

# Practical and epistemic reasoning in argumentation dialogues: from theory to practice

Eric M. Kok    John-Jules Ch. Meyer    Henry Prakken  
Gerard A. W. Vreeswijk

Utrecht University

June 4, 2012

Introduction

Argumentation in AI  
Practical reasoning

Models for practical reasoning

Existing approaches  
Difficulties

An experiment

Scenario generation  
A simple alternative

Results

Experimental results  
Conclusions



Universiteit Utrecht

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions

### Introduction

Argumentation in AI  
Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions



# Argumentation

- ▶ **Argumentation logics**  
(semantics, structure, values/preferences, ...)
- ▶ **Argumentation dialogues**  
(persuasion, negotiation, deliberation, ...)

## Introduction

### Argumentation in AI

Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Why argue?

Agent that argue are supposed to be

- ▶ more efficient
- ▶ more effective

But are they, in practise?

## Introduction

### Argumentation in AI

Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Experimental validation

## Validation through:

- ▶ Generating scenarios
- ▶ Running agents
- ▶ Measure the dialogues
- ▶ Analyse

## Deliberation!

- ▶ Multi-agent
- ▶ Shared and personal goals
- ▶ Epistemic and practical reasoning

### Introduction

#### Argumentation in AI

Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions



# Practical reasoning

## Epistemic arguments

- ▶ About the truth status of beliefs
- ▶ Sceptical reasoning

## Practical arguments

- ▶ About (proposals to do some) action
- ▶ Credulous reasoning (Prakken, 2006)

### Introduction

Argumentation in AI

Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions



# Argument scheme

## Argument scheme for practical reasoning (Atkinson, 2005)

*In the current circumstances R  
Action A should be performed  
To bring about new circumstances S  
Which will realise goal G  
And promote value V*

### Introduction

Argumentation in AI

Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions



# An example

## Epistemic reasoning

- ▶ ‘steaks made from wagyu cattle are wagyu steaks’
- ▶ ‘steaks from wagyu beef are the best steaks’

## Practical reasoning

- ▶ ‘to enjoy our dinner we should go to the bistro, because they serve the best steaks’

### Introduction

Argumentation in AI

Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions





# Existing approaches

Atkinson (2005)

- ▶ AS encoded as  $R \xrightarrow{A} S \models G \uparrow v$
- ▶ Strict protocol with pre- and post-conditions

Rahwan and Amgoud (2007)

- ▶ Distinct belief and desire undercut
- ▶ Desire and consequence conflicts using custom semantics

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Existing approaches (cont.)

Black (2011)

- ▶ AS encoded as single-inference abstract argument
- ▶ Asserted arguments are evaluated as argumentation theory

Bench-Capon and Prakken (2006); Prakken (2006)

- ▶ Accrual of structured arguments
- ▶ Desire modality in logical language
- ▶ E-p-semantics

Introduction

Argumentation in AI  
Practical reasoning

Models for practical reasoning

Existing approaches  
Difficulties

An experiment

Scenario generation  
A simple alternative

Results

Experimental results  
Conclusions



Universiteit Utrecht

# Desirable properties

- ▶ Embedded in the logical language
- ▶ Playing nice with existing semantics
- ▶ Structured argumentation

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Desire modality

Following Bench-Capon and Prakken (2006); Prakken (2006):

- ▶ backwards application of rules

$$\frac{\frac{\text{DenjoyDinner} \quad \text{bestSteak} \Rightarrow \text{enjoyDinner}}{\text{DbestSteak}} \quad \text{goToBistro} \Rightarrow \text{bestSteak}}{\text{DgoToBistro}}$$

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Attack between practical arguments

$$\frac{\frac{\text{DenjoyDinner} \quad \text{bestSteak} \Rightarrow \text{enjoyDinner}}{\text{DbestSteak}} \quad \text{goToBistro} \Rightarrow \text{bestSteak}}{\text{DgoToBistro}}$$

is alternative-attacked by

$$\frac{\text{DenjoyDinner} \quad \text{bestSteak} \Rightarrow \text{enjoyDinner}}{\text{DbestSteak}}$$

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Explosion of arguments

Now consider a (still small) knowledge base:

- ▶ Goals:  $Dg$
- ▶ Action:  $o$
- ▶ Rules:  $o \Rightarrow p; p \Rightarrow q; q \Rightarrow r; r \Rightarrow g$
- ▶  $q \Rightarrow g; p \Rightarrow g; o \Rightarrow g$
- ▶  $o \Rightarrow q; o \Rightarrow r$

Explosion of arguments and argument attacks!

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

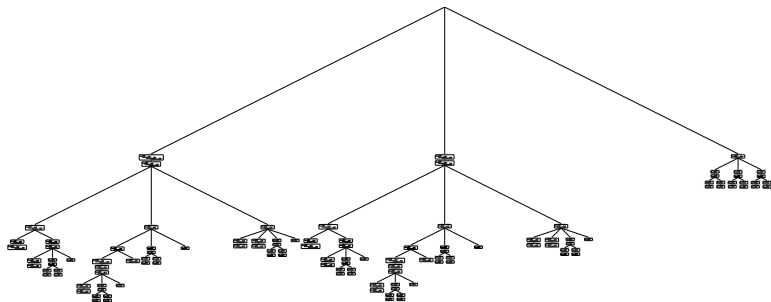
Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Explosion of arguments



Cause: alternatives

- ▶ How realistic is this?

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Generation deliberation scenarios

## Deliberation scenario characteristics:

- ▶ Multi-agent
- ▶ Shared and personal knowledge
- ▶ Shared and personal goals
- ▶ Various possible actions

### Introduction

Argumentation in AI  
Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions





# Knowledge assignment

Connect an assigned goal  $g$  to some possible action  $a$ :

$$o \Rightarrow p; p \Rightarrow q; q \Rightarrow r; r \Rightarrow g$$

Rule chaining (Kok et al., 2011)

- ▶ Repeat for actions and personal and mutual goals

Result: argument explosion...

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions



# Alternative encoding

Allow goals and actions in the topic language

$$\frac{\frac{\text{enjoyDinner} \quad \text{enjoyDinner} \Rightarrow \text{bestSteak}}{\text{bestSteak}} \quad \text{bestSteak} \Rightarrow \text{goToBistro}}{\text{goToBistro}}$$

Upside:

- ▶ normal models for structured argumentation apply
- ▶ no explosion of (attack amongst) arguments

Downside:

- ▶ action as conclusion instead of premise
- ▶ no intertwined credulous & epistemic reasoning

Introduction

Argumentation in AI  
Practical reasoning

Models for practical reasoning

Existing approaches  
Difficulties

An experiment

Scenario generation  
A simple alternative

Results

Experimental results  
Conclusions



Universiteit Utrecht

# An experiment with deliberation

## Full model for experimentation

- ▶ Formal model for deliberation dialogues
- ▶ Generating scenarios through rule chaining
- ▶ Simple arguing and non-arguing strategies

## Software simulation

- ▶ Play many dialogues
- ▶ Measure efficiency and effectiveness

(See <http://aspic.cossac.org/> for South and Vreeswijk's ASPIC Java Inference Components)

### Introduction

Argumentation in AI  
Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

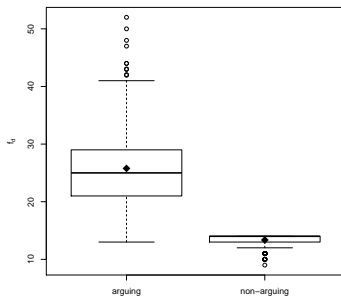
Scenario generation  
**A simple alternative**

### Results

Experimental results  
Conclusions



# Dialogue efficiency



Arguing vs. non-arguing efficiency in number of moves (Kok et al., 2012)

## Introduction

- Argumentation in AI
- Practical reasoning

## Models for practical reasoning

- Existing approaches
- Difficulties

## An experiment

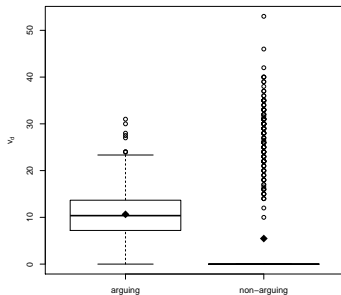
- Scenario generation
- A simple alternative

## Results

- Experimental results
- Conclusions



# Dialogue effectiveness



Arguing vs. non-arguing effectiveness as combined utility (Kok et al., 2012)

## Introduction

- Argumentation in AI
- Practical reasoning

## Models for practical reasoning

- Existing approaches
- Difficulties

## An experiment

- Scenario generation
- A simple alternative

## Results

- Experimental results
- Conclusions



# Wrap up

## Conclusions

- ▶ Formal models for practical reasoning not quite ready
- ▶ But argumentation has great potential benefits

I'll be...

- ▶ At AAMAS/ArgMAS
- ▶ Finishing up this work in my thesis

### Introduction

Argumentation in AI  
Practical reasoning

### Models for practical reasoning

Existing approaches  
Difficulties

### An experiment

Scenario generation  
A simple alternative

### Results

Experimental results  
Conclusions



# References

- ▶ Atkinson, K., Bench-Capon, T. J. M., and McBurney, P. (2005). A dialogue game protocol for multi-agent argument over proposals for action. *Autonomous Agents and Multi-Agent Systems*, 11(2):153171.
- ▶ Bench-Capon, T. J. M. and Prakken, H. (2006). Justifying actions by accruing arguments. In *Computational Models of Argument: Proceedings of COMMA 2006*, pages 247258.
- ▶ E. Black and K. Bentley. An empirical study of a deliberation dialogue system. In *Proceedings of the 1st International Workshop on the Theory and Applications of Formal Argumentation*, Barcelona, Spain, 2011.
- ▶ E. M. Kok, J.-J. C. Meyer, H. van Oostendorp, H. Prakken, and G. A. W. Vreeswijk. A Methodology for the Generation of Multi-Agent Argumentation Dialogue Scenarios. In *9th European Workshop on Multi-agent Systems*, Maastricht, The Netherlands, 2011.
- ▶ E. M. Kok, J.-J. C. Meyer, H. van Oostendorp, H. Prakken, and G. A. W. Vreeswijk. Testing the benefits of structured argumentation in multi-agent deliberation dialogues. To be presented at the 11th International Conference on Autonomous Agents and Multiagent Systems, Valencia, Spain, 2012.
- ▶ Prakken, H. (2006). Combining sceptical epistemic reasoning with credulous practical reasoning. In Dunne, P. and Bench-Capon, T., editors, *Proceedings of COMMA-06*, pages 311322. IOS Press.
- ▶ Rahwan, I. and Amgoud, L. (2007). An argumentation-based approach for practical reasoning. *Lecture Notes in Computer Science*, 4766:74.
  
- ▶ E-mail: [erickok@cs.uu.nl](mailto:erickok@cs.uu.nl)

## Introduction

Argumentation in AI  
Practical reasoning

## Models for practical reasoning

Existing approaches  
Difficulties

## An experiment

Scenario generation  
A simple alternative

## Results

Experimental results  
Conclusions

