

i. $(\forall a)(\forall b)(a \in C \,\&\, b \in C) \rightarrow \mathrm{val}(a) = \mathrm{val}(b)$);

ii. *a1* has no attacker in *C*;

iii. For all $a_i \in C$ if $i > 1$,

then a_i is attacked and

the sole attacker of a_i is a_{i-1}.

In any dichromatic cycle,
the odd numbered arguments of any chain preceded
by an even chain will be objectively acceptable.

The preferred extension of a dichromatic cycle comprises:

(i) the odd numbered arguments of all chains preceded by an even chain;

(ii) the odd numbered arguments of chains with the preferred value;

(iii) the even numbered arguments of all other chains.

PROPERTIES OF CYCLES (2)

In a dichromatic VAF:

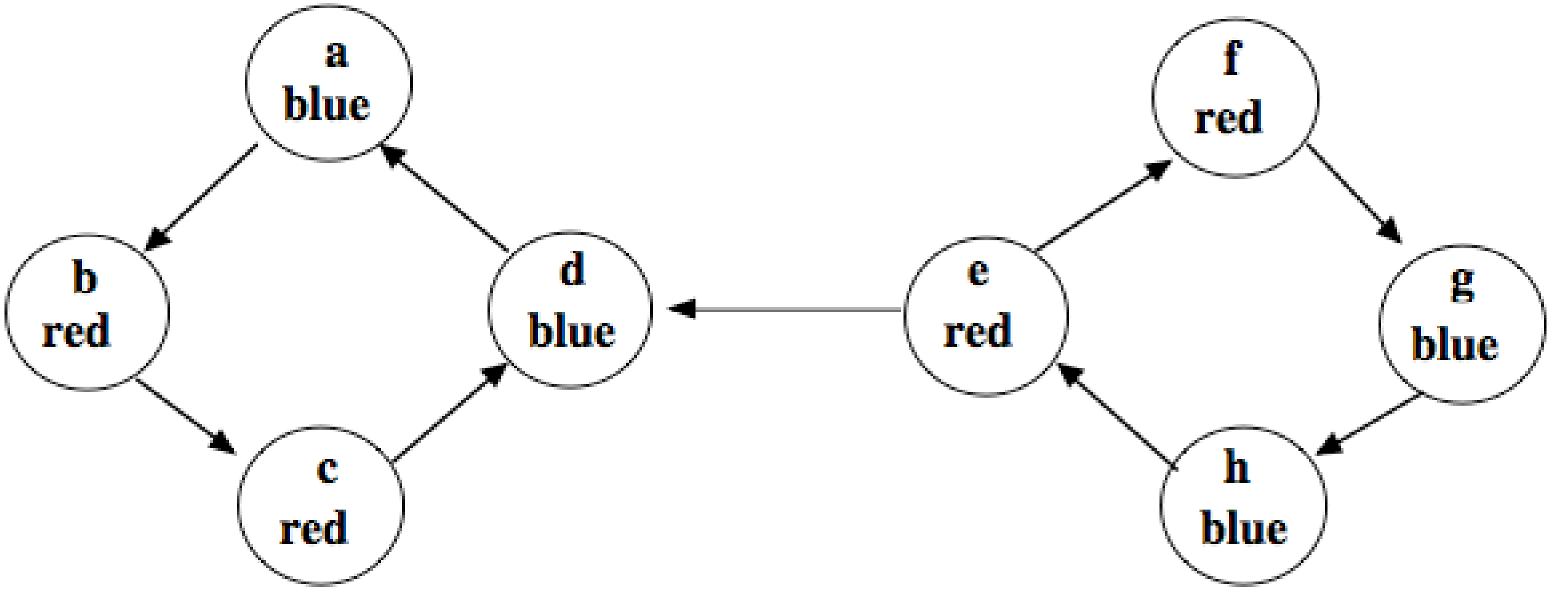
i. an argument is indefensible
if it an even numbered member of any chain preceded only by even chains;
or if it an even numbered member of a chain attacked by an odd chain, and is directly attacked by an odd chain;

ii. an argument is objectively acceptable
if it is only an odd numbered argument of a chain preceded only by even chains;

iii. an argument is subjectively acceptable otherwise.

An unattacked argument is considered to be preceded by a chain of length zero, hence an even chain.

AN EXAMPLE (1)

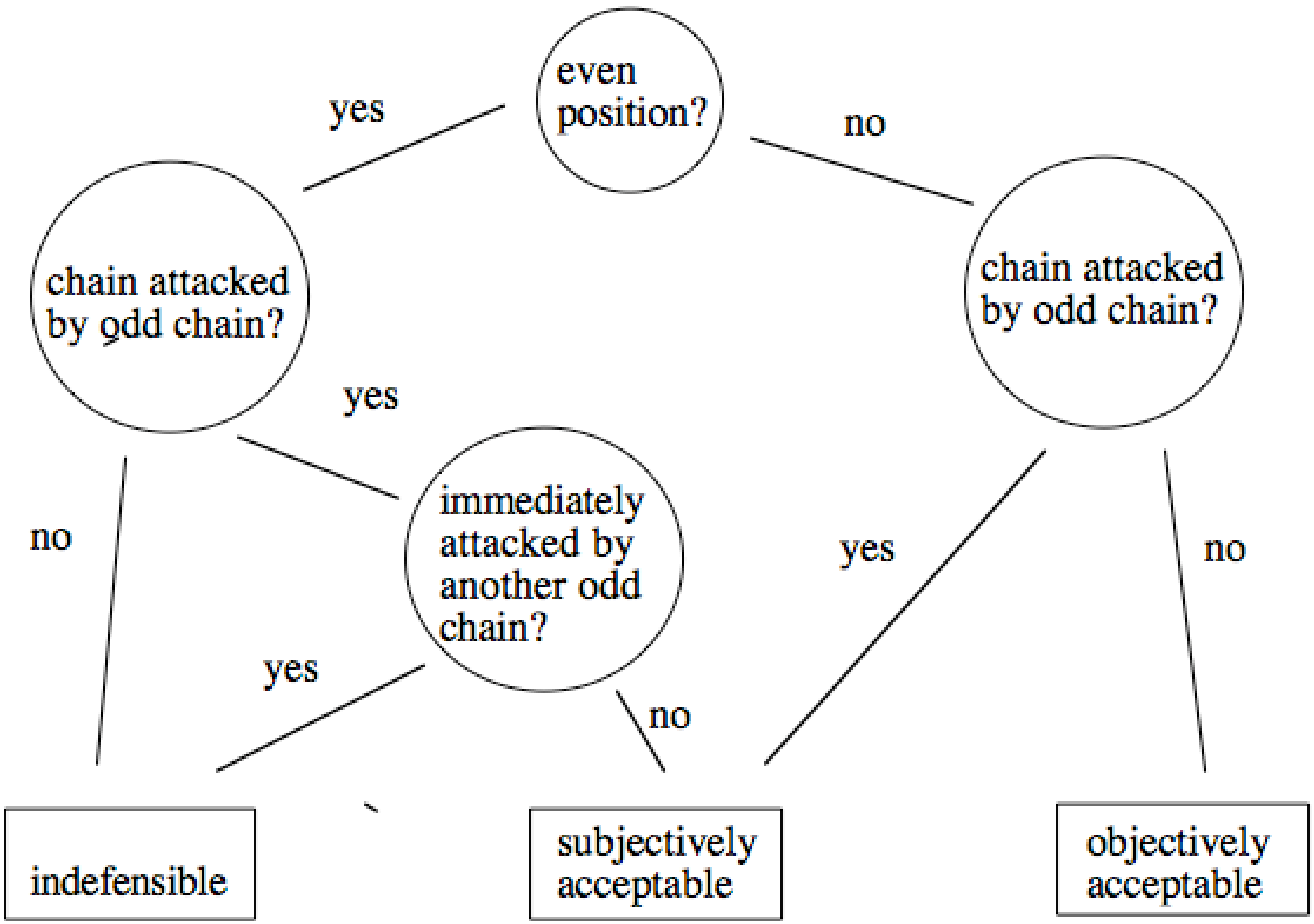


Now the blue argument d is the successor not only of the chain bc,
but also of the one argument chain e.
(Argument e is part of two chains, e and ef).

AN EXAMPLE (2)

There will be two preferred extensions,
according to whether red > blue, or blue > red.
If red > blue, the preferred extension will be {*e,g,a,b*}, and if blue > red, {*e,g,d,b*}.
Now *e* and *g* and *b* are objectively acceptable,
but *d*, which would have been objectively acceptable if *e* had not attacked *d*,
is only subjectively acceptable, and
***a*, which is indefensible if *d* is not attacked, is also subjectively acceptable**
Arguments *c* and *h* remains indefensible.
So, to be objectively acceptable,
an argument must be an odd numbered member of a chain preceded *only*
by even chains.
Suppose that instead of *e* attacking *d*, *h* attacked *d*.
In this case *d* would be part of the even chain *ghdb*, preceded by the even chain *ef*.
Now {*egdb*} is the only preferred extension, whatever the value ordering,
since all chains are preceded only by even chains.

DECISION PROCESS FOR STATUS OF AN ARGUMENT



AN EXAMPLE WITH CONFLICTS (1)

The basic situation

Hal, a diabetic, loses his insulin in an accident through no fault of his own.
Before collapsing into a coma he rushes to the house of Carla, another diabetic.
She is not at home, but Hal enters her house and uses some of her insulin.
Was Hal justified, and does Carla have a right to compensation?

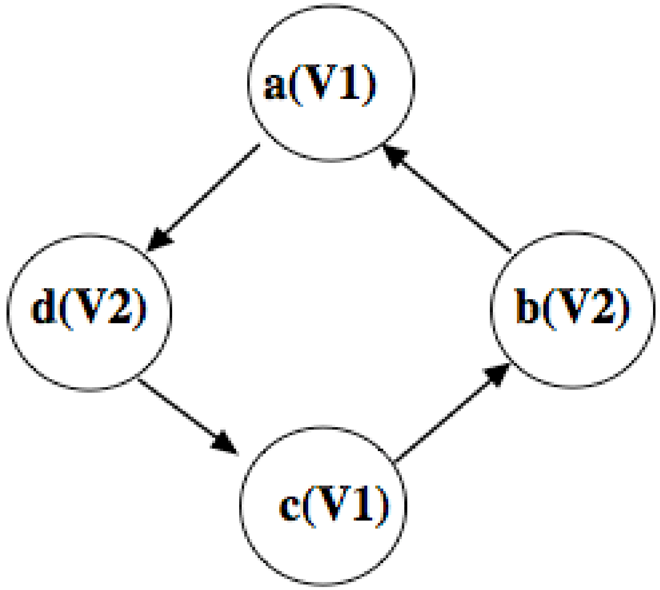
The first argument (*a*) is based on the value that life is important (V1), the second (*b*) on the value that property owners should be able to enjoy their property (V2).
By valuing life over property we can accept both arguments.

But now we may add a third argument, (*c*) attacking (*b*).
This says that even if Hal were too poor to compensate Carla,
then he should still be able to take the insulin: no one should die through their poverty.

This in turn could be attacked by argument (*d*) which is based on the fact that starvation is not a recognised defence against theft, even of food.
This argument is itself attacked by (*a*), so we have a four cycle with alternating values.

AN EXAMPLE WITH CONFLICTS (2)

The basic cycle



Either we can value human life over property, in which case we reject (*b*) and (*d*), and do not oblige Hal to compensate Carla, or we reverse our preference and have Hal in default if he cannot pay the compensation.

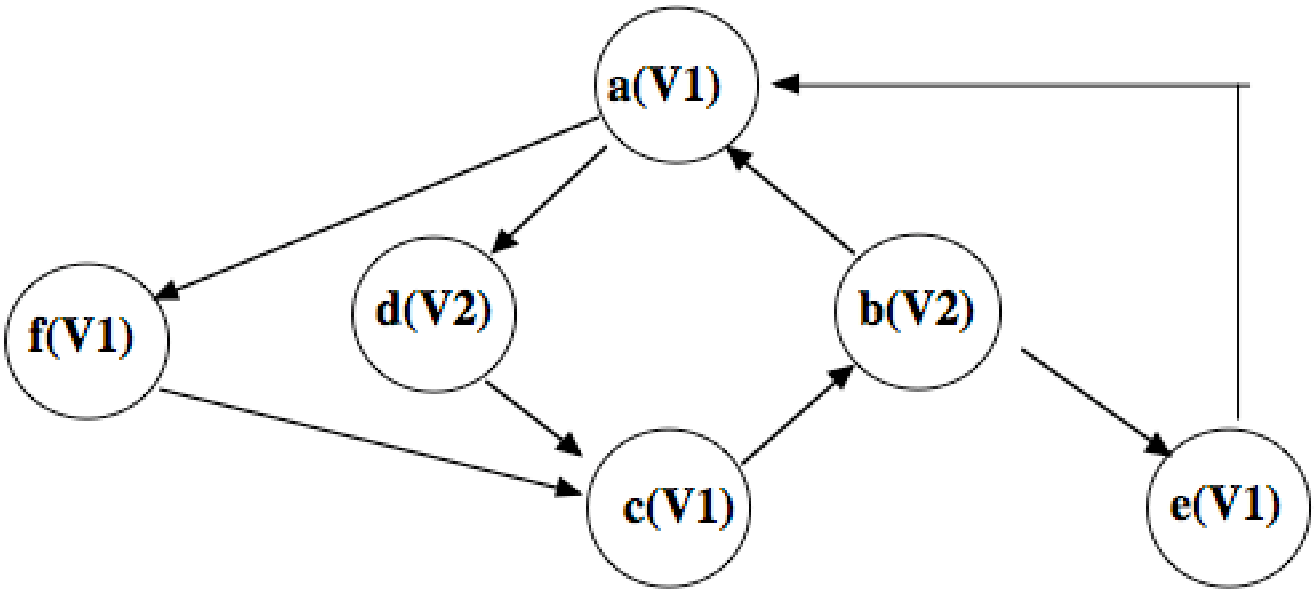
AN EXAMPLE WITH CONFLICTS - 1. EXTENSION (1)

Instead of using argument (b) we attack (a) with an argument (e)
to the effect that Hal is endangering Carla's life by consuming her insulin.
On her return she may be in need of the insulin which is no longer available.
Here both (e) and (a) are based on the same value, so (e) defeats (a).
The threat to Carla can be removed by Hal replacing the insulin,
so we can attack (e) by an argument that Hal should replace the insulin,
effectively argument (b) above.

Suppose we use a life based argument, (f) to the effect that
no one should preserve their own life at the cost of endangering another's.
This argument is attacked by (a)
which held that one may do anything to preserve one's own life.

In the five cycle,
we have objectively to accept the property based argument, and
conclude that Hal is not justified in taking the insulin without compensation.

AN EXAMPLE WITH CONFLICTS - 1. EXTENSION (2)



Suppose V1 (life) is preferred to V2 (property).
Now (*e*) is in the preferred extension
because it is attacked only by (*b*) which has the inferior value.
So (*a*) is out, because attacked by (*e*), so (*f*) and (*d*) are in, because attacked only by (*a*).
Now (*c*) is defeated by (*f*), and (*b*), attacked only by (*c*), is in.
Thus, given V1 > V2, the rational position is {*e*,*f*,*d*,*b*}.

AN EXAMPLE WITH CONFLICTS - 1. EXTENSION (3)

Now suppose V2 > V1:
now (*b*) is in, because it is only attacked by the lower ranked (*c*).
Therefore (*a*) and (*e*) are defeated by (*b*).

With (*a*) out, (*f*) and (*d*) are in and (*f*) defeats (*c*).
So, for V2 > V1, the rational position is {*b*,*f*,*d*}.

Thus (*b*), (*f*) and (*d*) are objectively acceptable, and
(*e*) is subjectively acceptable, if we value life over property.

No one should preserve their own life at the cost of endangering another's.
This argument is attacked by (*a*)
which held that one may do anything to preserve one's own life.

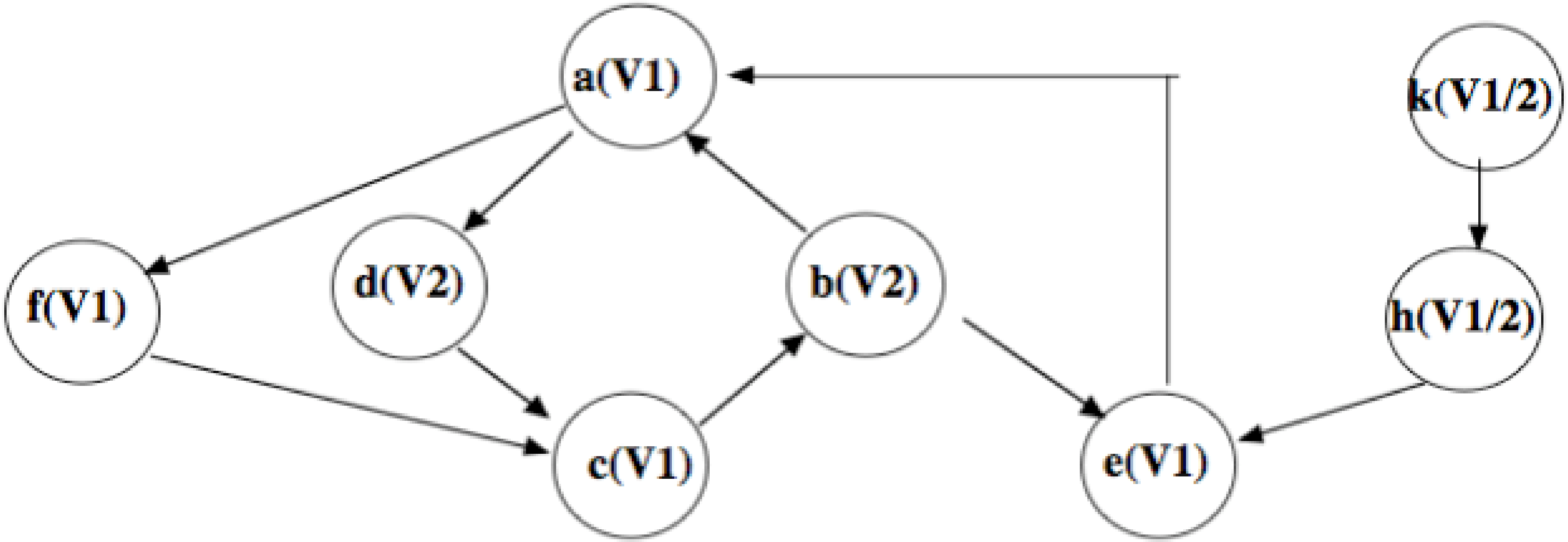
The conclusion is that Hal can take the insulin
only if he replaces it before Carla needs it, hence only if he is able to replace it.
Note that (*a*) and (*c*) are indefensible

AN EXAMPLE WITH CONFLICTS - 2. EXTENSION (1)

Now suppose Carla is a nurse.

Suppose we attack (*a*) by an argument (*g*) saying that
the life of some other diabetic is endangered,
since they may rely on Carla being in a position to supply them with insulin.

We may attack this by a factual argument (*h*) to the effect that
Carla is well stocked with insulin and will be able to meet any foreseeable demand.



AN EXAMPLE WITH CONFLICTS - 2. EXTENSION (2)

But we may again argue (k) that Hal cannot possibly know that this so:
Carla may have allowed her stocks to run down.

Suppose here we allow it to take V1, since that will ensure that it always defeats (g).
Now (k) is undefeated since it is a source. (h) is therefore defeated by (k).
(a) will be defeated by (b) if V2 > V1 and by (g) if V1 > V2.
Thus (f) and (d) are undefeated, and (c) is defeated by (f), leaving (b) undefeated.
Thus all of (k), (b), (f) and (d) are objectively acceptable, and
(g) is acceptable provided that V1 > V2.

(a) and (c) are indefensible. This seems to be a reasonable resolution of the dispute:
that the principle of necessity, that one may do anything to preserve one's own life, does not license endangering the lives of others.

No attack on a successor argument, or any more remote argument need be considered.
To change the position of an argument within a chain we can either extend the chain (with an argument of the same colour), if the chain is unattacked; or attack some preceding odd numbered argument in the chain (with an argument of either colour).
To make an argument part of an additional chain we must attack that argument

CONSTRUCTING AN ADMISSIBLE SET

An argument game is played by a proponent PRO and an attacker CON.

The game amounts to testing membership in some extension for an argument.

Since each admissible set is contained in a maximally admissible set,

constructing an admissible set around the argument in question is attempted

Composition of two kinds of subtasks

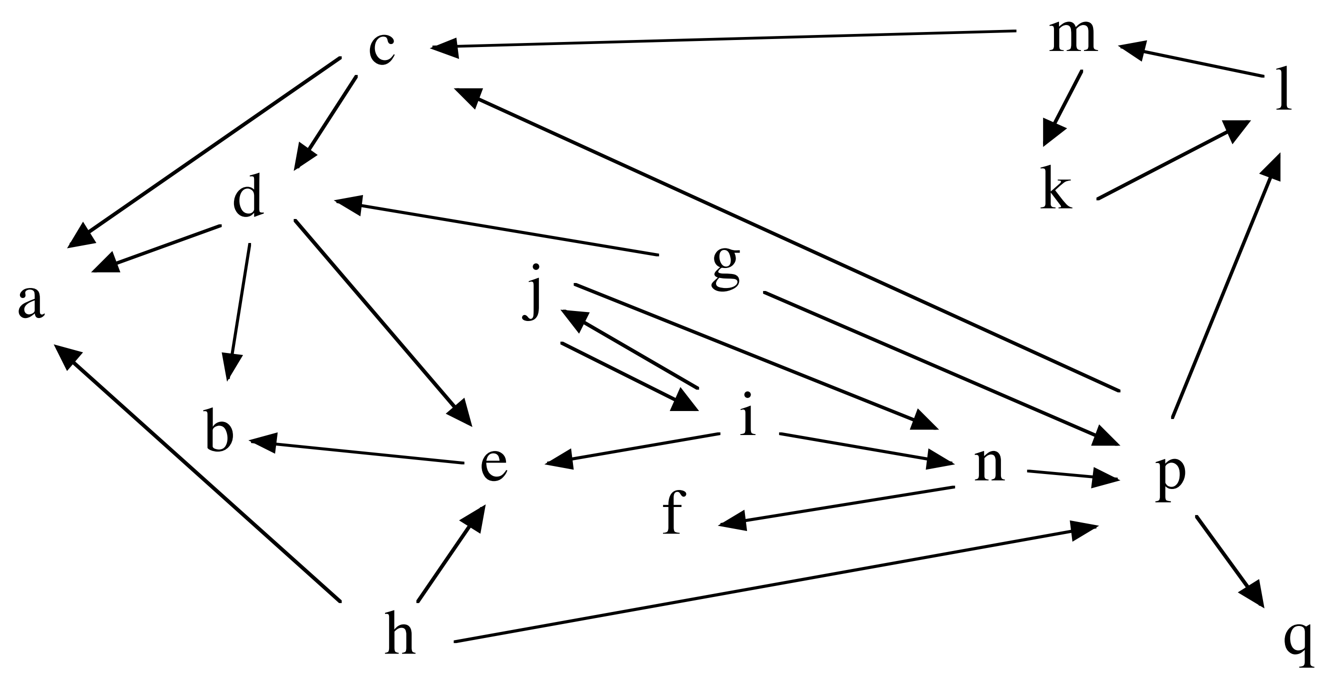
Construction

Finding attackers to counterarguments of the argument is question, which are consistent

Criticism

Finding attackers to an argument raised by PRO, to force him to raise more arguments

AN ARGUMENT SYSTEM



REPETITION OF MOVES

Questions

Is move repretition meaningful?

Under what circumstances (by PRO or by CON, in the same line or not, …)

Constellations of interest

PRO can repeat himself, since CON may fail to find a new attacker; in this case, PRO's repetition closes a cycle of even length, of which PRO's arguments are admissible.

CON should repeat PRO, since this would show PRO's arguments being not conflict-free

PRO should not repeat CON, because this would introduce a conflict in his arguments

For CON, repeating an own argument does not make sense, since PRO has already shown

THE CREDULOUS ARGUMENT GAME

Correspondence between disputes and preferred extensions

A *move* is an argument (if the first move) or else an argument attacking one of the previous arguments of the other player

An *eo ipso* is a move that uses a previous non-backtracked argument by the other player

A *block* is a move that places the other player in a position in which he cannot move

A *two-party immediate response dispute* (TPI-dispute) is a dispute in which both parties are allowed to repeat PRO, in which PRO is not allowed to repeat CON, and in which CON is allowed to repeat CON iff the second use is in a different line of the dispute. CON wins if he does an eo ipso or blocks PRO. Otherwise, PRO wins.

Definition (soundness and completeness)

An argument is in some preferred extension iff it can be defended in every TPI-dispute

THE SCEPTICAL ARGUMENT GAME

Correspondence between disputes and preferred extensions

Rather than showing that the main argument is contained in a preferred set, PRO wishes to verify whether the main argument is contained in *all* preferred sets.

A result for sceptical reasoning can be obtained by observing that a dispute is symmetric, since CON can also be given the task of constructing an admissible set for each attacker he uses. If CON succeeds, he has shown that there exists at least one admissible set not included in the main argument

Definition (soundness and completeness)

In argument systems where each preferred extension is also stable, an argument is in all preferred extensions iff it can be defended in every TPI-dispute, and none of its attackers can be defended in every TPI-dispute

ARGUMENTATION FRAMEWORKS

Components

1. **The underlying logic**
2. **Arguments (a move or a sequence of moves in a dispute)**
3. **Conflicts between arguments (rebutting or undercutting)**
4. **Standards for comparing arguments**
   (ordering, e.g. specificity; only general criteria, such as non-circularity, transitivity)
5. **Assessment of arguments**

The first two constitue a general logical framework, the last three are specific for argumentative frameworks

Note, that conflict resolution is done outside the proper logic

LAYERS IN ARGUMENTATION

Components

1. **The *logical* layer**
   How pieces of information can be combined

2. **The *dialectical* layer**
   Given a set of arguments and evaluation criteria, it defines which arguments prevail

3. **The *procedural* layer**
   Regulates how an actual dispute is conducted, how each party can act and react

4. **The *strategic* or *heuristic* layer**
   Rational ways of conducting a dispute within the rules given by the third layer

An alternative view (Gordon, Brewka) has three layers (missing the strategic part):

1. **The *logical* layer (comprising levels 1 and 2 from the above)**
2. **The *speechact* layer (differentiating level 3 from the above)**
3. **The *protocol* layer (differentiating level 3 from the above)**

THE FOUR LAYERS IN A LEGAL DISPUTE

An example

P_1: I claim that John is guilty of murder.

O_1: I deny your claim.

P_2: John's fingerprints were on the knife.
If someone stabs a person to death, his fingerprints must be on the knife.
So, John has stabbed Bill to death.
If a person stabs someone to death, he is guity of murder.
So, John is guilty of murder.

O_2: I concede your premises, but I disagree that they imply your claim:
Witness *X* says that John has pulled the knife out of the dead body.
This explains why his fingerprints were on the knife.

P_3: X's testimony is inadmissible evidence, since she is anonymous.
Therefore, my claim still stands.

THE FOUR LAYERS IN THE LEGAL DISPUTE

The procedural layer

With P_1, the proponent of a claim starts a dispute by stating his claim.

The opponent can either accept or deny this claim

Since the opponent does not accept, the burden of proof passes to P.

P attempts to fulfil this burden with a argument for his claim (P_2).

The logical layer

Whether a non-deductive argument is constructible, is determined at this layer.

This hold for arguments with an abductive inference step, such as P_2.

The dialectical layer

Whether an argument has attacking sufficient strength is determined at this layer.

The strategic layer

Evidence can be attacked by arguing that it is inadmissible, which it what P_3 does.

THE PLEADINGS GAME (Gordon)

The idea - models procedural view on justice

Parties exchange arguments and counterarguments, to identify the issues to be decided

Keeping track of stated arguments and their dialectical relations

Chacking whether the procedure is obeyed, according to speech acts admissible

Structural rules

Starting with the plaintiff stating his main claim

Players must respond in some permissible way to every still relevant opponent move

Moves must be permissible

Game results

Lists of issues identified during the game

A winner, if there is one

THE PLEADINGS GAME (An example, Gordon) (1)

The moves

P_1: Claim [(1) Contract]

O_1: Deny (1).

P_2: Argue [(2) Offer, (3) Acceptance, (4) Offer ^ Acceptance ⇒ Contract, so Contract].

O_2: Concede(2,4), Deny (3),

Argue [(5) "Accept" late, (6) "Accept" late ⇒ ¬Acceptance, so ¬Acceptance]

P_3: Concede(5), Deny (6), Argue [(5) "Accept" late, (7) "Accept" recognized,

"Accept" late ^"Accept" recognized ⇒ Acceptance, so Acceptance]

O_3: Concede(8,[5,7,8]), Deny (7)

P_4: Deny (Deny(7)).

THE PLEADINGS GAME (An example, Gordon) (2)

The resulting dialectical graph

P_1: [2,3,4] for Contract

O_1: [5,6] for ¬Acceptance

P_2: [5,7,8] for Acceptance

Unconceeded claims

(1) Contract

(3) Acceptance

(6) "Accept" late ⇒ ¬Acceptance

(7) "Accept" recognized

The judge has to decide whether the conceded claims (2), (4), (5) should be extended by the issues (6) and (7). Only then the main claim (1) is defeasibly implied by the premises

AN ARGUMENTATIVE DIALOG

P:	**My car is safer than your car.**	**(persuasion: making a claim)**
O:	**Why is your car safer?**	**(persuasion: asking grounds for a claim)**
P:	**Since it has an airbag.**	**(persuasion: offering grounds for a claim; dispute: stating an initial argument)**
O:	**That is true,**	**(persuasion: conceding a claim)**
	but I disagree that this makes your car safer: the newspapers recently reported on airbags expanding without cause.	**(dispute: stating a counterargument)**
P:	**I also read that report,**	**(persuasion: conceding a claim)**
	but a recent scientific study showed that cars with airbags are safer than cars without airbags, and scientific studies are more reliable than sporadic newspaper reports.	**(dispute: rebutting a counterargument, and arguing about the strength of conflicting arguments)**
O:	**OK, I admit that your argument is stronger than mine.**	**(persuasion: conceding a claim)**
	However, your car is still not safer, since its maximum speed is much higher.	**(dispute: alternative counterargument)**

ELEMENTS OF A DIALOG

- **Players, a proponent and an opponent (referees, mediators etc. belong to other protocols)**
- **A set of arguments (well-formed, valid), according to some notion of logical consequence**
- **A relation of relative strength of arguments (one of the grounds for legality of moves)**
- **Well-formed moves, including a player, an argument, reference to move it replies to**
- **A function Player to move, for each stage; it is usually alternating, but not necessarily**
- **A legal move function, determines which of the well-formed moves are also legal**
- **A notion of a dialog, the series of moves made by the player to move**
- **A winning criterion, that is a dialog being won by a player if the opponent cannot move**
- **A provability criterion, that is an argument is provably tenable, if it starts a winning strategy against every way of attack**

ELEMENTS OF A FRAMEWORK

Aspects of dialog systems

- ***Locution* rules (what rules are possible)**
- ***Structural* rules (what rules are legal)**
- ***Commitment* rules (the effects of moves on the players commitments)**
- ***Termination* rules (when dialogs terminate and with what outcome)**

Variations

- **Single or multiple moves per turn**
- **Choices in alternatives to earlier moves**
- **Various sets of speech acts (always including claims and arguments)**
- **Different rules for legality**
- **Different underlying argument games**
- **Different rules for the effects of moves on the commitments of the players**
- **Different termination and winning criteria**

SOME ELEMENTS IN DETAIL (1)

Speech acts and replies

- ***Speech acts*: {claim(φ), argue(ϕ ,so φ)}**
- ***Replies:* a function which assigns possible replies to a speech act**
  - **defined in terms of (disjoint) functions *Attackers* and *Surrenders*;**
  - **to the former, there are always further replies, to the latter there are none**

Commitment and legality

- ***Commitment:* assigns to players at each stage of a dialog a set of commited propositions**
- ***Legal*: a function that specifies legal moves at each point of a dialog**
  - **based on the dialog so far and the players' commitments**

SOME ELEMENTS IN DETAIL (2)

Disputes and winning

- ***Dispute*: sequence of moves, all of which are legal in given state with player to move**
- ***Winner:* a (partial) function which maps disputes to players**
  - **Conditions: player p wins if it is the opponents move, but he has no legal moves**

Relevance

- ***Goal:* allowing maximal freedom (e.g., backtracking and postponing replies)**

  thereby ensuring focus
- ***Dialogical status*:**

  a move is either *in* or *out*; it is *in* if is conceded or all its attacking moves are out
- ***Relevant move:* attacking replies to it change the dialogical status of the initial move**

SPEECH ACTS

Possible continuations

Acts	Attacks	Surrenders
claim φ	**why φ**	**concede φ**
why φ	**argue(ϕ , so φ)**	**retract φ**
concede φ		
retract φ		
argue(ϕ ,so φ)	**why φ_i ($\varphi_i \in \phi$)**	**concede φ_i ($\varphi_i \in \phi$)**
	argue(ϕ',so φ')	**concede φ' (φ' implies ϕ)**
concede (ϕ implies φ)		

SOME ELEMENTS IN DETAIL (3)

Commitment and legality

- ***Commitment*: propagated from previous dialog state**

  formulas referred to in *claim* or *argue* added, formulas in *retract* retracted

- ***Legality:* regulated by some conditions**
  - **Each move must leave the mover's commitments classically consistent**
  - **For a *concession*, the content must not be derivable from the previous commitments, and these commitments must not justify the opposite of this content**
  - **The content of a *retract* move must have been previously added to the commitments**
  - **For a *why* act, the commitments must not justify the content of the *why* act**
  - **For an *argue* act, all preceding why moves with related content are out**
  - **Replies to an *argue* act are not possible, if that *argue* move is already condeded**

A FIRST EXAMPLE

Moves	Commitments(P)	Commitments(O)
	$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p\}$	$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p\}$
P_1: *claim* p	$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p, p\}$	
O_1: *why* p		
P_2: argue (r, s, $r \wedge s \Rightarrow p$, so p)	$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p, p,$ $r, s, r \wedge s \Rightarrow p\}$	
O_2: concede r		
argue (q, $q \Rightarrow t$, $t \Rightarrow \neg s$, so $\neg s$)		$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p,$ $p, r, q \Rightarrow t, t \Rightarrow \neg s, \neg s\}$
P_3: argue (r, q, $q \Rightarrow t$, $r \wedge t \Rightarrow p$, so p)	$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p, p,$ $r, s, r \wedge s \Rightarrow p, r, t, q \Rightarrow t\}$	
O_3: argue (s, $s \Rightarrow \neg q$, so $\neg q$)		$\{s \Rightarrow \neg q, r \wedge t \Rightarrow p, q, r,$ $q \Rightarrow t, t \Rightarrow \neg s, \neg s\}$

A LONGER EXAMPLE (only moves)

P_1: *claim* **p**

P_2: *argue* **(q, q ⇒ p, so p)**

P_3: *argue* **(s, t, s ^ t ⇒ p, so p)**

P_4: *argue* **(u, u ⇒ s, so s)**

P_5: *argue* **(x, x ⇒ s, so s)**

P_6: *argue* **(z, z ⇒ ¬r, so ¬r)**

(O_6 jumps back to P_3)

P_7: *argue* **(k, k ⇒ t, so t)**

O_1: *why* **p**

O_2: *argue* **(r, r ⇒ ¬p, so ¬p)**

(P_3 jumps back to O_1)

O_3: *why* **s**

O_4: *argue* **(v, v ⇒ ¬u, so ¬u)**

(P_5 jumps back to O_3)

O_5: *argue* **(y, y ⇒ ¬x, so ¬x)**

(P_6 jumps back to O_2)

O_3: *why* **t**

BUILDING LEGAL ARGUMENTATION TREES

Combinations of arguments

Let (A=S, so φ) and (B = S', so ϕ) be two arguments such that $\phi \in$ S.

Then A $\otimes$ B = (S/{ϕ}) $\cup$ S', so φ.

In the example – the final structure

P_2:	**q, q $\Rightarrow$ p, so p**
O_2:	**r, r $\Rightarrow$ ¬p, so ¬p [P_2]**
P_6:	**z, z $\Rightarrow$ ¬r, so ¬r [O_2]**
$P_3 \otimes P_4 \otimes P_7$:	**u, u $\Rightarrow$ s, k, k $\Rightarrow$ t, s ^ t $\Rightarrow$ p, so p**
$P_3 \otimes P_5 \otimes P_7$:	**x, x $\Rightarrow$ s, k, k $\Rightarrow$ t, s ^ t $\Rightarrow$ p, so p**
O_4:	**v, v $\Rightarrow$ ¬u, so ¬u [$P_3 \otimes P_4 \otimes P_7$]**
O_5:	**y, y $\Rightarrow$ ¬x, so ¬x [$P_3 \otimes P_5 \otimes P_7$]**

CONSTRUCTING THE DISPUTE (same example)

T(P_2) = P_2

T(O_2) = P_2, O_2 [P_2]

T(P_3) = P_2, O_2 [P_2], P_2 **an alternative argument**

T(P_4) = P_2, O_2 [P_2], $P_2 \otimes P_4$ **the first modification, combing arguments**

T(O_4) = P_2, O_2 [P_2], $P_2 \otimes P_4$, O_4 [$P_2 \otimes P_4$] **adds an argument**

T(P_5) = P_2, O_2 [P_2], $P_2 \otimes P_4$, O_4 [$P_2 \otimes P_4$], $P_2 \otimes P_5$ **splits in alternatives**

T(O_5) = P_2, O_2 [P_2], $P_2 \otimes P_4$, O_4 [$P_2 \otimes P_4$], $P_2 \otimes P_5$, O_5 [$P_2 \otimes P_5$] **extends the new one**

T(P_6) = P_2, O_2 [P_2], P_6 [O_2], $P_2 \otimes P_4$, O_4 [$P_2 \otimes P_4$], $P_2 \otimes P_5$, O_5 [$P_2 \otimes P_5$] **extends the first**

THE CASE TO HANDLE (1)

(Dutch Supreme-Court decision HR 23 Oct. 1992, NJ 1992, 813)

The issue

Car accident, occurred when the driver and the passenger were returning from a party

The passenger sued the driver for the damages he suffered

Claims and arguments

The passenger claimed that the driver caused the accident, by losing control without another car or obstacle in sight

The driver defended herself by claiming that the plaintiff has caused the accident, by suddenly pulling the handbrake, which caused the wheels to lock

THE CASE TO HANDLE (2)

Evidence collected - police and expert reports (undisputed)

The accident occurred beyond an S-curve

Tire marks caused by locked tires found just beyond the curve

Tire marks caused by a sliding vehicle found 25 meteres further down the road

The driver said the passenger has pulled the handbrake, which was in pulled position

No sign of any obstacles or other unusual circumstances

Pulling the handbrake in that car can cause wheels to lock (expert report)

The passenger had drunk alcohol

Decision

Evidence and circumstances make the cause claimed by the defendant not unlikely

The fact that the car crashed is insufficient to conclude the defendants responsibility

RECONSTRUCTION BY ABDUCTION (1)

Rules

r_1: skidding ⇒ accident

r_2: skidding ⇒ tire marks present

r_3: obstacles ⇒ skidding

r_4: loss of control ⇒ skidding

r_5: wheels locked ⇒ skidding

r_6: speeding in curve ⇒ loss of control

r_7: speeding in curve ⇒ ¬ observed nature of tire marks

r_8: slowing down in curve ⇒ observed nature of tire marks

r_9: passenger drunk ⇒ passenger pulls handbrake

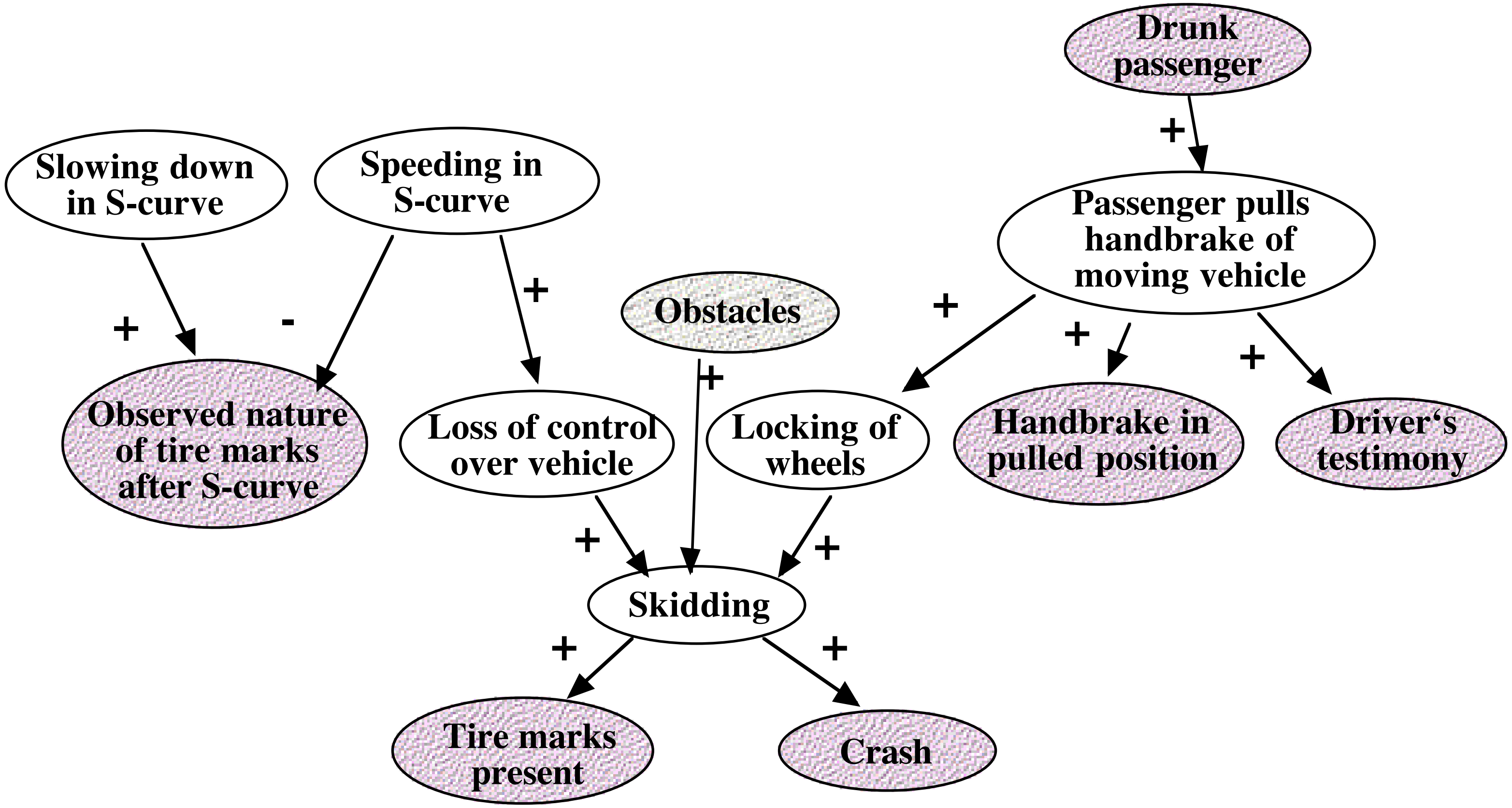
r_{10}: passenger pulls handbrake ⇒ wheels locked

r_{11}: passenger pulls handbrake ⇒ handbrake in pulled position after accident

r_{12}: passenger pulls handbrake ⇒ driver said “passenger pulled handbrake”

RECONSTRUCTION BY ABDUCTION (2)

Qualitative probabilistic network



RECONSTRUCTION BY ABDUCTION (3)

Facts / evidence

(1) ¬ obstacles

(2) tire marks present

(3) observed nature of tire marks

(4) handbrake in pulled position after accident

(5) driver said “passenger pulled handbrake”

(6) passenger was drunk

Solutions offered by plaintiff (π) and defendant (δ)

H_π = {(7) speeding in curve, (8) loss of control}

H_π additionally explains (2)

H_π contradicts (3)

H_δ: = {(9) passenger pulls handbrake}

H_δ additionally explains (2, 4, 5)

H_δ contradicts nothing

ARGUMENTATION-BASED RECONSTRUCTION (1)

Plaintiffs (passengers) argument

(0) accident (1) ¬ obstacles

(7) speeding in curve

(8) loss of control (7) speeding in curve

(14) driver caused accident

Defendants (drivers) counterargument

(4) handbrake in pulled position (5) driver said "passenger pulled handbrake"

(9) passenger pulled handbrake

(10) wheels locked

(11) skidding

(0) accident (9) passenger pulled handbrake

(15) passenger caused accident

ARGUMENTATION-BASED RECONSTRUCTION (2)

Judge's counterarguments

(3) observed nature of tire marks
{0,1} do not support (7)

(3) observed nature of tire marks
(12) slowing down in curve

Judge's first priority argument

(3) observed nature of tire marks
second argument above not weaker than plaintiff's subargument

Judge's second priority argument

(5) (4) (13) expert report (2) (3) (6) passenger was drunk
Defendant's counterargument not weaker than plaintiff's argument

ARGUMENTATION-BASED RECONSTRUCTION (3)

2 kinds of rules

Explanations **– derive causes from effects (evidential rules)**

E.g., handbrake in pulled position is evidence that passsenger pulled it

Prediction **– derive effects from causes (causal rules)**

E.g., passsenger pulled handbrake caused wheels being locked

Combination of rules and relations among them

A conclusion established by a causal rule cannot be premise for an evidential rule

The plaintiff's and the defendant's arguments rebuts each other

The counterarguments of the court undercut and rebut, resp. plaintiff's subargument (7)

CATO – AN INTELLIGENT TUTORIAL SYSTEM

Components

- ***Database* – textual summaries and factor sets (147 trade secret cases)**
- ***Factor Browser* – 26 factors for trade secret law**
- ***Case Analyzer* – Lets students compile a list of factors and generates feedback**
- ***Argument Maker* – Presents argumentations in the context of students reactions**
- ***Issue-Based Argument Window* – Presents examples of arguments**
- ***Squib Reader* – Displays squibs of retrieved cases**

Elaborated for Mason vs. Jack Daniel Distillery case

(a trade secret problem)

PREDICTING CASE OUTCOMES (Grabmair 2017)

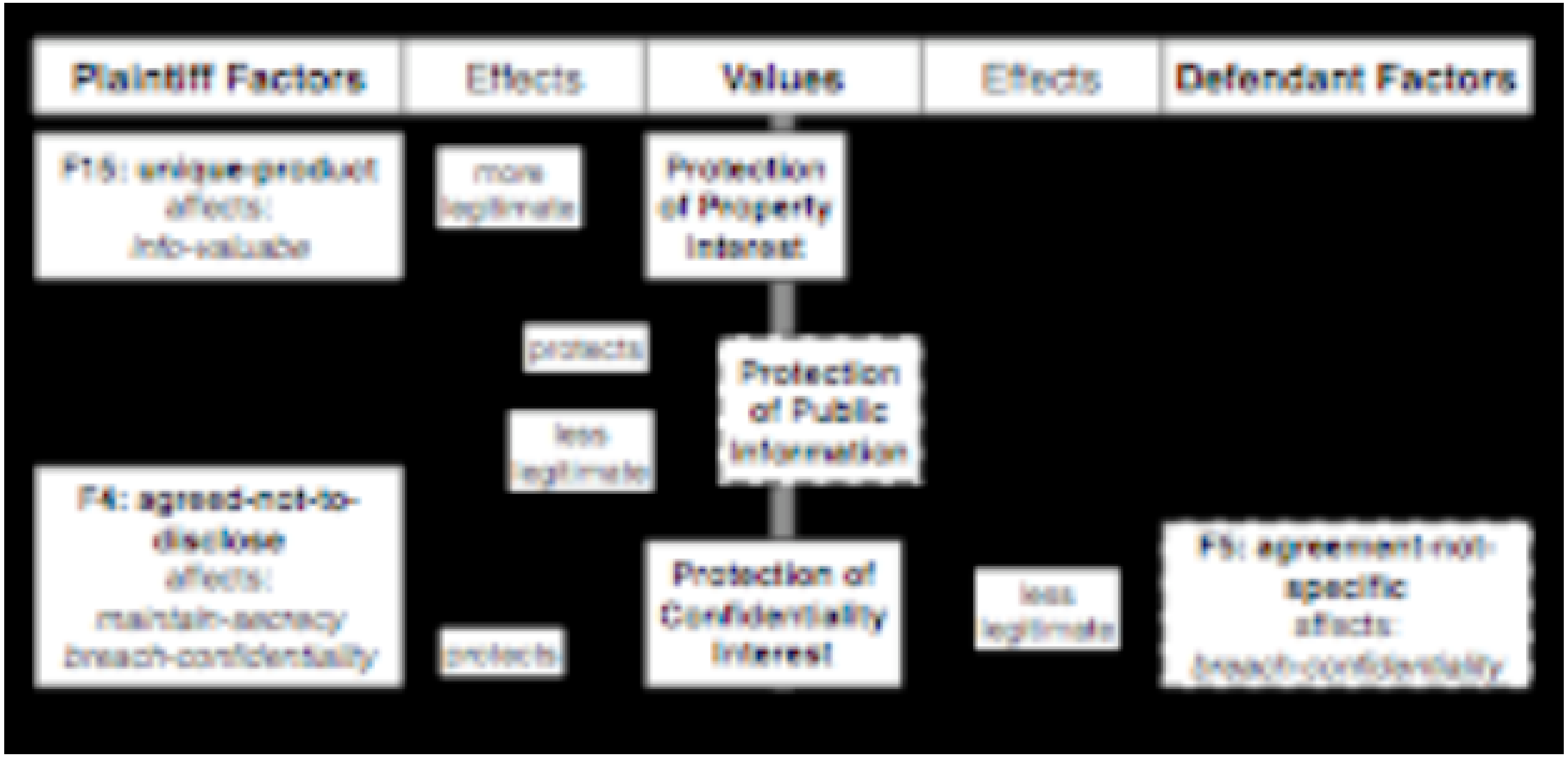
Method

- ***Database*** **of previous cases**
- **Factors favoring plaintiff or defendant**
- **Court decisions for each case**
- **Elaborated for trade secret problems**
- **Based on previous systems (CATO)**
  in particular, the database

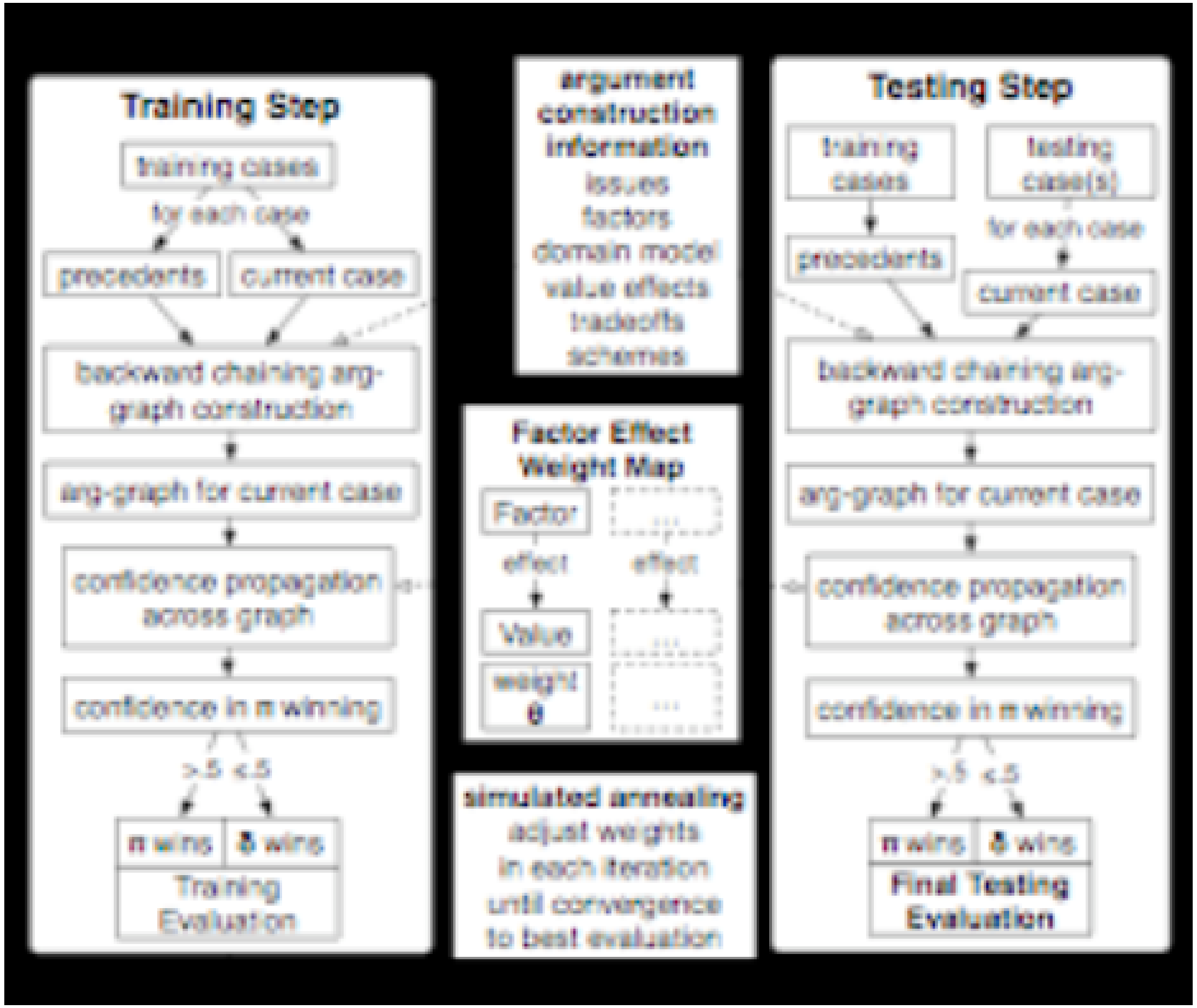
DOMAIN MODEL OF ISSUES AND FACTORS

THE CASE TO HANDLE IN THE DOMAIN MODEL

INTER-ISSUE TRADE-OFF
(FOR BREACH OF CONFIDENTIALITY)



SYSTEM ARCHITECTURE



RESULTS

model	LOO	train	5-fold	train	fold-5D
GTW	.802 .	.84	.805	.845	.059
VJAP-full	.793	.828	.779	.837	.046
VJAP-local	.694	.717	.691	.725	.095
VJAP-no-precedent	.711	.727	.715	.73	.097
VJAP-timeline	.843	.854	.821	.862	.079
major-label	.612	n/a	.612	n/a	n/a
naive-bayes	.843	n/a	.851	n/a	n/a
decision tree	.777	n/a	.835	n/a	n/a
IBP	.81	n/a	.725	n/a	.112
IBP-noEE	.587	n/a	.562	n/a	.14

RESCHER'S THEORY OF FORMAL DISPUTATION (FORMALIZED AND EXTENDED BY BREWKA)

Components of the theory

Three-party game with proponent, opponent, and determiner

A number of moves in extended logical language that players can make

!P (categorical): “P is the case”; only made by proponent

†P (cautious): “P is the case for all you have shown” only made by opponent

P/Q (provisoed: “P generally obtains provided that Q” only made by both

Still some informal specifications, open to interpretations

Formalization

Assertions identified with prioritized defaults (e,.g., preferring more specific defaults)

Disputation viewed as a constructive process of a default theory agreed upon by disputant

STRUCTURE OF THE DISPUTE

Move sequences

Start always with a categorical assertion !P

Counter by a challenge †¬P or a provisoed denial ¬P/Q ^ †Q

In the first case, the proponent can give an argument by a proof or by a provisoed assertion

In the second case, the proponent can attack the prerequite of the provisoed denial Q, or he can come up with a strong distinction (also called exception): P/(Q ^ R) ^ !(Q ^ R)

Example dialogs

P_1:	**!P**	**O_1:**	**¬P/Q ^ †Q**
P_2:	**!¬Q**	**O_2:**	**Q/R ^ †R**
P_3:	**!¬R**	**O_3:**	**R/S ^ †S**
P_4:	**¬R/(S ^ T) ^ !(S ^ T)**	**O_4:**	**Q/U ^ †U**
P_5:	**¬Q/(U ^ V) ^ !(U ^ V)**		
P'_1:	**!¬Flies**	**O'_1:**	**¬Flies/Bird ^ †Bird**
P'_2:	**¬Flies/(Pen. ^ Bird) ^ !(Pen. ^ Bird)**	**O'_2:**	**¬Flies/Bird ^ †Bird**

DEFAULT THEORY WITH SPECIFICITY (1)
(EXTENDING REITER'S DEFAULT LOGIC)

Definitions

1. **Let *E* be a set of formulas. A default $\delta = a \rightarrow c$ is active in *E* iff (1) $a \in E$, (2) $c \notin E$, and (3) $\neg c \notin E$.**

2. **Let $\Delta = (D,W,<)$ be a (prioritized) default theory, << a strict total ordering containing <. We say E is the (PDL) extension of Δ generated by <<, iff $E = \cup E_i$, with $E_0 = Th(W)$, and**

   $E_{i+1} = E_i$ if no default is active in E_i, otherwise

   $E_{i+1} = Th(E_i \cup \{c\})$, where c is the consequent of the <<-minimal default active in E_i

3. **Let $\Delta = (D,W,<)$ be a (prioritized) default theory, *E* is a (PDL) extension of Δ, iff there is a strict total ordering containing < that generates *E*.**

DEFAULT THEORY WITH SPECIFICITY (2)

Assertions in W distinguished into background knowledge T and contingent facts C
Only Defaults D and background knowledge T used to determine specificity
P $\vdash_D$ q means that q is contained in the smallest deductively closed set of formulas in P

Additional definitions

4. Let $\Delta = (D,T,C)$ be a default theory, $D \supseteq D'$.
D' is p-conflicting (in Δ) iff for some δ = pre $\rightarrow$ cons $\in D'$ we have $T \cup \{pre\} \vdash_{D'}$ false

5. Let $\Delta = (D,T,C)$ be a default theory. $<_\Delta$ is the specificity ordering associated with Δ iff $<_\Delta$ is the smallest strict partial ordering on D satisfying the condition that $\delta_1 = pre_1 \rightarrow cons_1 < \delta_2 = pre_2 \rightarrow cons_2$ whenever

1. δ_1, δ_2 are contained in a minimal set D' of defaults p-conflicting in Δ, and
2. $T \cup \{pre_1\} \vdash_{D'}$ false, yet not $T \cup \{pre_1\} \vdash_{D'}$ false

6. E is an SDL-extension of $\Delta = (D,T,C)$ iff the specificity ordering $<_\Delta$ of Δ exists and E is a prioritized extension of $(D, T \cup C, <_\Delta)$.

EXTENSIONS TO RESCHER'S THEORY

in the default logic implementing the theory

Not using special notations ! and †, corresponds to the disputants – keep track of speakers

Distinction between background knowledge and contingent facts

Treatment of concessions: instead of “silence implies consent” explicitly stating it:

1. **Avoids ambiguity with disjunctions**
2. **Distinguishes between not believing p and believing ¬p**

Identifying provisoed assertions with defaults in an SDL theory

Debate about formula P viewed as the process of constructing a default theory

Proponent's task:

Find default theory that skeptically implies P and is accepted by opponent

Opponent's task:

tries to undermine this goal by challenging claims of the proponent or adding evidence

IMPLEMENTATION OF THE THEORY

Distinguishing the following sets

D the set of defaults stated by one of the players

T the background knowledge both players agree upon

C the contingent facts both players agree upon

T_{pro} the background knowledge believed by the proponent

C_{pro} the contingent facts believed by the proponent

T_{opp} the background knowledge believed by the opponent

C_{opp} the contingent facts believed by the opponent

Default theory held by a player $(D, T \cup T_{pro/opp}, C \cup C_{pro/opp})$

State in the disputation is a tuple consisting of these seven sets

MOVES IN THE GAME

Elementary moves

add$_g$(i) **If *i* is a formula then *g* must be either *T* or *C*. In the firts case, *i* is added to the current player's background knowledge, in the second case to its contingent facts. If *i* is a default then *g* must be *D* and *i* is added to *D*.**

concede$_g$(i) **Moves formula *i* from the other player's background knowledge to *T* (if *g* = *T*) or from the other player's contingent facts to *C* (if *g* = *C*)**

remove$_g$(i) **Removes formula *i* from the current player's background knowledge to *T* (if *g* = *T*) or from the current player's contingent facts to *C* (if *g* = *C*)**

A *move* is an arbitrary finite sequence of elementary moves

Categorical assertion !P is an addition *add$_T$(P)* or *add$_C$(P)* performed by the proponent

Provisoed assertion P/Q is an addition *add$_D$(Q $\rightarrow$ P)* performed by the proponent

Cautious assertion †P is an addition *add$_T$(P)* or *add$_C$(P)* performed by the opponent

MOVE STATES AND GAME STATES

Legal moves

A move of player *x* is legal iff

1. **the player's new default theory Δ_x produced by the move is consistent, i.e., has at least one consistent SDL extension, and**
2. **the new state produced by the move is different from each state reached earlier in the game except the last one.**

Game state

The proponent wins a debate about *P* if after a move of the opponent *P* is a skeptical consequence of Δ_{opp}.

The opponent wins a debate about *P* if after a move of the proponent P is not a skeptical consequence of Δ_{pro}.

If the game terminates earlier (for whatever reason) the detreminer has to decide who won based on the plausibility of the unconceded beliefs of the players

SEQUENCES OF MOVES

Example disputation

(1) $add_C(\neg Flies)$

(2) $add_D(Bird \rightarrow Flies)$, $add_C(Bird)$

(3) $concede_C(Bird)$, $add_D(Pen. \rightarrow \neg Flies)$
$add_C(Pen.)$, $add_T(Pen. \supset Bird)$

(4) $concede_T(Pen. \supset Bird)$, $add_C(\neg Pen.)$

(5) $add_D(Bird \wedge Swim \rightarrow Pen.)$
$add_C(Swim)$

(6) $concede_C(Swim)$, $retract_C(\neg Pen.)$

D = $\{Bird \rightarrow Flies, Pen. \rightarrow \neg Flies, Bird \wedge Swim \rightarrow Pen.\}$

C = $\{Bird, Swim\}$

T = $\{Pen. \supset Bird\}$

T_{opp} and C_{opp} are empty, hence the proponent has won

FURTHER PROPERTIES OF THE EXTENSION

Example disputation (about Nixon)

Use of a conflicting default not standing in specificity relationship to proponent's defaults

(1)	$add_C(Pacifist)$	
(2)		**"empty move", thesis not conceded**
(3)	$add_D(Quaker \rightarrow Pacifist)$ $add_C(Quaker)$	
(4)		$concede_C(Quaker)$ $add_D(Republican \rightarrow \neg Pacifist)$ $add_C(Republican)$
(5)	$concede_C(Republican)$	

Main limitation

no chance to disagree about defaults

Possible remedy

split defaults into D, D_{pro} (acc. by opponent only), and D_{opp} (acc. by opponent only)

ARGUMENTATION SCHEMES (Walton)

Components

A basic scheme - rationale reasoning pattern

Critical questions - making implicit premises explicit

A list of schemas developed

1. Argument from Analogy
2. Argument from a Verbal Classification
3. Argument from Rule
4. Argument from Exception to a Rule
5. Argument from Precedent
6. Practical Reasoning
7. Lack of Knowledge Arguments
8. Arguments from Consequences
9. Fear and Danger Appeals
10. Arguments from Alternatives and Opposites
11. Pleas for Help and Excuses

LIST OF ARGUMENTATION SCHEMES CONT'D

12. **Composition and Division Arguments**
13. **Slippery Slope Arguments**
14. **Arguments from General Acceptance**
15. **Argument from Commitment**
16. **Arguments from Inconsistency**
17. **Ethotic Ad Hominem**
18. **Circumstantial Ad Hominem**
19. **Argument from Bias**
20. **Ad Hominem Strategies to Rebut a Personal Attack**
21. **Argument from Cause to Effect**
22. **Argument from Effect to Cause**
23. **Argument from Correlation to Cause**
24. **Argument from Evidence to a Hypothesis**
25. **Abductive Reasoning**
26. **Argument from Position to Know**
27. **Argument from Expert Opinion**
28. **Argument from Waste**

More schemes (subtypes) later developed, various categorizations

AN EXAMPLE ARGUMENTATION SCHEME

Appeal to expert opinion - basic structure

Source Premise:

Source E is an expert in subject domain S containing proposition A.

Assertion Premise:

E asserts that proposition A (in domain S) is true (false).

Warrant Premise:

If source E is an expert in subject domain S containing proposition A, and
E asserts that proposition A (in domain S) is true (false),
then A may plausibly be taken to be true (false).

Conclusion:

A may plausibly be taken to be true (false).

CRITICAL QUESTIONS TO THIS SCHEME

Function

If a respondent asks any of the critical questions appropriate for some scheme, the proponent must either give a satisfactory answer to the question asked, or else give up the appeal to the argument encapsulated in the scheme

Critical questions for appeal to experts opinion

1. Expertise Question: How credible is E as an expert source?
2. Field Question: Is E an expert in the field that A is in?
3. Opinion Question: What did E assert that implies A?
4. Trustworthiness Question: Is E personally reliable as a source?
- **Subquestion 1: Is E biased?**
- **Subquestion 2: Is E honest?**
- **Subquestion 3: Is E conscientious?**

5. Consistency Question: Is A consistent with what other experts assert?
6. Backup Evidence Question: Is E's assertion based on evidence?

ABDUCTIVE ARGUMENTATION SCHEMES

F is a finding or given set of facts

E is a satisfactory explanation of F

No alternative explanation E given so far is as satisfactory as E

E is plausible, as a hypothesis with the following critical questions:

(1) How satisfactory is E itself as an explanation of F, apart from the alternative explanations available so far in the dialogue?

(2) How much better an explanation is E than the alternative explanations available so far in the dialogue?

(3) How far has the dialogue progressed? If the dialogue is an inquiry, how thorough has the search been in the investigation of the case?

(4) Would it be better to continue the dialogue further, instead of drawing a conclusion at this point?

ARGUMENTATION SCHEME FOR ARGUMENT FROM CORRELATION TO CAUSE

PREMISE There is a positive correlation between A and B.

CONCLUSION Therefore A causes B.

Three critical questions matching the scheme

CQ1: Is there really a correlation between A and B?

CQ2: Is there any reason to think that the correlation is any more than a coincidence?

CQ3: Could there be some third factor C, that is causing both A and B?

THE CARNEADES SYSTEM (Tom Gordon)

Carneades is both

a mathematical model of argumentation and

a software toolbox providing support for

argument evaluation, construction and visualization.

Carneades is a research vehicle for

studying argumentation from a more formal, computational perspective

than is typical in the field of informal logic, and

for developing prototypes of tools designed to be useful

for supporting real-world argumentation in practice

THE ROLE OF RULES IN CARNEADES

1. Rules have properties, such as their date of enactment, jurisdiction and authority.

2. When the antecedent of a rule is satisfied by the facts of a case, the conclusion of the rule is only presumably true, not necessarily true.

3. Rules are subject to exceptions.

4. Rules can conflict.

5. Some rule conflicts can be resolved using rules about rule priorities, e.g. lex superior, which gives priority to the rule from the higher authority.

6. Exclusionary rules provide one way to undercut other rules.

7. Rules can be invalid or become invalid. Deleting invalid rules is not an option when it is necessary to reason retroactively with rules which were valid at various times over a course of events.

8. Rules do not counterpose. If some conclusion of a rule is not true, the rule does not sanction any inferences about the truth of its premises.

THE ROLE OF INFERENCES IN CARNEADES (1)

The Carneades inference engine uses rules to construct and search a space of argument states, where each state consists of:

topic

The statement, i.e. proposition, which is the main issue of the dialogue, as claimed by its proponent.

viewpoint

Either 'pro' or 'con'. When the viewpoint is pro, the state is a goal state if and only if the topic of the state satisfies its proof standard.
If the viewpoint is con, the state is a goal state only if the topic does not satisfy its proof standard.
Notice the asymmetry between pro and con.
The con viewpoint need not prove the complement of the topic, but need only prevent the pro viewpoint from achieving its goal of proving the topic.

THE ROLE OF INFERENCES IN CARNEADES (2)

pro-goals

A list of clauses, in disjunctive normal form, where each clause represents a set of statements which might be useful for helping the proponent to prove the topic.

con-goals

A list of clauses, in disjunctive normal form, where each clause represents a set of statements which might be useful for helping the opponent to prevent the proponent from proving the topic.

arguments

A graph of the arguments, representing all the arguments which have been put forward, hypothetically, by both the pro and con roles during the search for arguments.

THE ROLE OF INFERENCES IN CARNEADES (3)

substitution

A substitution environment mapping schema variables to terms.
The scope of variables is the whole argument graph.
Variables in rules are renamed to prevent name conflicts
when they are applied to construct arguments.

candidates

A list of candidate arguments, which have been previously constructed.
A candidate argument is added to the argument graph, and
removed from this list,
only after all of its schema variables are instantiated in the substitution environment.
This assures that all statements in the argument graph are ground atomic formulas.

RESULTS OF INFERENCES IN CARNEADES

SE (Scintilla of Evidence)

A statement meets this standard

iff it is supported by at least one defensible pro argument.

BE (Best Argument)

A statement meets this standard

iff it is supported by some defensible pro argument

with priority over all defensible con arguments

DV (Dialectical Validity)

A statement meets this standard iff it is supported by at

least one defensible pro argument and none of its con arguments are defensible.

A CARNEADES EXAMPLE FEATURING BURDEN OF PROOF

Prakken and Sartor's example about a murder trial

Section §187 of the California Penal Code, murder is killing
with 'malice aforethought'.
Section §197 states an exception for self-defense.

The prosecution filing a complaint in which it makes its first arguments,
by applying a scheme for arguments from legal rules to Section §187 and
providing enough evidence of killing and malice aforethought
to meet the burden of production

The defense has accepted the killing and malice elements of the crime

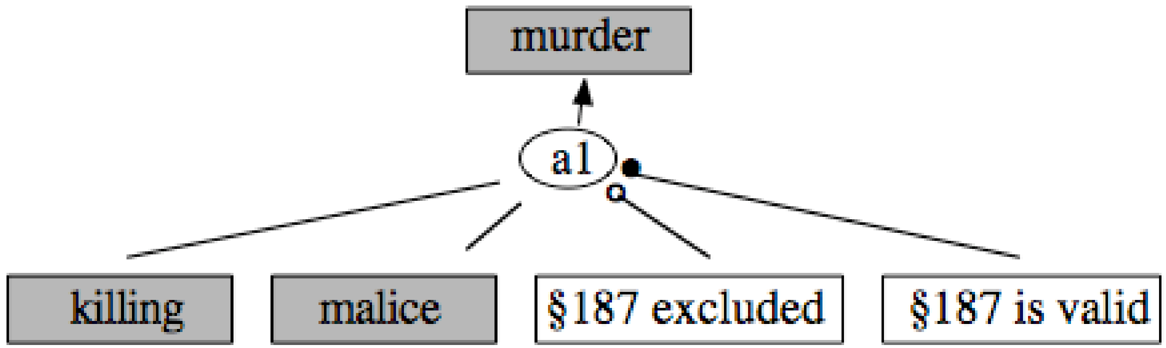
THE CARNEADES EXAMPLE - FIRST STATE

The appropriate type of premise is a policy issue in developing argumentation schemes

In the scheme for arguments from legal rules used here,
the validity of a legal rule is assumed,
and thus must be supported with evidence only if questioned;

Being excluded by some other rule is an exception,
and the elements of the crime, killing and malice here,
are ordinary premises which must always be supported with evidence.

Accepted/acceptable statements appear with background grey color



THE CARNEADES EXAMPLE - NEXT STATES

The defense cities Section §197of thePenal Code, and calls a witness
who testifies that the defendant was attacked with a knife by the victim.

The argument concluding that Section§187 is excluded, a2, is
another instance of the scheme for arguments from legal rules.

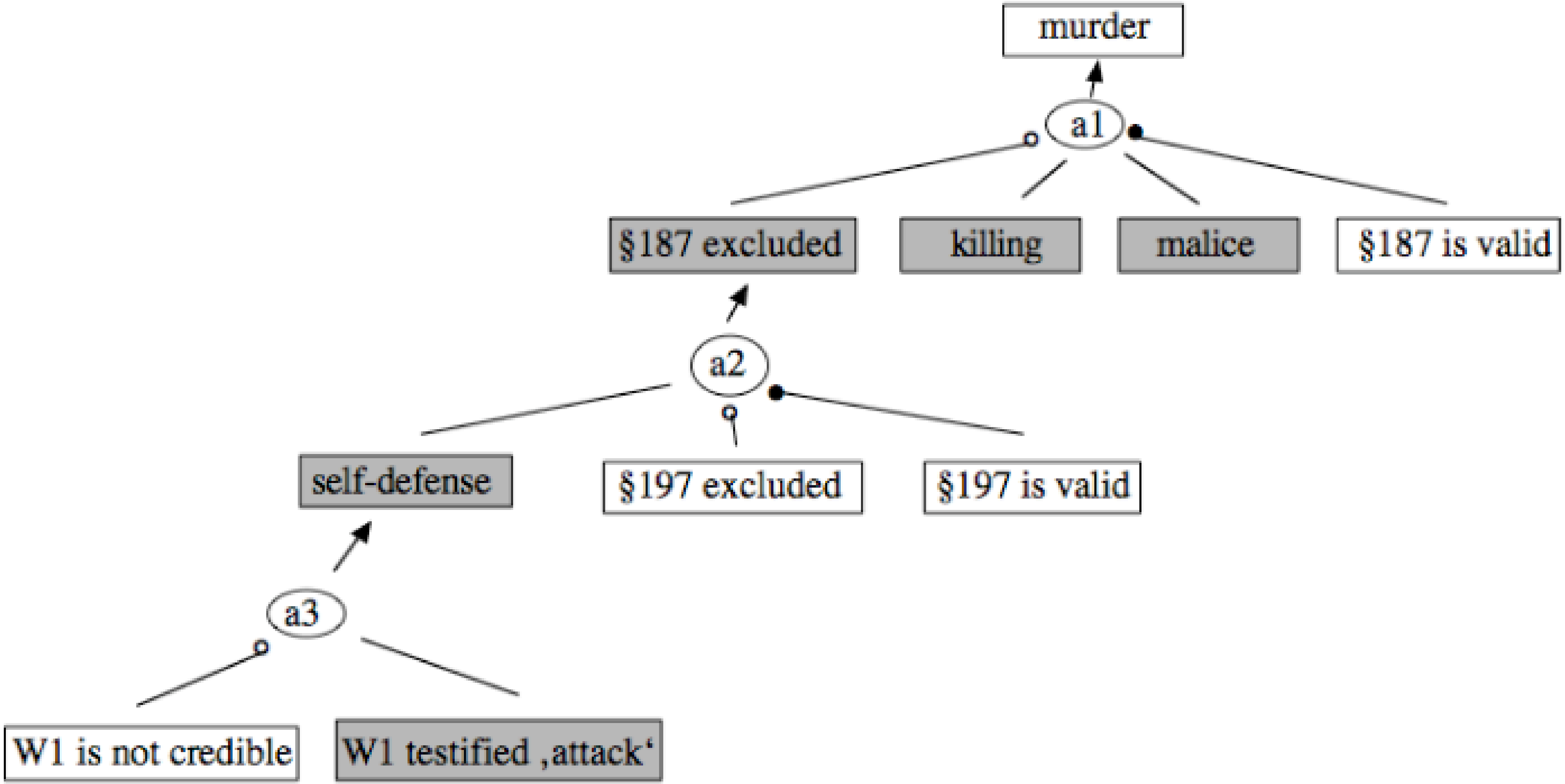
The third argument applies as implified scheme for arguments from testimony.
Since the witness testified before the court, this testimony is accepted (assumption)
This does not imply accepting that the defendant was attacked
This is enough to meet the defense's burden of production for the self-defense claim

The prosecution calls another witness to the stand to testify that
the defendant had enough time to run away.

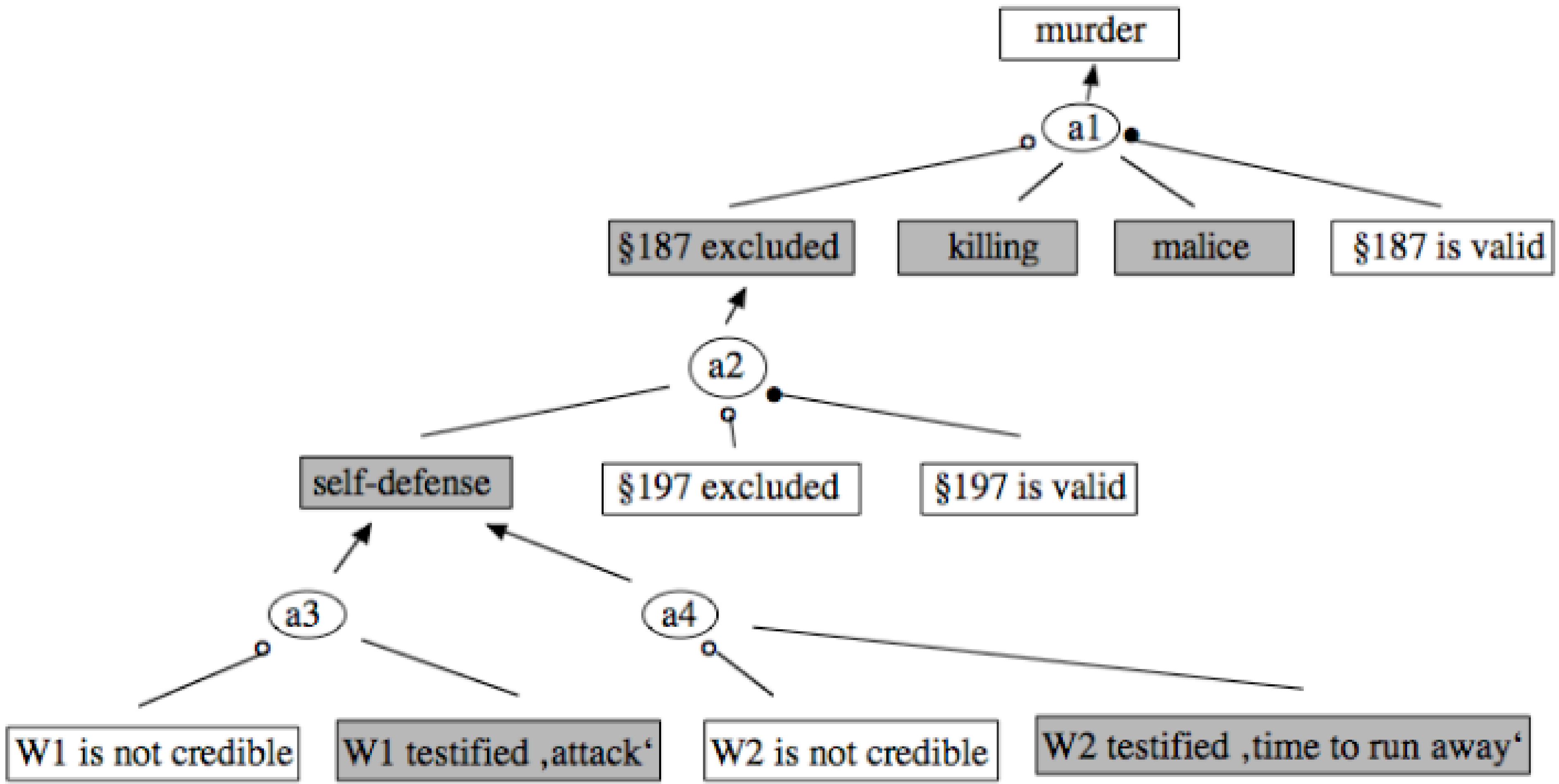
Notice, however, that this rebuttal does not (yet) succeed.

The self-defense claim is still acceptable, because the prosecution has the burden of persuasion in criminal cases, also for exceptions such as the self-defense claim here

THE CARNEADES EXAMPLE - SELF DEFENSE ARGUMENT



THE CARNEADES EXAMPLE - WiTNESS PUTTING DOUBT ON THIS ARGUMENT



FROM NATURAL LANGUAGE TO LOGIC (Wyner)

A case under debate - How can a government reduce the amount of garbage?

Example text (1)

1. Every householder should pay tax for the garbage which the householder throws away.

2. No householder should pay tax for the garbage which the householder throws away.

3. Paying tax for garbage increases recycling.

4. Recycling more is good.

5. Paying tax for garbage is unfair.

6. Every householder should be charged equally.

7. Every householder who takes benefits does not recycle.

FROM NATURAL LANGUAGE TO LOGIC

A case under debate - How can a government reduce the amount of garbage?

Example text (2)

8. **Every householder who does not take benefits pays for every householder who does take benefits.**
9. **Professor Resicke says that recycling reduces the need for new garbage dumps.**
10. **A reduction of the need for new garbage dumps is good.**
11. **Professor Resicke is not objective.**
12. **Professor Resicke owns a recycling company.**
13. **A person who owns a recycling company earns money from recycling.**
14. **Supermarkets create garbage.**
15. **Supermarkets should pay tax.**
16. **Supermarkets pass the taxes for the garbage to the consumer.**

THE EOLE OF NATURAL LANGUAGE STATEMENTS

Statments by individuals, linguistically "polished", in may be introduced in different order

An individual makes statement [1]

Another makes [4] as a reason or premise for [1]

Yet another makes [3] as an additional reason for [3],
which can be understood to lend greater strength to the claim that [1] should hold.

[9] supports the claim in [4].

However, this is undercut by the claim that the Professor is not objective,
so the implication one might draw from his statement does not hold.

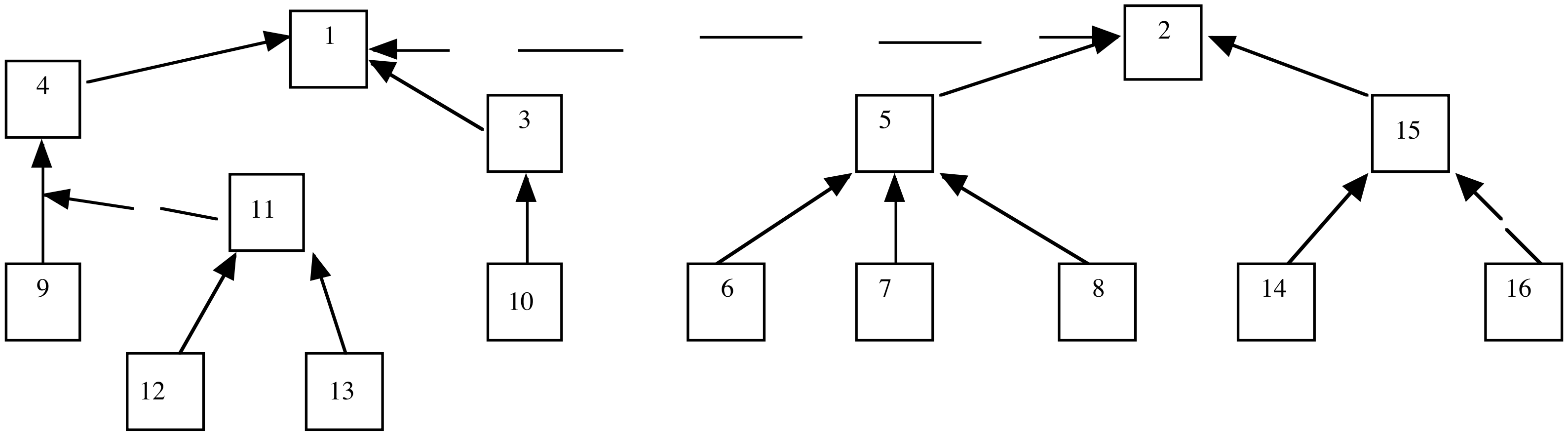
In [2], we have a counter-proposal with a range of supporting reasons;
understood as a rebuttal to the previous argument in favour of taxing garbage.

[16] attacks [15], which is one of the premises of the argument in favour of [2],
so constitutes a premise defeat.

In some cases, there is an intuition that one statement attacks another statement

Much is left implicit

GRAPHICAL DISPLAY OF ARGUMENTS



Each statement is represented as a node

Claims and premises are represented with continuous arrows between nodes

Contradictions or conflicts between statements are represented with dashed arrows

(from 11, 16, and between 1 and 2)

RECASTING IN AN ARGUMENTATION FRAMEWORK

Abstracting the "arguments" and their relationship into an argumentation framework

Argument a1 is comprised of statements {1, 3, 4, 9, 10},
a2 of {11, 12, 13},
a3 of {2, 5, 6, 7, 8, 14, 15}, and
a4 of {16}

a1	⇔	**a3**
⇑		⇑
a2		**a4**

There are several preferred extensions depending on what is asserted to be true:
if neither of a2 or a4 hold, then {a1} and {a3};
if a2 holds, but a4 not hold, then {a2, a3};
if a4 holds, but a2 does not, then {a4, a1}

STATE OF AFFAIRS

Major issue is the translation into an argumentation framework

Abstracting from subtleties of relations between details of arguments

Abstracting from linguistic subtleties of argument presentations

Interpretation of ambiguous, implicit relations between statements/arguments

In particluar:

1. **What are the well-formedness conditions on premises and conclusions?**
2. **How is inconsistency between one statement and another determined?**
3. **What is the relevant notion of “attack” between arguments?**
4. **How is implicit information represented (enthymemes)?**
5. **Must an “argument” comprised of premises and a conclusion be introduced as a whole or can “arguments” be constructed incrementally?**