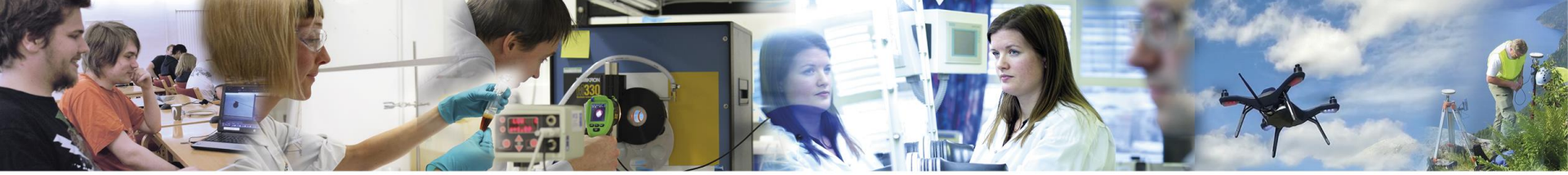

UiO : Department of Technology Systems
University of Oslo

TEK5010/9010 - Multiagent systems 2023
Lecture 13

Arguing

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Highlights lecture 13 – Arguing*

- What is arguing?
- Modes of argument
- Abstract argumentation
- Deductive argumentation
- Dialogues

*Wooldridge, 2009: chapter 16

What is arguing?

“Arguing was originally studied by philosophers and logicians in an attempt to understand the ‘informal logic’ that humans use to interact with one another.” [Wooldridge, 2009]

During the 1990s [Fox et al., 1992; Dung, 1995; Vreeswijk and Prakken, 2000] arguing was rephrased as an abstract argumentation system, making it more accessible to MAS analysis.

What is arguing?

In terms of MAS, agents often need to reach agreements about what to believe.

If you believe *p* and I believe ¬*p*, it is not at all clear what we should agree upon in order to coordinate our behaviours.

Arguing is the process of reaching a **rationally justifiable position** based on arguments put forward by the multiple agents.

What is arguing?

In terms of MAS, agents often need to reach agreements about what to believe.

Arguing is the process of reaching a rationally justifiable position based on arguments put forward by the multiple agents:

1. Arguments could be mutually consistent
2. Arguments could be inherently contradictory

Rationally justifiable position

1. Arguments could be mutually consistent

In this case there is no disagreement between the agents and a rationally justifiable position is (relatively) easy to derive.

There is no need for further arguing.

Rationally justifiable position

2. Arguments could be inherently contradictory

In this case, establishing a rationally justifiable position would inevitably involve rejecting or disregarding some of the arguments put forward by the agents.

Arguing is the principled techniques for extracting rationally justifiable positions from this inconsistent pool of arguments.

Arguing

So in general, arguing involves the process of agents putting forward arguments for and against propositions, together with justifications for the acceptability of these arguments.

These justifications are based on the modes or types of argumentation used by the different agents.

Modes of argument

Different modes of argument [Gilbert, 1994]

1. Logical mode
   Mathematical deductions of type “If you accept *A* and *A* implies *B* then you must also accept *B*”.
   This mode is the focus of this analysis of arguing.
2. Emotional mode
   Appeal to feelings and attitudes like “how would you feel if this happened to you?”.

Modes of argument

Different modes of argument [Gilbert, 1994]

3. Visceral mode
   The physical and social aspect of human argumentation, like stamping your feet into the ground to emphasis the strength of your feelings.
4. Kisceral mode
   Appeal to the intuitive, mystical, religious or the metaphysical.

Some of these modes might not be acceptable.

Types of argumentation systems

1. Abstract argumentation systems

Arguments are considered indivisible atomic things with given relations. A system oriented focus, deciding on which arguments can coexist with each other.

2. Deductive argumentation systems

The meaning of the different arguments in relation to one another are considered. Focus is on logical reasoning and the process of deducing relations between the various arguments.

Abstract argumentation systems

In [1995, Dung] introduced a ground breaking abstract augmentation systems called Dung-style argumentation system.

Dung-style argumentation systems can be used to construct rationally justifiable positions.

Abstract argumentation systems

A directed graph with **nodes as arguments** put forward and their **relations represented by edges** between nodes.

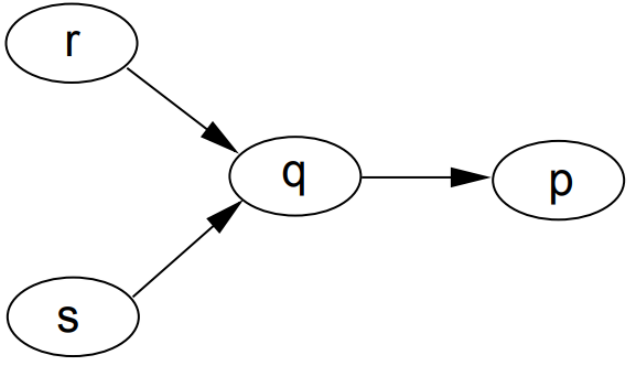
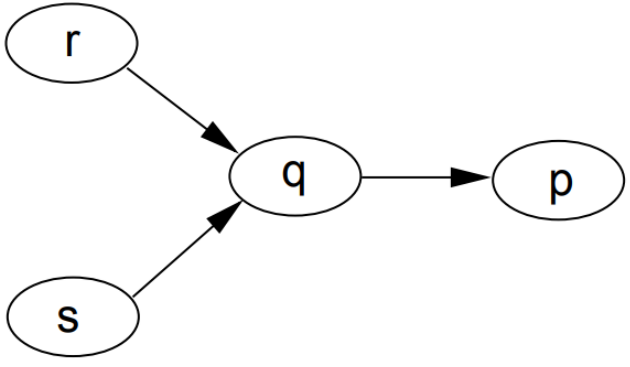


Image: Figure 16.1a, Wooldridge 2009

Abstract argumentation systems

‘*A* attacks *B*’ relation

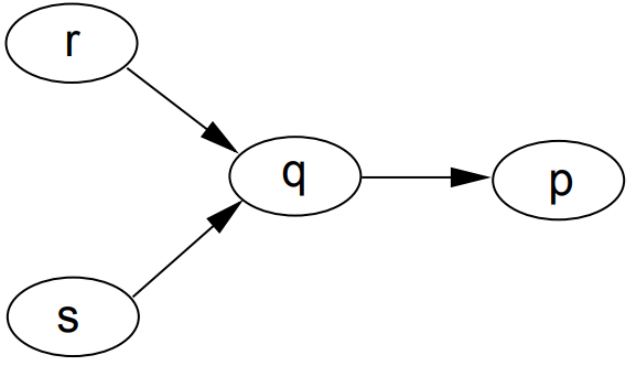
We say that argument *q* attacks *p*, meaning that if we accept argument *q* we have to reject argument *p*.



Abstract argumentation systems

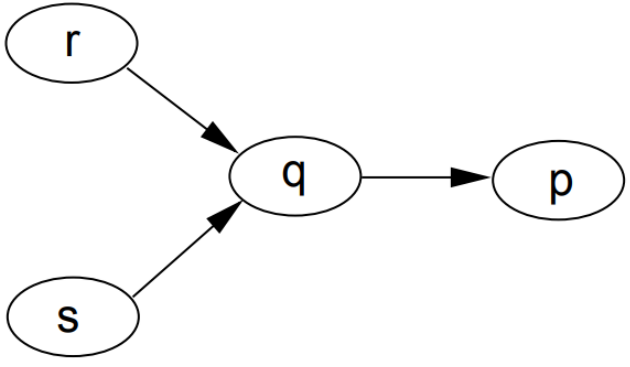
‘*A* defends *B*’ relation

If an argument *p* is attacked by *q*, and *q* is attacked by another argument *r* we say that *p* is defended by *r*.



Abstract argumentation systems

This Dung-style graph can be represented by:
$\langle \{p, q, r, s\}, \{(r, q), (s, q), (q, p)\} \rangle$



Abstract argumentation systems

What is the acceptable set of arguments?

Unfortunately, there is no universally accepted definition of acceptability. However, there are different notions of acceptability, each with their own advantages and disadvantages, proposed by Dung and other researchers.

In the following the key notions proposed are described:

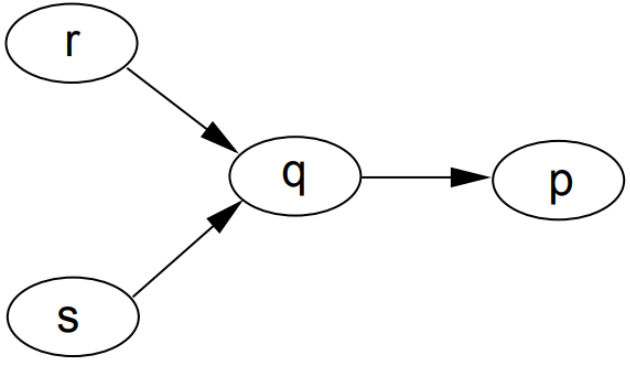
Abstract argumentation systems

A position is simply a set of arguments that can be:

1. Conflict free
2. Mutually defensive
3. Admissible
4. Preferred extensions
5. Grounded extensions

Abstract argumentation systems

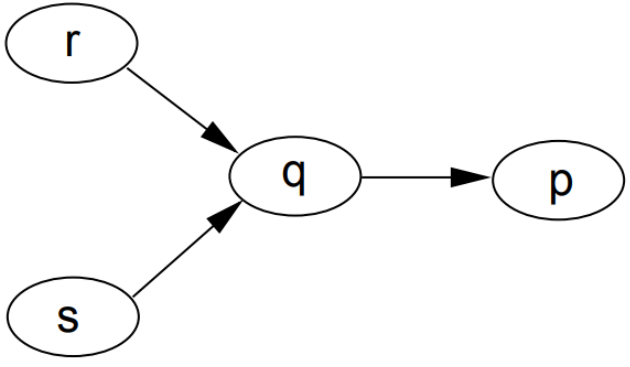
Conflict free: A position *S* is conflict free if no member of *S* attacks any other member of *S*.



$$\emptyset, \{p\}, \{q\}, \{r\}, \{s\}, \{rs\}, \{pr\}, \{ps\}, \{rsp\}$$

Abstract argumentation systems

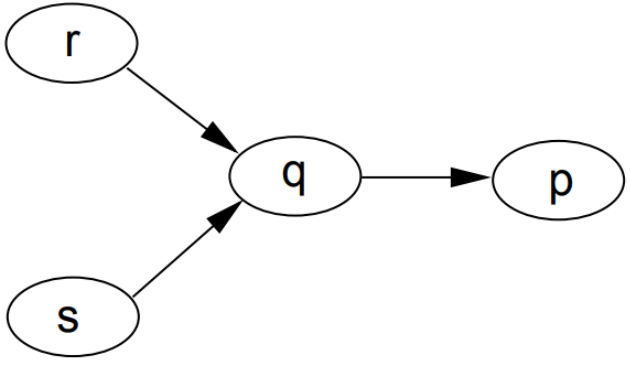
Mutually defensive: A position *S* is mutually defensive if every element of *S* that is attacked is defended by some element of *S*.



$$\emptyset, \{r\}, \{s\}, \{rs\}, \{pr\}, \{ps\}, \{rsp\}$$

Abstract argumentation systems

Admissible set: A position *S* that is conflict free and mutually defensive is an admissible set and internally consistent.



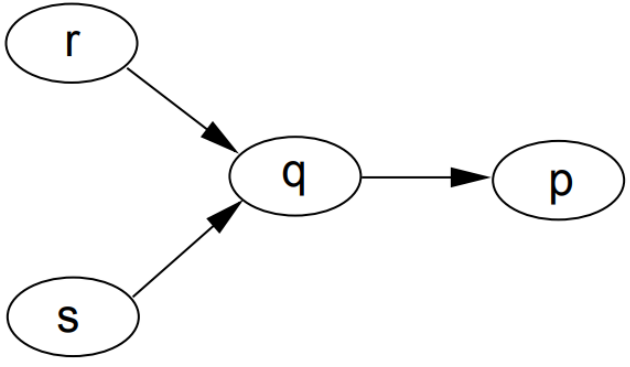
$$\emptyset, \{r\}, \{s\}, \{rs\}, \{pr\}, \{ps\}, \{rsp\}$$

Abstract argumentation systems

Preferred extensions: A preferred extension is an admissible set that no argument can be added without it failing to be admissible.

Abstract argumentation systems

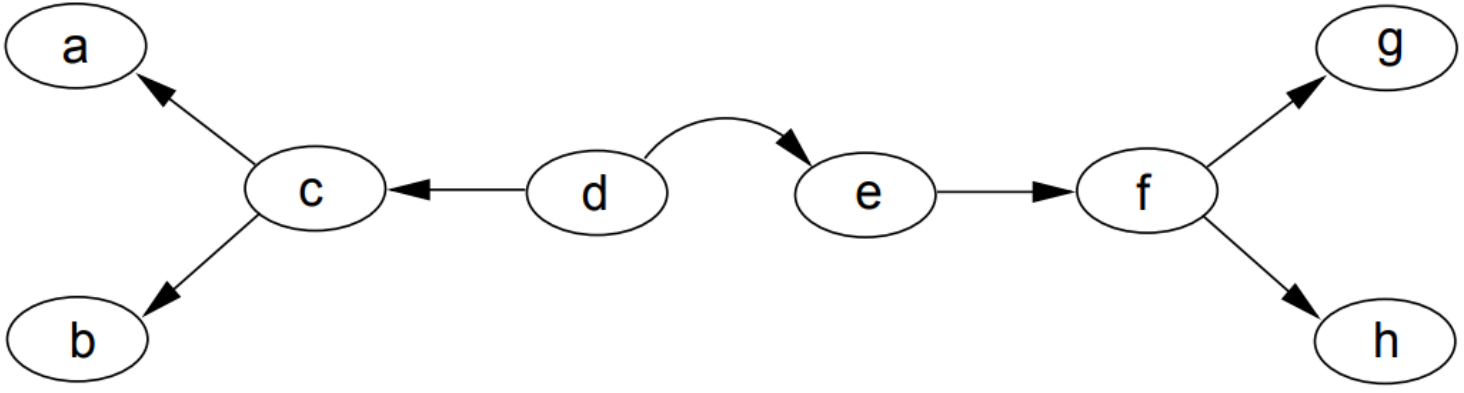
Preferred extensions: *S* is admissible but every superset of *S* is inadmissible.



$$\emptyset, \{r\}, \{s\}, \{rs\}, \{pr\}, \{ps\}, \boldsymbol{\{rsp\}}$$

Abstract argumentation systems

Preferred extensions:



Admissible set:

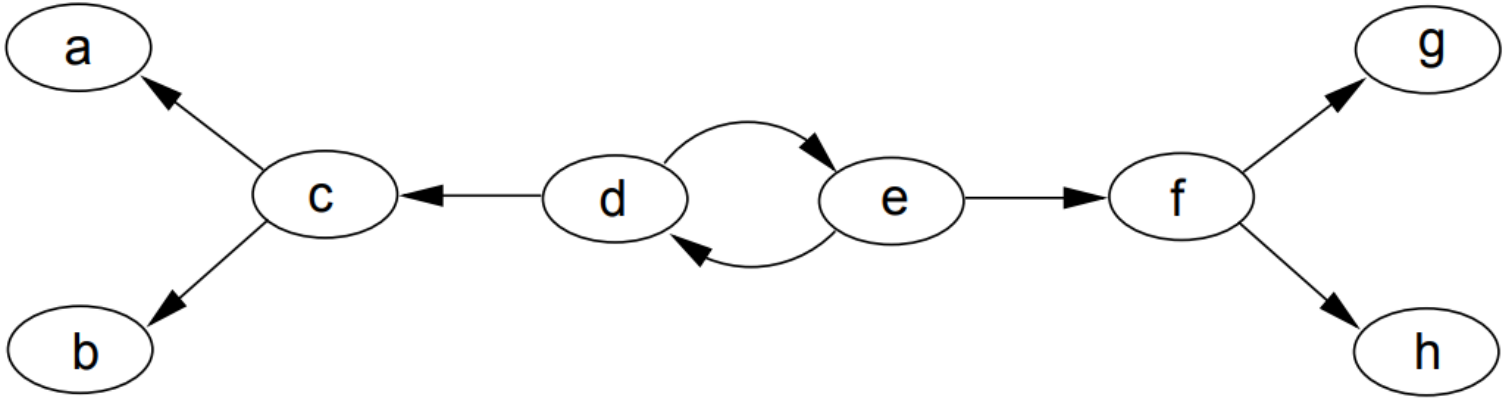
$$\emptyset, \{d\}, \{da\}, \{db\}, \{df\}, \{daf\}, \{dab\}, \{dbf\}, \{dabf\}$$

Preferred extension: $\{abdf\}$

Image: Figure 16.1c, Wooldridge 2009

Abstract argumentation systems

Preferred extensions:



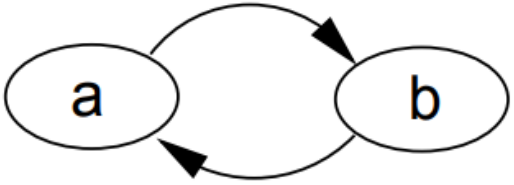
Ad. set: $\emptyset, \{d\}, \{da\}, \{db\}, \{df\}, \{daf\}, \{dab\}, \{dbf\}, \{dabf\},$
$\{e\}, \{eg\}, \{eh\}, \{ec\}, \{egh\}, \{ecg\}, \{ech\}, \{ecgh\}$

Preferred extension: $\{abdf\}, \{cegh\}$

Image: Figure 16.1b, Wooldridge 2009

Abstract argumentation systems

Preferred extensions:



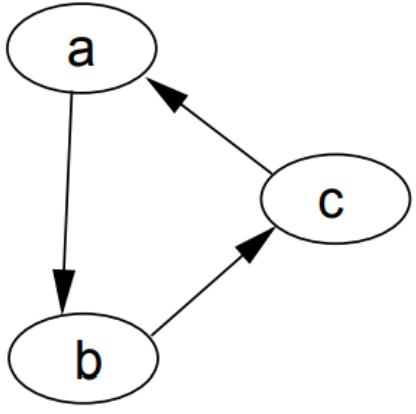
Admissible set: $\emptyset, \{a\}, \{b\}$

Preferred extension: $\{a\}\ and\ \{b\}$

Image: Figure 16.1d, Wooldridge 2009

Abstract argumentation systems

Preferred extensions:



Admissible set: ∅

Preferred extension: ∅

Image: Figure 16.1e, Wooldridge 2009

Abstract argumentation systems

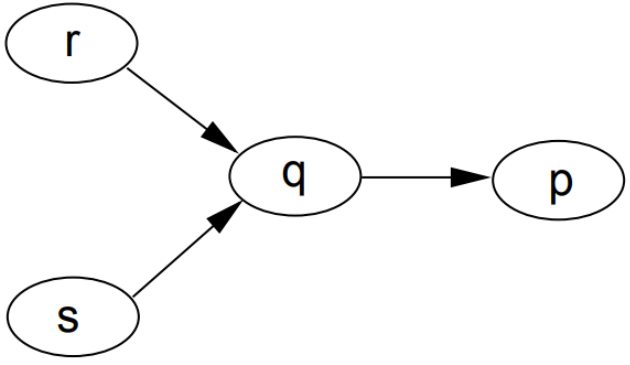
Grounded extensions: Alternative notion of acceptable set of arguments, [Dung, 1995].

Start with arguments guaranteed to be acceptable, i.e. arguments with no attacker whatsoever, and proceed with eliminating those arguments attacked by them. Repeat the process defining ‘in’ and ‘out’ arguments until the graph doesn’t change.

The set of ‘in’ arguments make up the grounded extension.

Abstract argumentation systems

Grounded extensions

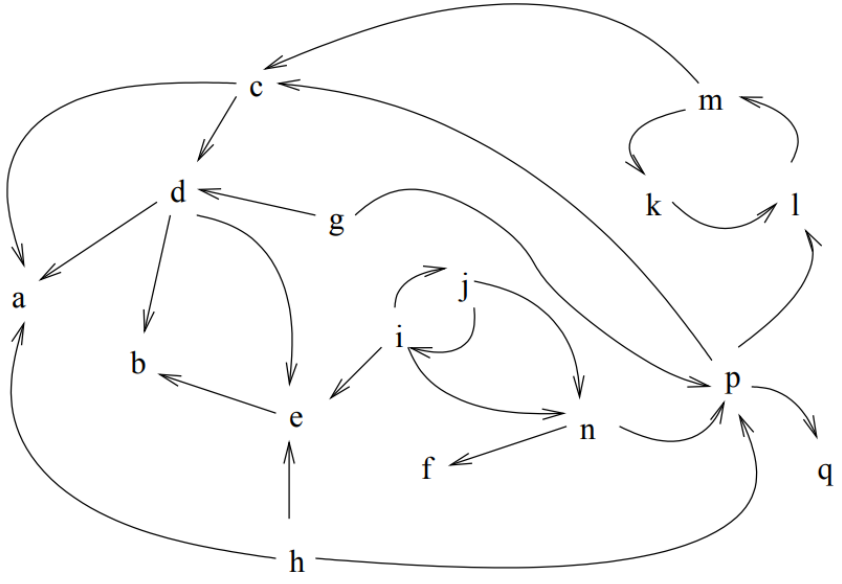


In: $\{rsp\}$ Out: $\{q\}$

Image: Figure 16.1a, Wooldridge 2009

Abstract argumentation systems

Grounded extensions



In: $\{hqgb\}$ Out: $\{aepd\}$

Image: Figure 16.3, Wooldridge 2009

Abstract argumentation systems

Which arguments to choose if multiple preferred extensions?

Count how many preferred extensions an argument is in.

- Sceptical acceptance
  An argument is in every preferred extension

- Credulous acceptance
  An argument is in at least one preferred extension

Abstract argumentation systems

Which arguments to choose if multiple preferred extensions?

Count how many preferred extensions an argument is in.

In our example *r*, *s* and *p* are all sceptically accepted, and *q* is neither sceptically or credulously accepted.

Deductive argumentation

Deductive argumentation takes into account the relationship between arguments. Arguments are built from logical relations, formulas and proofs on the form like:

$$a \vdash b$$

meaning there is a sequence of inferences from premise *a* leading to a conclusion *b*.

Deductive argumentation

Basic form of deductive arguments is as follows:

$$Database \vdash (Sentence, Grounds)$$

where $Database$ is a (possibly inconsistent) set of logical formula

$Sentence$ is a logical formula known as the conclusion

$Grounds$ is a set of logical formulae such that:

1. $Sentence$ can be proved from $Grounds$.
2. $Grounds \subseteq Database$

Slide from Wooldridge

http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Attack and defeat

Let (φ_1, Γ_1) and (φ_2, Γ_2) be arguments from some database DB, then (φ_2, Γ_2) can be defeated (attacked) in one of two ways:

1. (φ_1, Γ_1) *rebuts* (φ_2, Γ_2) if $\varphi_1 \equiv \neg\varphi_2$.
2. (φ_1, Γ_1) *undercuts* (φ_2, Γ_2) if $\varphi_1 \equiv \neg\psi$ for some $\psi \in \Gamma_2$.

A rebuttal or undercut is known an attack.

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Attack and defeat

Once we have identified attacks, we can look at preferred extensions or grounded extensions to determine what arguments to accept.

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Argumentation and communication

We have two agents, P and C, each with some *knowledge base*, ΣP and ΣC.

Each time one makes an assertion, it is considered to be an addition to its *commitment store*, $CS(P)$ or $CS(C)$.

Thus P can build arguments from $\Sigma P \cup CS(C)$, and C can use $\Sigma C \cup CS(P)$.

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Argumentation and communication

We assume that dialogues start with P making the first move.

The outcomes, then, are:

- P generates an argument both classify as ‘in’, or
- C makes Ps argument ‘out’.

Can use this for negotiation if the language allows you to express offers.

Slide from Wooldridge
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Argumentation Protocol

A typical persuasion dialogue would proceed as follows:

1. P has an acceptable argument (S, p), built from ΣP, and wants C to accept p. P asserts p.
2. C has an argument $(S', \neg p)$. C asserts $\neg p$.
3. P cannot accept $\neg p$ and challenges it.
4. C responds by asserting S'
5. P has an argument $(S'', \neg q)$ where $q \in S'$, and challenges q.
6. …

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Argumentation Protocol

This process eventually terminates when

$$\Sigma P \cup CS(P) \cup CS(C) \text{ and } \Sigma C \cup CS(C) \cup CS(P)$$

eventually provide the same set of ‘in’ arguments and the agents agree.

Clearly here we are looking at grounded extensions.

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Different dialogues

1. Information seeking – Tell me if p is true.
2. Inquiry – Can we prove p?
3. Persuasion – You're wrong to think p is true.
4. Negotiation – How do we divide the pie?
5. Deliberation – Where shall we go for dinner?

Slide from Wooldridge
http://www.cs.ox.ac.uk/people/michael.wooldridge/pubs/imas/distrib/pdf-slides/lect16.pdf

Summary lecture 13 – Arguing*

- What is arguing?
- Modes of argument
- Abstract argumentation
- Deductive argumentation
- Dialogues

*Wooldridge, 2009: chapter 16