Abstract Machines for Argumentation

Logic and Interactions 2012, Week 2

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Summary One of the most striking features of ludics is that it provides us with convenient tools for the modelling of interaction. As a consequence, ludics has been exploited to provide a framework for the modelling of dialogues. In this talk we shall address some of the issues that arise when one tries to model certain types of dialogues that occur frequently in the field of argumentation. We shall exploit that ludics' designs can be regarded as abstract Böhm trees and explain how the pointer interaction of the associated geometric abstract machine GAM relates to a notion of backtracking.

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1 Introduction

Summary of content

- Related work and motivations
- Aim of talk and contributions

Lecomte and Quatrini

- *Ludics and its applications to natural language semantics* (in LNAI 5514, 2009)
- A theory of meaning that is based on ludics
  - convergence via daimon
  - meaning via orthogonality
- Match between rules of ludics and moves in dialogue

- rules of ludics: positive vs negative
- roles in dialogue: speaker vs hearer
- actions in dialogue: sender vs receiver

- Put these aspects together by means of normalisation

Curien and Herbelin

- *Abstract machines for dialogue games* (in Panoramas et Synthèses 27, 2009)
- Proofs in ludics regarded as abstract Böhm trees
- Various abstract machines for computing with ABTs

Combining these strands

- Want to extend duality to abstract Böhm trees
  - rules of ludics: positive vs negative
  - roles in dialogue: speaker vs hearer
  - actions in dialogue: sender vs receiver
  - abstract Böhm trees: replies vs queries
- Towards computational account for modelling dialogue
  - normalisation by means of geometric abstract machine
- ABTs more expressive than MLL-based variant of ludics

Basaldella and Faggian

- *Ludics with repetitions: exponentials, interactive types and completeness* (in LMCS 7, 2011)
- An extension of ludics that deals with exponentials
- Add pointers to trace occurrences of subformulae

Relation to our framework

- Relevant differences mostly of technical nature
  - normalisation via view abstract machine
  - pointer interaction not a primary concern
  - main focus on repetition of actions
- Should be possible to translate all of our examples
- Pointer interaction one of the central topics of this talk

2 Abstract machines

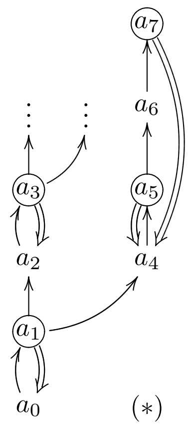
Summary of content

- Sketch of formal definitions
- How does GAM actually work?

General considerations

- Operational account of concepts from game semantics
- Crisp graphical representation for abstract Böhm trees
  - interaction may be seen as interleaved tree traversal
  - graphical representation vs concrete implementation
- Small number of rules leads to compact implementation
- Rapid prototyping as main benefit of implementation
  - a potential framework for developing applications
  - why not abstract Böhm trees as data structures?

Abstract Böhm trees



- Two types of moves
  - queries: a_0, a_2, a_4, a_6
  - replies: a_1, a_3, a_5, a_7
- Pointer conditions
  - from reply to query
  - only within branch
- Branching condition

- only after replies

- (Counter-)strategies
  - $(*)$ is counterstrategy
  - strategy when 1) $a_0 = \star$ and 2) no pointers to $\star$

Geometric abstract machine

$$\frac{}{\mapsto \{1 \leftarrow \star\}}\ (1) \qquad \frac{hd(\Gamma) = \{\overline{2n} \leftarrow \mathbf{q}[a, -]\}}{\Gamma \mapsto \Gamma\{2n \leftarrow a\}}\ (2n)_f$$

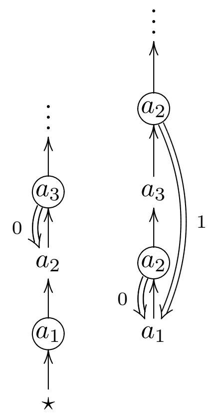
$$\frac{hd(\Gamma) = \{2n-1 \leftarrow \mathbf{q}\}, \phi(\mathbf{q}) = [a, \kappa]}{\Gamma \mapsto \Gamma\{\overline{2n} \leftarrow \mathbf{q}[a, \kappa]\}}\ (\overline{2n})$$

$$\frac{hd(\Gamma) = \{\overline{2n} \leftarrow \mathbf{q}[a, \iota]\}, \pi(pop^{\iota}(\mathbf{q})) = 2k-1, \Gamma \bullet \overline{2k-1} = \mathbf{r}}{\Gamma \mapsto \Gamma\{2n \leftarrow \mathbf{r}a\}}\ (2n)_b$$

$$\frac{hd(\Gamma) = \{2n \leftarrow \mathbf{q}\}, \psi(\mathbf{q}) = [a, \kappa]}{\Gamma \mapsto \Gamma\{\overline{2n+1} \leftarrow \mathbf{q}[a, \kappa]\}}\ (\overline{2n+1})$$

$$\frac{hd(\Gamma) = \{\overline{2n+1} \leftarrow \mathbf{q}[a, \iota]\}, \pi(pop^{\iota}(\mathbf{q})) = 2k, \Gamma \bullet \overline{2k} = \mathbf{r}}{\Gamma \mapsto \Gamma\{2n \leftarrow \mathbf{r}a\}}\ (2n+1)$$

GAM at work: outline



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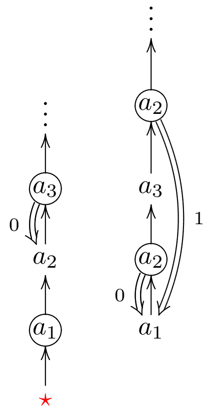
GAM at work: step 1



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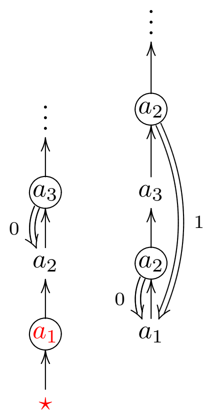
GAM at work: step $\overline{2}$



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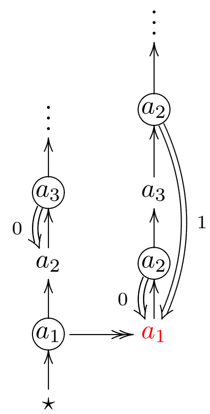
GAM at work: step 2



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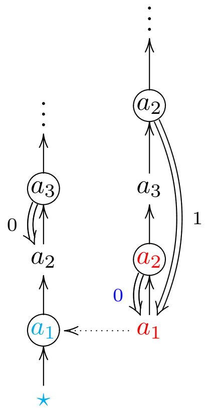
GAM at work: step $\overline{3}$



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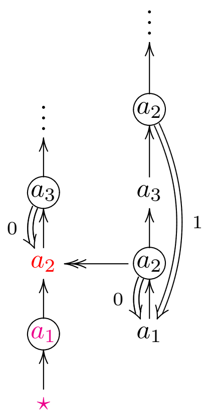
GAM at work: step 3



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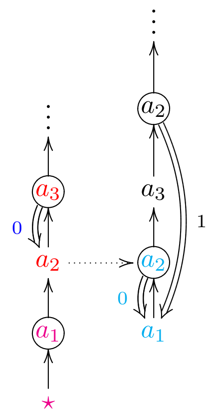
GAM at work: step $\overline{4}$



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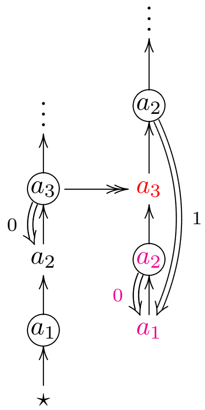
GAM at work: step 4



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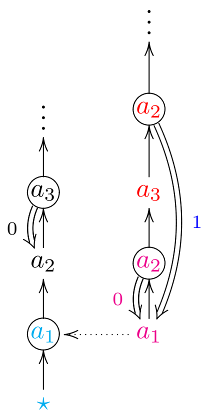
GAM at work: step $\overline{5}$



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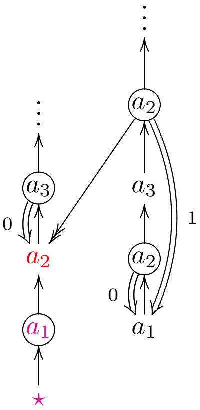
GAM at work: step 5



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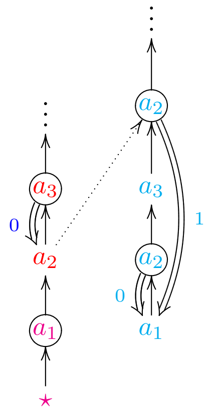
GAM at work: step $\overline{6}$



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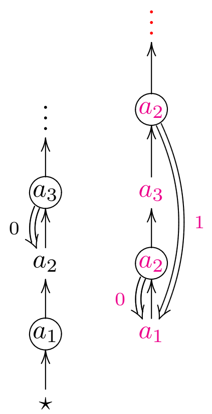
GAM at work: step 6



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3 Argumentation

Summary of content

- Example dialogue about burden of proof
- Synthesised dialogue and formalisation

Prakken, Reed and Walton

- *Dialogues about the burden of proof* (in ICAIL, 2005)
- Combine persuasion dialogue with burden of proof
  - argumentation schemes, critical questions
  - technical solution based on dialogue levels

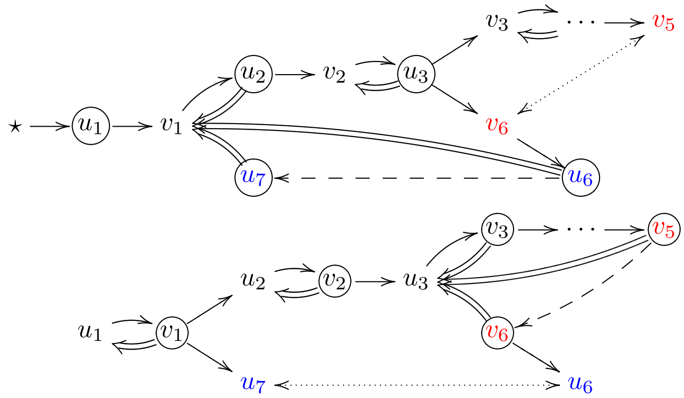
Use of pointer interaction

- Embedded dialogues and concept of backtracking
  - backtracking: returning to earlier point in dialogue
- Dialogue as product of normalisation via GAM

Example of legal dispute

u_1:CLAIM C
v_1:WHY C
$\ulcorner u_2$:C SINCE $\mathit{says}(e,C) \wedge \mathit{expert}(e,C)$
v_2:WHY $\neg\mathit{biased}(e)$
u_3:WHY $\mathit{biased}(e)$
$\ulcorner v_3$:BOP $(\neg\mathit{biased}(e), u)$ SINCE $\neg\mathit{biased}(e) \rightarrow \mathit{trusted}(e)$
u_4:WHY $\neg\mathit{biased}(e) \rightarrow \mathit{trusted}(e)$
v_4:WHY $\neg(\neg\mathit{biased}(e) \rightarrow \mathit{trusted}(e))$
u_5:$\neg(\neg\mathit{biased}(e) \rightarrow \mathit{trusted}(e))$ SINCE $\mathit{presumed}(\neg\mathit{biased}(e))$
$\llcorner v_5$:RETRACT $\neg\mathit{biased}(e) \rightarrow \mathit{trusted}(e)$
v_6:$\mathit{biased}(e)$ SINCE $\mathit{paid}(e,c) \wedge \mathit{testifies}(e,c)$
$\llcorner u_6$:CONCEDE $\mathit{biased}(e)$
u_7:RETRACT C

u's & v's point of view



4 Conclusion

General considerations

- Dialogue regarded as product of interaction
- Pointer interaction crucial for backtracking
- Lots of other applications indeed possible

Ongoing and future work

- Syntax versus semantics
  - grammars as abstract Böhm trees
  - compositional theory of meaning?
- Analysis versus synthesis
  - modular approach to abstract Böhm trees
  - abstract Böhm trees as data structures?
- Rationality, decision making
  - implementation of selection functions?