

Challenges with Obligations in Multiagent Deontic Logic

Challenges 2, 3 and 4

Raik Hipler and Mark Scheibner

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Outline

Introduction

Non-Deterministic Actions

Moral Luck

Procrastination

Summary

Introduction

Ought-to-be and Ought-to-do

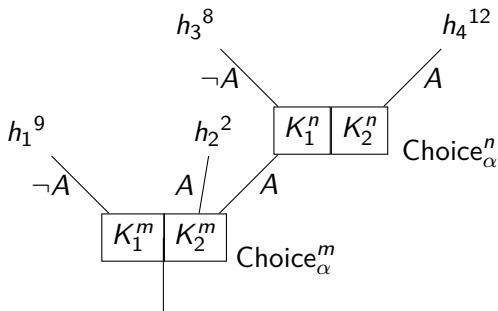
- ▶ SDL and DSDL give us frameworks for handling how things *ought to be*
- ▶ Since we are interested in the actions of agents, we need to describe what agents *ought to do*
- ▶ Simply redefining *ought to do* as *ought to be done* leads to various problems

STIT logic

- ▶ STIT trees model possible decisions of (multiple) agents
- ▶ Inner node are sets of actions the agent has to decide between
- ▶ Each action may non-deterministically lead to different outcomes
- ▶ Leafs are histories with associated utility values

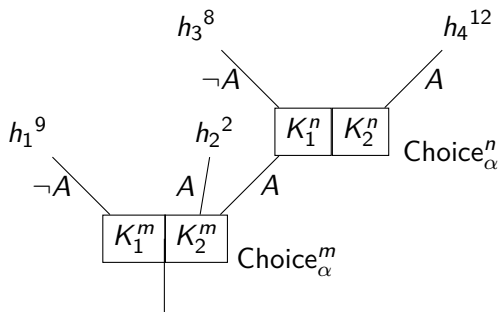
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STIT logic

Semantics



- Consider moment-history pairs
- Does $m, h \models \varphi$ hold?

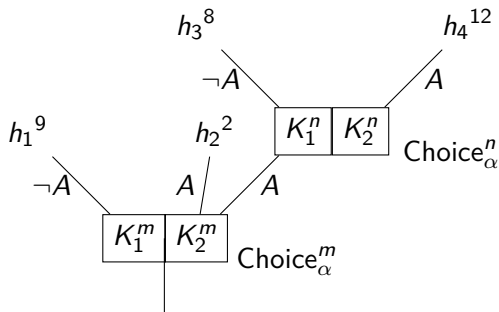
Semantics

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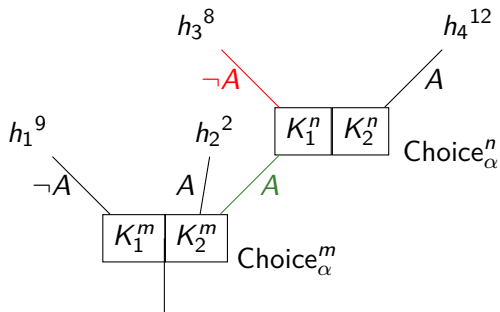


Atomic propositions

- $m, h_3 \models A$?
- $n, h_3 \models A$?

STIT logic

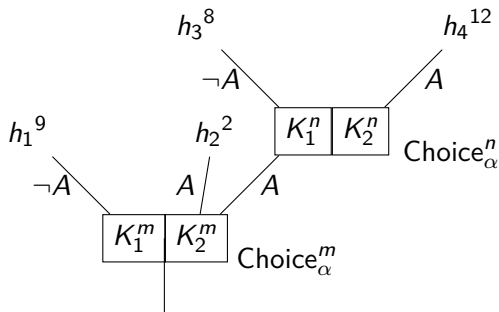
Semantics



Atomic propositions

► $m, h_3 \models A$

► $n, h_3 \not\models A$

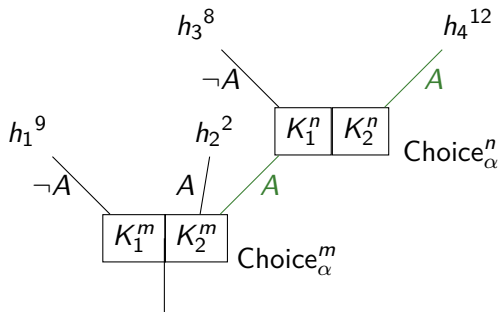


Obligations

- $m, h_2 \models \bigcirc A?$
- $m, h_2 \models \bigcirc \neg A?$

STIT logic

Semantics

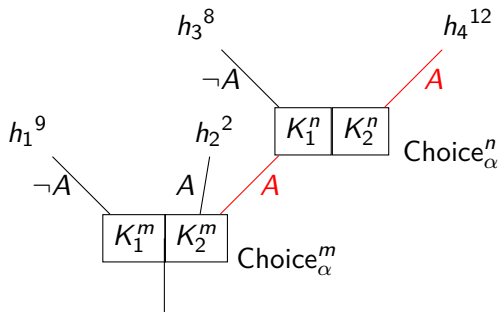


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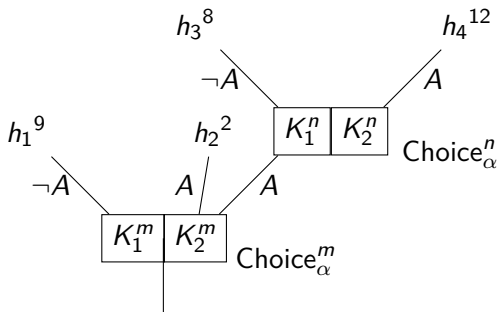
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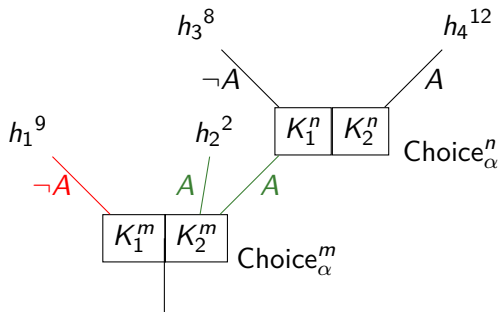


See-To-It-That

- ▶ $m, h_3 \models [\alpha \text{ cstit}: A]$?
- ▶ $m, h_1 \models [\alpha \text{ cstit}: A]$?

STIT logic

Semantics



See-To-It-That

- ▶ $m, h_3 \models [\alpha \text{ cstit}: A]$
- ▶ $m, h_1 \not\models [\alpha \text{ cstit}: A]$

Challenge 2: Non-Deterministic Actions

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How can we deal with different possible outcomes caused by non-determinism?

Challenge 2: Non-Deterministic Actions

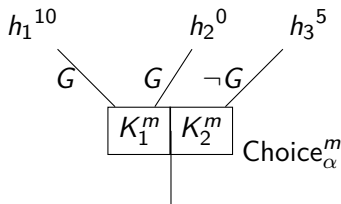
The gambling problem

- ▶ The agent is presented with two options
- ▶ If he gambles, he can either double or lose his bet
- ▶ If he does not gamble, he preserves his money

Challenge 2: Non-Deterministic Actions

The gambling problem

- ▶ The agent is presented with two options
- ▶ If he gambles, he can either double or lose his bet
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How can we formulate that the agent should arrive at h_1 ?

Challenge 2: Non-Deterministic Actions

Optimality of non-deterministic actions

- ▶ The optimal path ends in h_1
- ▶ The agent should “ought to see to it that G ”
- ▶ Intuitive formulation $\bigcirc[\alpha \text{ cstit: } G]$ problematic since K_1^m is not necessarily better than K_2^m

Challenge 2: Non-Deterministic Actions

Optimality of non-deterministic actions

- ▶ The optimal path ends in h_1
- ▶ The agent should “ought to see to it that G ”
- ▶ Intuitive formulation $\bigcirc[\alpha \text{ cstit}: G]$ problematic since K_1^m is not necessarily better than K_2^m
- ▶ We cannot infer optimal actions from optimal histories
- ▶ An action may lead non-deterministically to worse histories

Challenge 2: Non-Deterministic Actions

More appropriate approach:

- ▶ Compare all possible histories
- ▶ K_1 is more optimal than K_2 if each of its histories is at least as good as every history of K_2

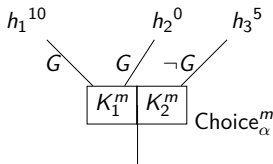
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More appropriate approach:

- Compare all possible histories
- K_1 is more optimal than K_2 if each of its histories is at least as good as every history of K_2

New operator: $\odot[\alpha \text{ cstit}: G]$

- Fulfilled if no action not leading to G is the optimal action
- Back to the gambling problem:
Neither $\odot[\alpha \text{ cstit}: G]$ nor $\odot[\alpha \text{ cstit}: \neg G]$ hold for m



Challenge 3: Moral Luck

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How do we deal with luck?

Challenge 3: Moral Luck

- ▶ Sometimes the consequences of our actions are outside of our control
- ▶ This may for example happen if the outcome is also dependent on someone else's actions

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- ▶ Sometimes the consequences of our actions are outside of our control
- ▶ This may for example happen if the outcome is also dependent on someone else's actions
- ▶ How do we evaluate the formula $\odot[\alpha \text{ cstit}: A]$ if the outcome also depends on another agents decision?

Challenge 3: Moral Luck

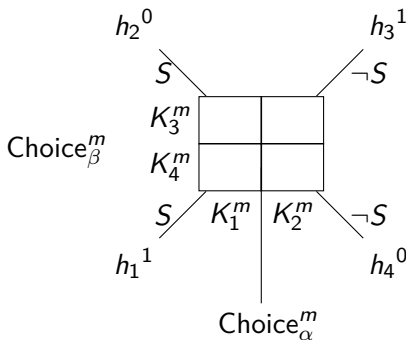
The driving example

- ▶ Two cars are driving towards each other on a small road
- ▶ The drivers (α and β) both have to decide whether to swerve to the side (S) or drive straight ($\neg S$)

Challenge 3: Moral Luck

The driving example

- ▶ Two cars are driving towards each other on a small road
- ▶ The drivers (α and β) both have to decide whether to swerve to the side (S) or drive straight ($\neg S$)
- ▶ If both decide on the same action, they will crash
- ▶ How do we deal with $\odot[\alpha \text{ cstit}: S]$?



Challenge 3: Moral Luck

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There are two views:

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There are two views:

- Dominance act utilitarianism:

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There are two views:

- ▶ Dominance act utilitarianism:
 - ▶ $\odot[\alpha \text{ cstit}: S]$ if all optimal outcomes guarantee S
 - ▶ In the example this is not the case, since $\neg S$ can also lead to an optimal outcome
 - ▶ The same goes for $\odot[\alpha \text{ cstit}: \neg S]$

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- ▶ Orthodox perspective

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 - ▶ The same goes for $\odot[\alpha \text{ cstit}: \neg S]$
- ▶ Orthodox perspective
 - ▶ We don't evaluate the formula at the time of m
 - ▶ We decide whether $\odot[\alpha \text{ cstit}: S]$ should be true based on the outcome
 - ▶ Intuitively, we ask whether α *should have* swerved

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How do we deal with actions that will never be taken?

Challenge 4: Procrastination

- ▶ Agents can put off on following through with obligations
- ▶ Since they can do so over and over, tasks need deadlines
 - ▶ See also: Thread Starvation
- ▶ But what if agents still procrastinate?

Challenge 4: Procrastination

The story of Professor Procrastinate

- ▶ Professor Procrastinate is requested to write a review
- ▶ He is the best person available for writing the review
- ▶ He is known to procrastinate and will not actually write the review
- ▶ Should Professor Procrastinate accept the request?

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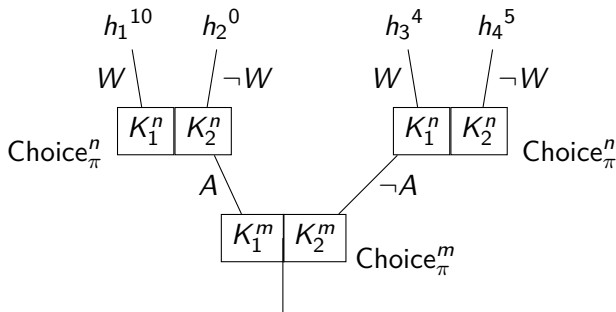
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We now run into a paradox:

- ▶ He ought to accept since him writing the review is the best scenario
- ▶ He ought to decline since he will not actually write the review, which leads to the worst outcome

Challenge 4: Procrastination

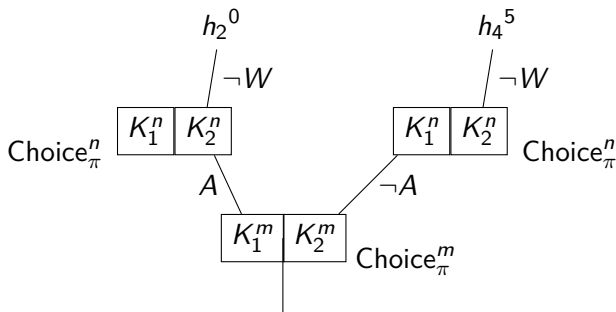
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Challenge 4: Procrastination

The solution: Just prune the branch!



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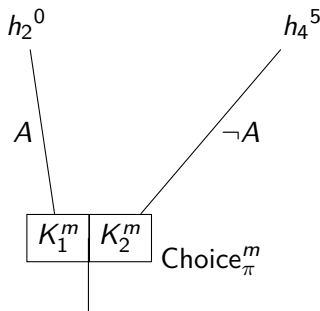
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The solution: Just prune the branch!



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- ▶ For the gambling problem we can circumvent the problem by modifying the semantics
 - ▶ Instead of considering only the best outcome we consider every possible outcome
- ▶ We we're unable to solve the driving example
 - ▶ Instead two perspectives on how the semantics should work were given
 - ▶ Which one is to be used is a design decision
- ▶ The problem of procrastination can be solved by using additional knowledge to cut branches from the STIT-tree