



# Assumption-based argumentation for the minimal concession strategy of agents engaged in resource negotiation

MFI 2009.

Maxime Morge and Paolo Mancarella - Università di Pisa  
Philippe Mathieu - LIFL Univ. Lille 1

# Strategy of Negotiation for Argumentative Agents



Dialogue \ Purpose	Expressivity	Optimality
Adjudication		[Rahwan & Larson AAI'08]
Theoretical		[Parsons et al. JLC'03]
Practical	[Kakas et al. ArgMAS'04]	[Dung et al. COMMA'08]

- In [Morge & Mancarella ArgMAS'09]
  - Realisation of the strategy using argumentation
  - The agents ignore the reservation values/preferences of the others
- In [Morge, Mathieu & Mancarella MFI'09]
  - Resource allocation

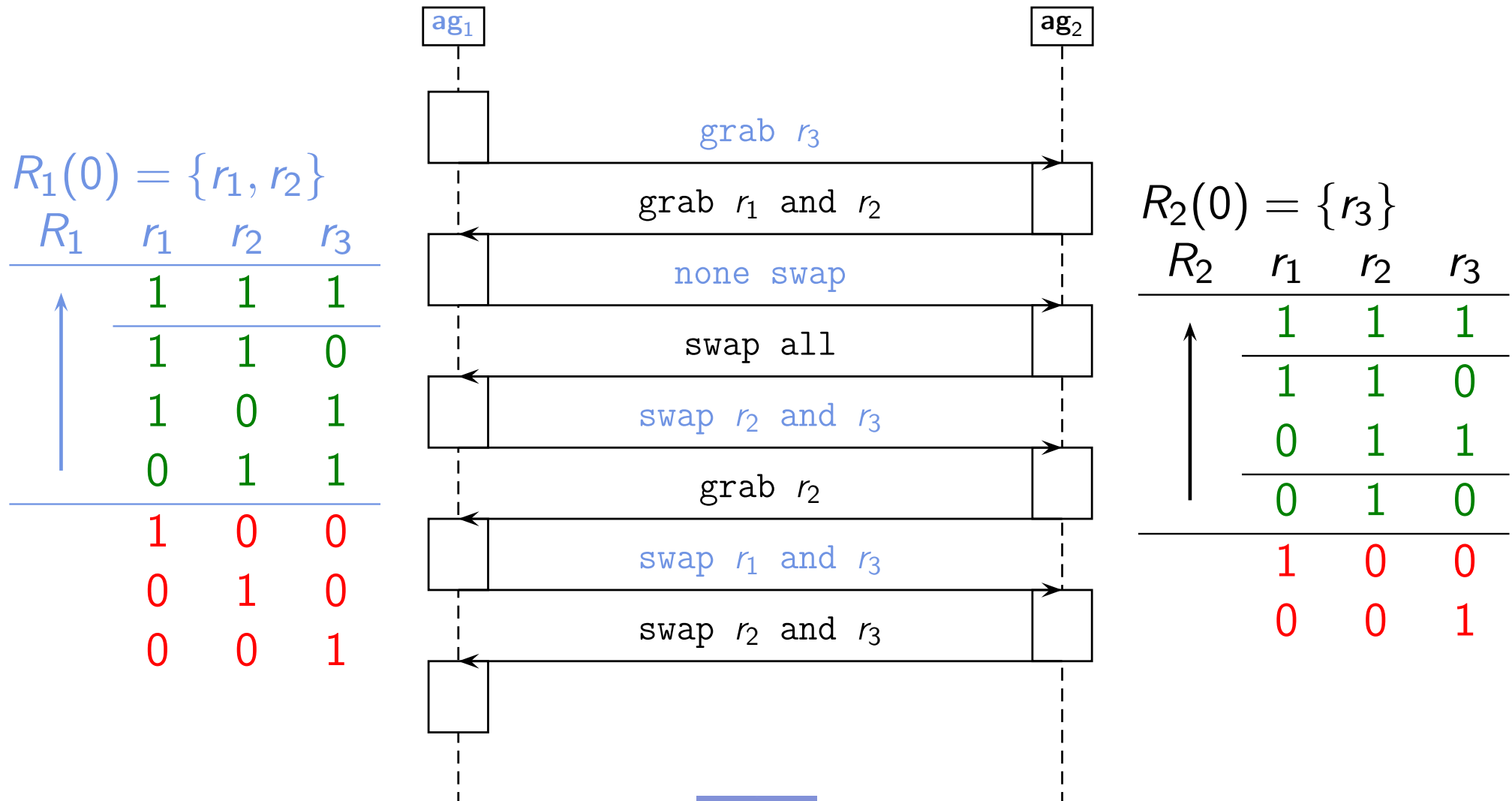


# Outline



- Motivation
- Walk-through example
- Decision-making
- Social Interaction
- Negotiation strategy
- Conclusion and future works

## Resource negotiation



# Assumption-based argumentation for decision-making



$$\mathcal{L} = \mathcal{G} \cup \mathcal{D} \cup \mathcal{B}$$

$\text{control}(\text{ag}_1, [1, 1, 0]) \leftarrow$

$\text{control}(\text{ag}_2, [0, 0, 1]) \leftarrow$

$\text{o}([u, v, 1], [x, y, 0]) \leftarrow$

$\text{d}([0, 0, 0], [0, 0, 1]),$

$\text{control}(\text{ag}_1, [u, v, 0]),$

$\text{control}(\text{ag}_2, [x, y, 1])$

$\text{o}([0, v, 1], [1, y, 0]) \leftarrow$

$\text{d}([1, 0, 0], [0, 0, 1]),$

$\text{control}(\text{ag}_1, [1, v, 0]),$

$\text{control}(\text{ag}_2, [0, y, 1])$

...

$\mathcal{Asm} = \{\text{d}([0, 0, 0], [0, 0, 1]), \text{d}([1, 0, 0], [0, 0, 1]), \dots\}$

$\text{Con}(\text{d}([0, 1, 0], [0, 0, 1])) = \{\text{d}([1, 0, 0], [0, 0, 1]), \text{d}([0, 0, 0], [0, 0, 1]), \dots\}$

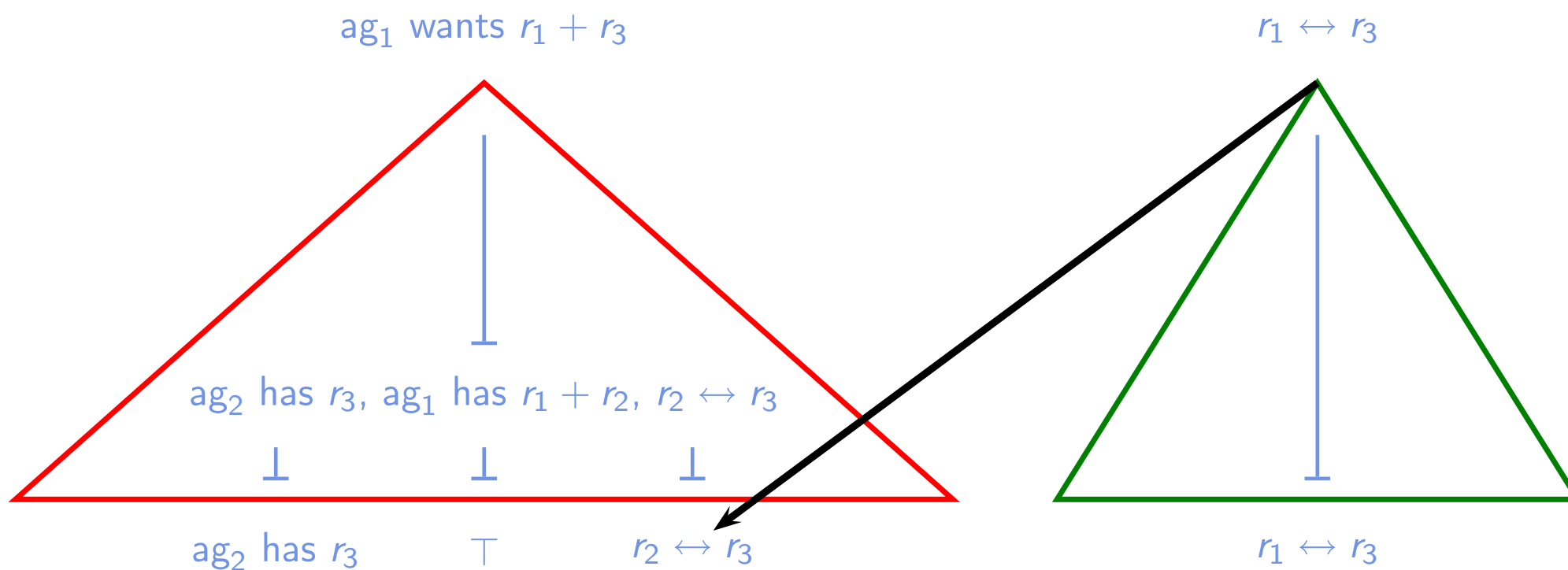
...

# Argument: deduction tree

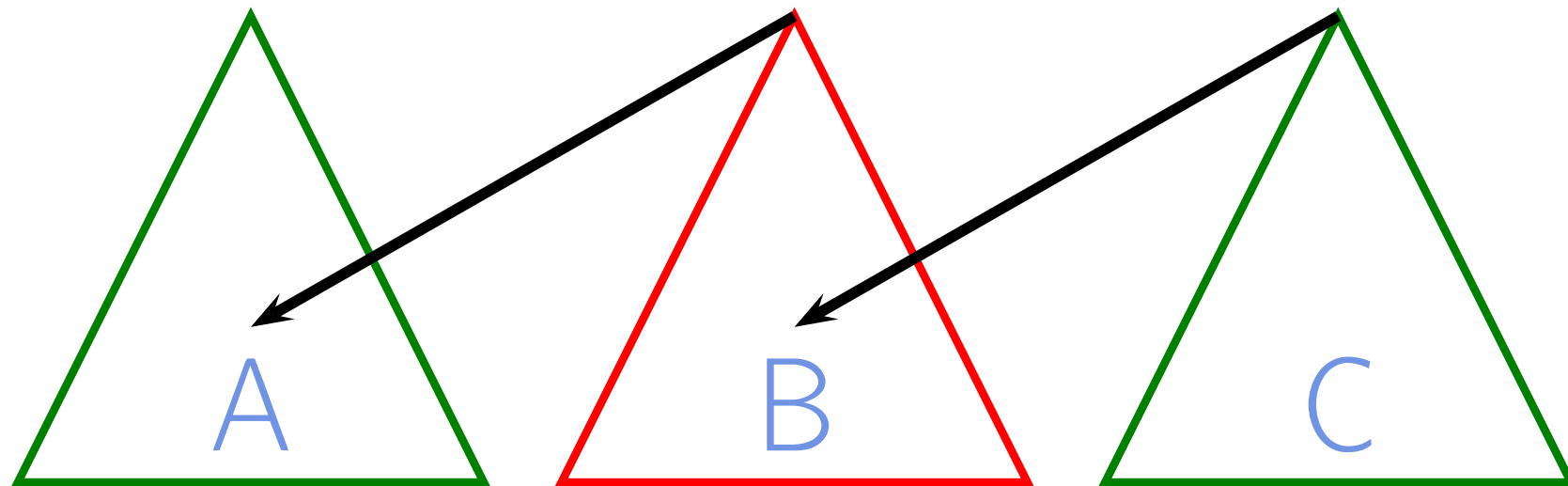


Attacks comes from the contraries:

- $ag_1$  wants  $r_1$  and  $r_3$
- $r_1$  and  $r_3$  can be swapped



# Dialectical proof procedure [Dung AIJ06]



- $\Leftrightarrow$  declarative model-theoretic semantic (soundness)
- interleaves arguments construction/dispute (efficiency)
- as a game (turn-taking, backtracking, ...)

## Minimal concession [Morge &amp; Mancarella ArgMAS'07]



If

- $|R_1| = 3 \succ |R_1| = 2$
- the reservation value is  $|R_2| = 2$

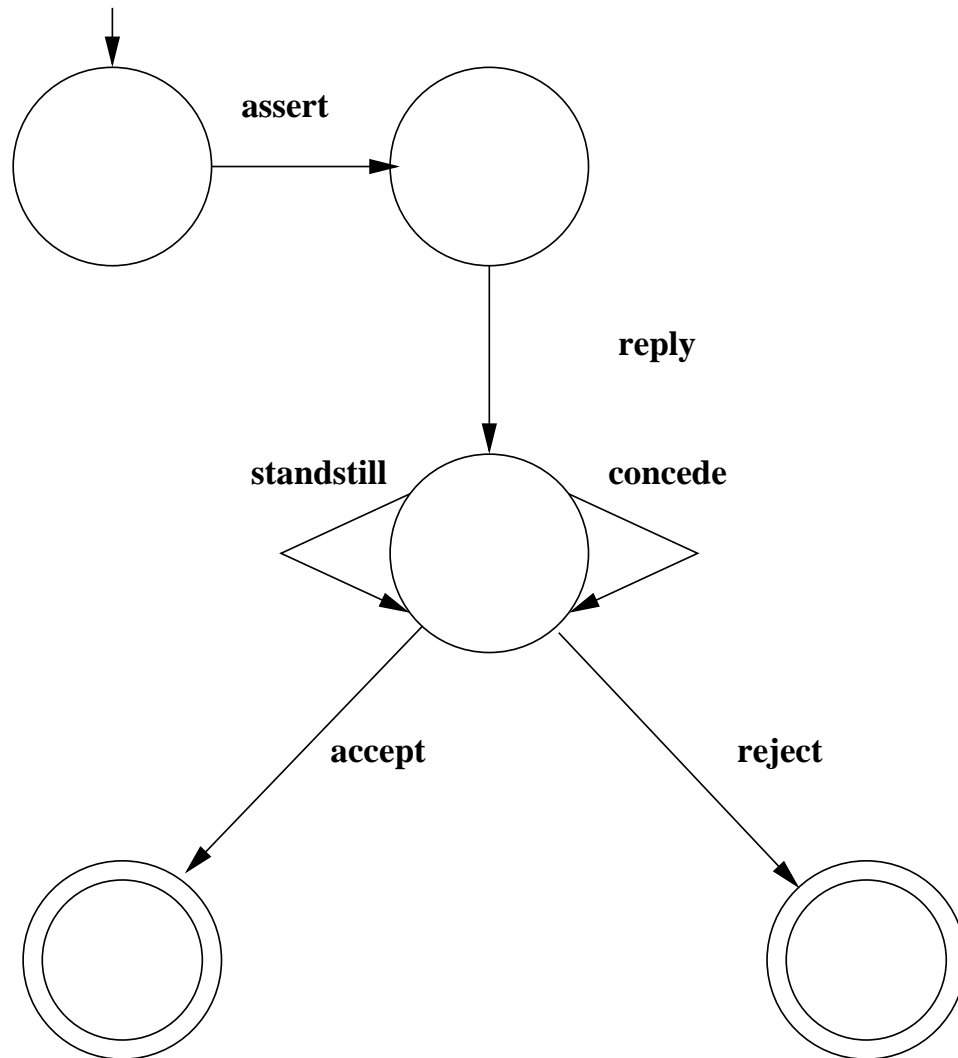
Then

- $[1, 1, 1]$  is optimal
- $[0, 1, 1]$  is a minimal concession wrt  $[1, 1, 1]$

$$R_1(0) = \{r_1, r_2\}$$

$R_1$	$r_1$	$r_2$	$r_3$
	1	1	1
	1	1	0
	1	0	1
	0	1	1
	1	0	0
	0	1	0
	0	0	1

# Game-based social interaction model



- Bilateral bargaining protocol
- Strategy interface:
  - condition of utterances
  - dialogue state

## Minimal concession strategy



- Agents start the negotiation with their best offers
- After the optimal offers, an agent starts conceding
- An agent concedes if the other has conceded and
  - if there is still a rational possible offer,
  - the concession is **minimal** since there is no possible offer which is preferred
- An agent stands still if the interlocutor has stood still
- *Agents concede after 3 consecutive standstills to reach an agreement (ignorance of the reservation values/preferences)*
- An agent accepts a previous offer which is a minimal concession
- Otherwise an agent rejects the last offer

# Realisation of the minimal concession strategy



optimal  $\leftarrow$  loc(assert), ll(none) (1)

optimal  $\leftarrow$  loc(reply), ll(assert) (2)

optimal  $\leftarrow$  loc(concede), d(x, y), ll(reply),  
notrejected(d(x, y)), notpo(part, d(x, y)) (3)

respond  $\leftarrow$  loc(standstill), d(x, y), ll(reply),  
po(init, d(x, y)) (4)

optimal  $\leftarrow$  loc(standstill), ll(standstill),  
notnbss(3) (5)

optimal  $\leftarrow$  loc(concede), d(x, y), ll(standstill),  
notrejected(d(x, y)),  
notpo(part, d(x, y)), nbss(3) (6)

...



## Properties



### Theorem (Termination)

The dialogues are finite.

### Claim (Success/Optimality)

If both of the players adopt a MC strategy and a potential agreement exists, then

- the dialogue is a success
- the outcome is Pareto optimal

### Warning (Non-incentive)

The dialogue is not in a pure symmetric Nash equilibrium.

## What you need to buy



- **Realisation** of the minimal concession strategy using assumption-based argumentation
- **Realistic** agents ignore the preferences and the reservation values of the others
- **Resource negotiation** is guaranteed to terminate and the outcome is optimal (when it is possible)
- Implementation with `www.MARGO.sf.net`  
[Morge & Mancarella ArgMAS'07]
- ... Toward multi-agent resource negotiation

Thanks











Let us have a walk !



# References



- 
 Maxime Morge and Paolo Mancarella The hedgehog and the fox. An argumentation-based decision support system. In Proc. of ArgMAS 2007.
- 
 Maxime Morge and Paolo Mancarella Assumption-based argumentation for the minimal concession strategy. In Proc. of ArgMAS 2007.
- 
 Maxime Morge and Paolo Mancarella Assumption-based argumentation for the minimal concession strategy of agents engaged in resource negotiation. In Proc. of MFI 2009.
- 
 Dung, P.M., Thang, P.M., Toni, F. Towards argumentation-based contract negotiation. In Proc. of COMMA 2008.
- 
 Rahwan, I., Larson, K.: Pareto optimality in abstract argumentation. In Proc. of AAI 2008.
- 
 Parsons, S., Wooldridge, M., Amgoud, L. Properties and complexity of some formal inter-agent dialogues. JLC 2003.
- 
 Kakas, A.C., Maudet, N., Moraitis, P. Layered strategies and protocols for argumentation-based agent interaction. In Proc. of ArgMAS 2004.
- 
 Phan Minh Dung, Robert A. Kowalski, and Francesca Toni. Dialectic proof procedures for assumption-based, admissible argumentation. Artificial Intelligence, 170(2):114–159, 2006.

