

Action Theory Contraction and Minimal Change

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Motivation



Motivation



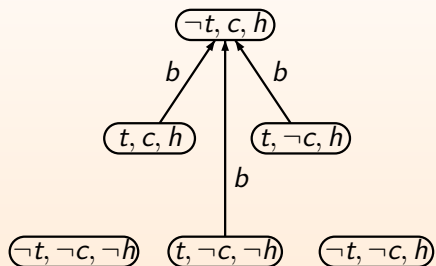
Knowledge Base

'A coffee is a hot drink'

'With a token I can buy coffee'

'After buying I have a hot drink'

Motivation



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Observations

'I have a cold coffee'

'I cannot buy'

'I bought and got no hot drink'

Motivation



Observations

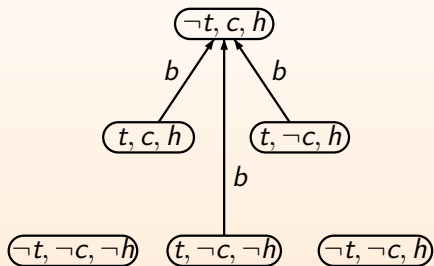
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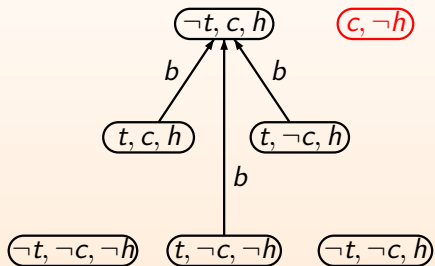
Need for change the laws about the *behavior* of actions

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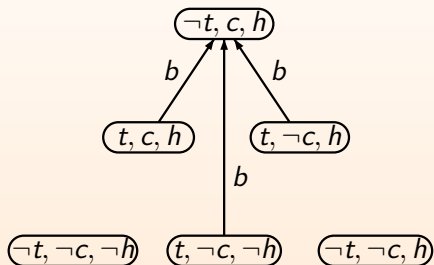
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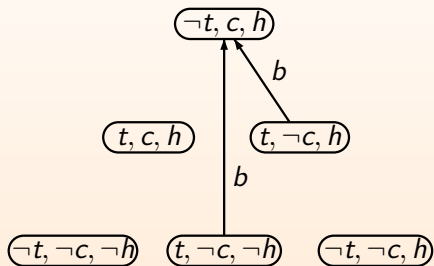
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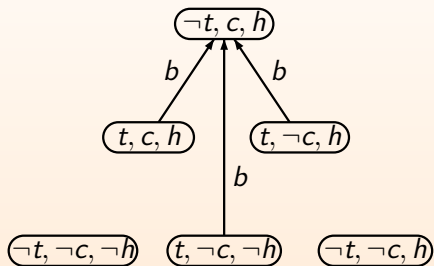
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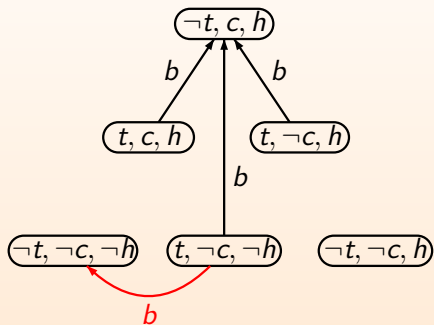
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Need for change the laws about the *behavior* of actions

Outline

- 1 Preliminaries
 - Action Theories in Dynamic Logic
- 2 Contraction of Laws
 - Semantic Contraction
 - Postulates
- 3 Conclusion

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Action Theories in Dynamic Logic

Dynamic Logic

- Well defined semantics
 - ▶ Possible worlds models
- Expressive
 - ▶ Programs, actions, state constraints
- Decidable
 - ▶ EXPTIME or PSPACE-complete, though
- (In off: more elegant than SitCalc. . .)

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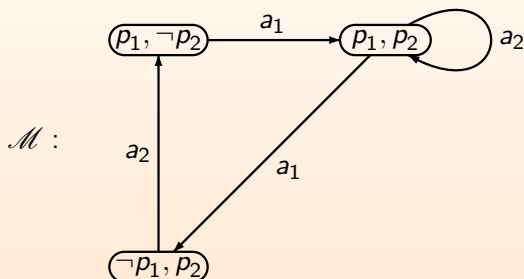
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Action Theories in Dynamic Logic

Possible worlds semantics: Transition Systems $\mathcal{M} = \langle W, R \rangle$

- W : possible worlds
- R : accessibility relation



Action Theories in Dynamic Logic

Describing Laws

Three types of laws

- Static Laws: $p_1 \vee p_2$
- Executability Laws: $p_2 \rightarrow \langle a_2 \rangle \top$
- Effect Laws: $p_1 \rightarrow [a_1] p_2$

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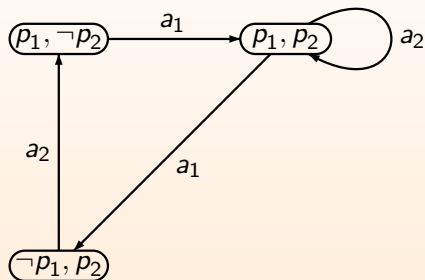
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Action Theories in Dynamic Logic

Formulas that hold in \mathcal{M}

\mathcal{M} :

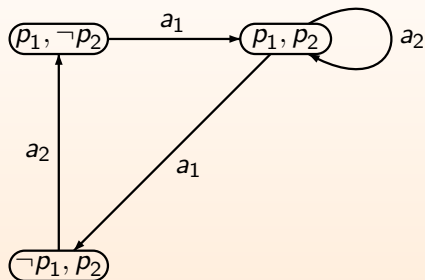


- $p_1 \vee p_2$
- $p_1 \rightarrow [a_1]p_2$
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Action Theories in Dynamic Logic

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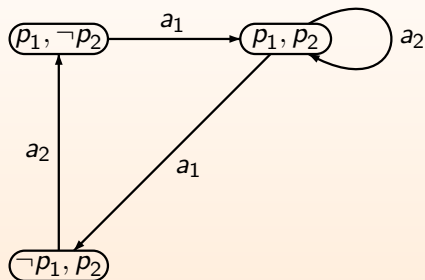
\mathcal{M} :



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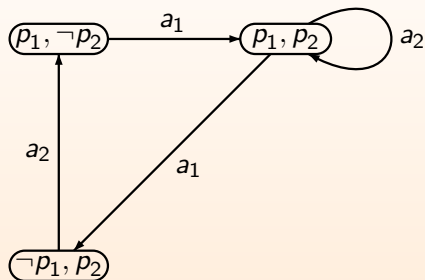


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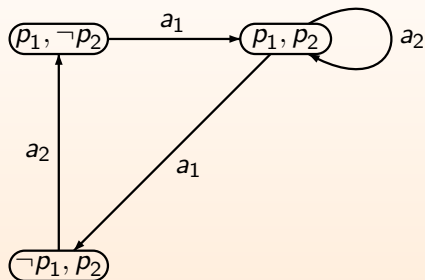


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Action Theories in Dynamic Logic

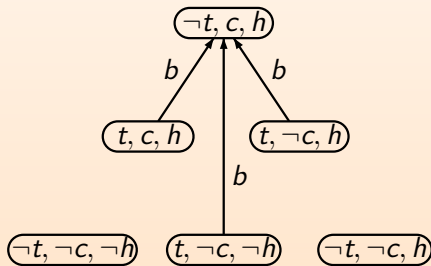
In our exemple

- Static Law: $\text{coffee} \rightarrow \text{hot}$
- Executability Law: $\text{token} \rightarrow \langle \text{buy} \rangle \top$
- Effect Law: $\neg \text{coffee} \rightarrow [\text{buy}] \text{coffee}$

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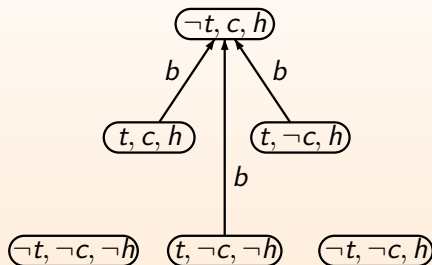


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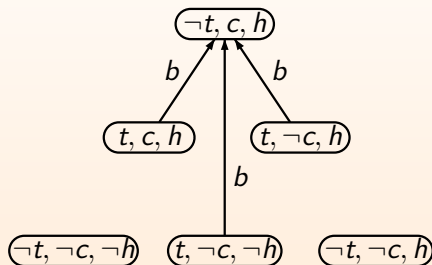
Intuitions About Contraction

Contracting laws



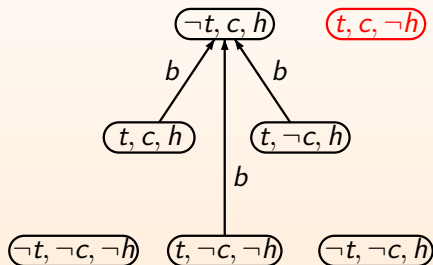
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Contracting *coffee* \rightarrow *hot*



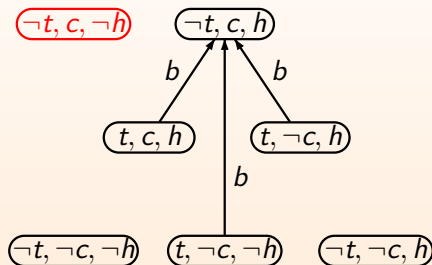
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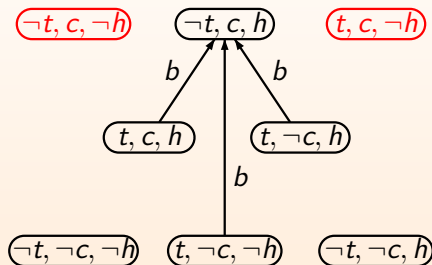
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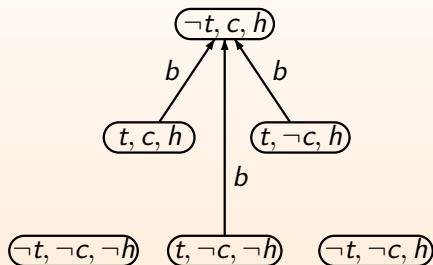
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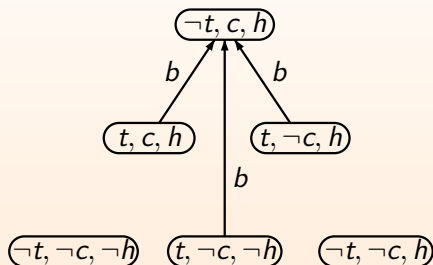
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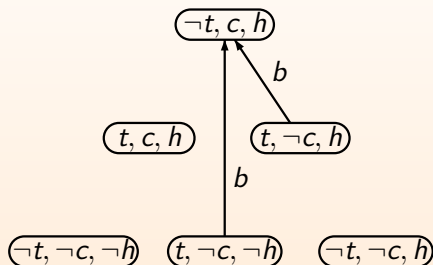
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Contracting $\textit{token} \rightarrow \langle \textit{buy} \rangle \top$



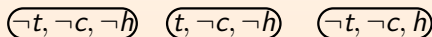
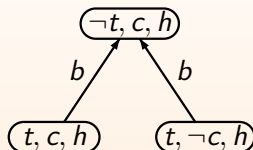
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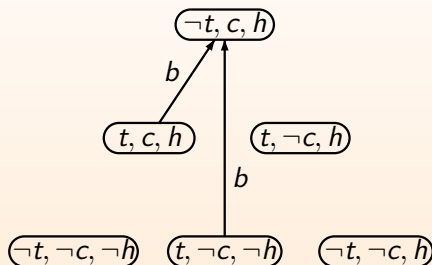
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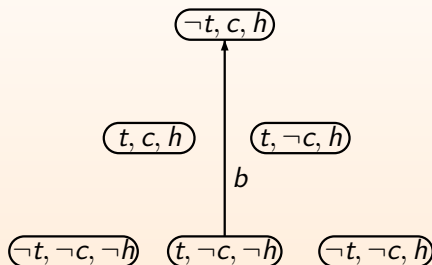
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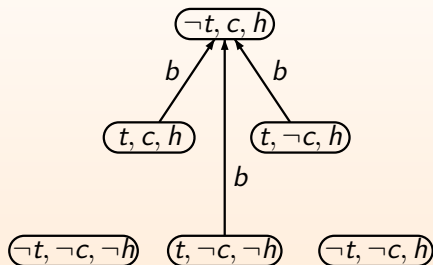
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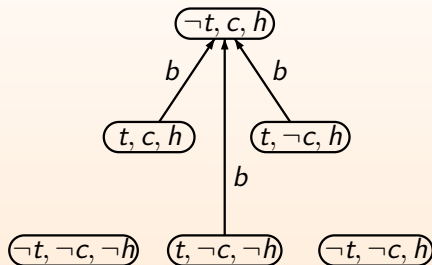
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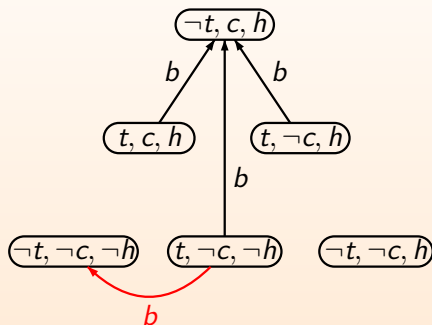
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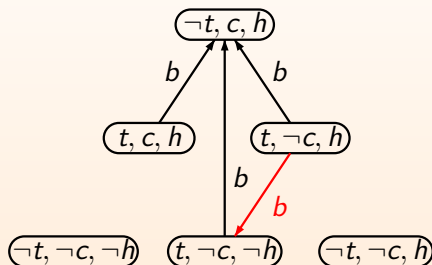
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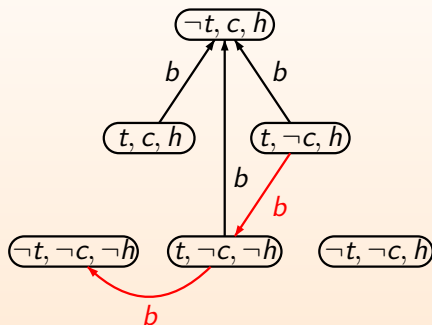
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Principles of Theory Change

(Dalal, 1988)

- Irrelevance of Syntax 
- Maintenance of Consistency 
- Primacy of New Information 
- Persistence of Prior Knowledge 
- Fairness 

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(Dalal, 1988)

- Irrelevance of Syntax +-
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Minimal Change

Choosing models

- Distance between models
 - ▶ Prefer models closest to the original one
 - ▶ Hamming distance, Dalal, etc
- Distance dependent on the type of law retracted
 - ▶ Static law: look at the set of possible states (worlds)
 - ▶ Executability law: look at the leaving arrows
 - ▶ Effect law: look at the arriving arrows

Definition

Let $\mathcal{M} = \langle W, R \rangle$. $\mathcal{M}' = \langle W', R' \rangle$ is as close to \mathcal{M} as $\mathcal{M}'' = \langle W'', R'' \rangle$ iff

- either $W \dot{-} W \subseteq W \dot{-} W'$
- or $W \dot{-} W = W \dot{-} W''$ and $R \dot{-} R' \subseteq R \dot{-} R''$

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Choosing models: contracting φ

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$contract(\mathcal{M}, \varphi) = \bigcup \min\{\mathcal{M}_\varphi^-, \preceq \mathcal{M}\}$

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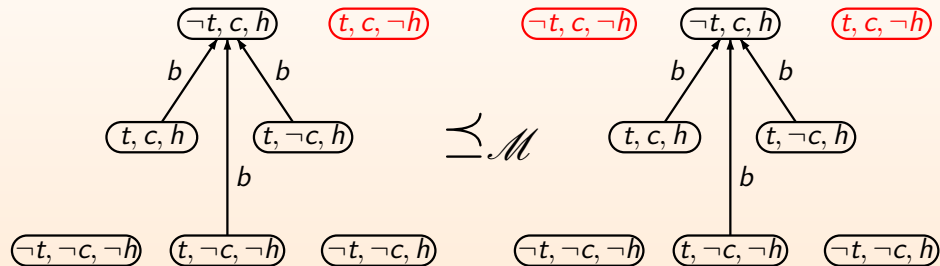
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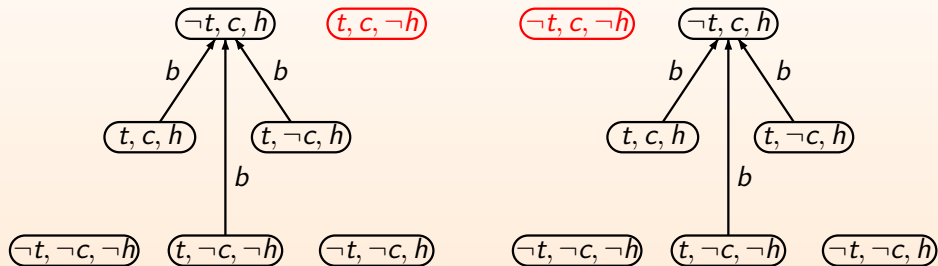
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Incomparable

Minimal Change

Choosing models: contracting $\varphi \rightarrow \langle a \rangle_{\top}$

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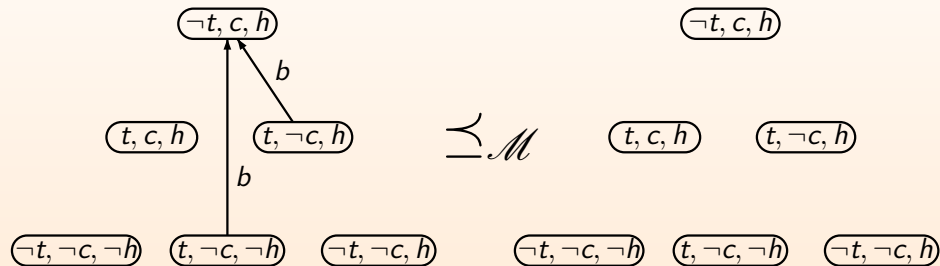
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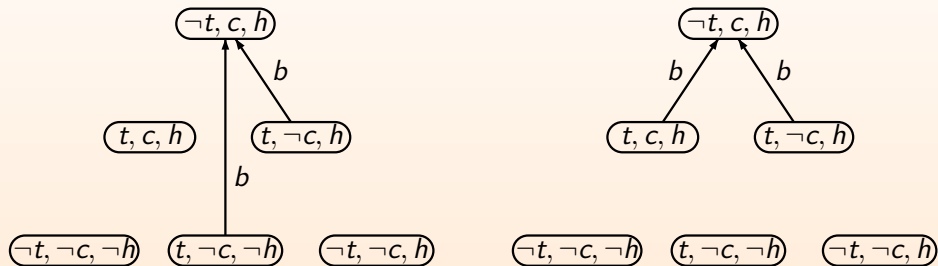
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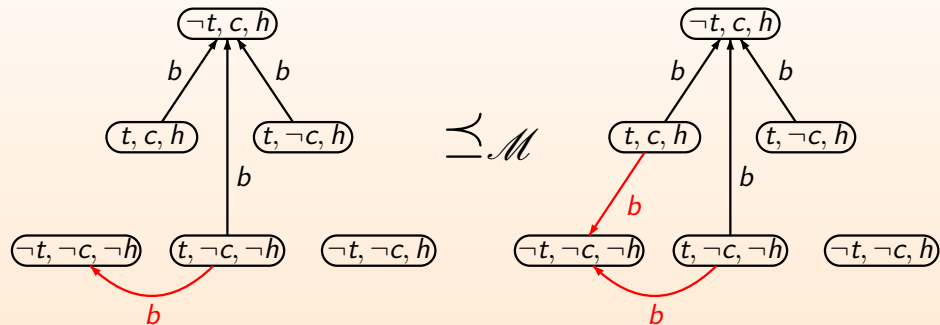
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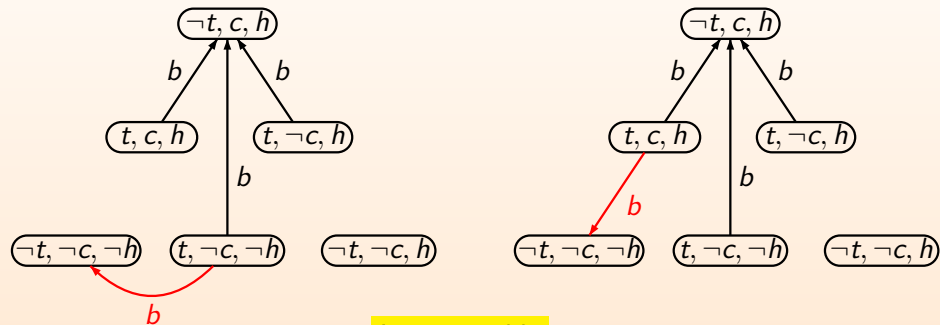
Minimal Change

Choosing models: contracting $token \rightarrow [buy]hot$



Minimal Change

Choosing models: contracting *token* \rightarrow $[buy]hot$



Incomparable

Quick look: Correctness of the Algorithms

- \mathcal{T} an action theory
- Φ a law

We have defined algorithms that contract Φ from \mathcal{T} , giving a weaker \mathcal{T}'

- φ a static law
- $\mathcal{S} \subseteq \mathcal{T}$ set of static laws in \mathcal{T}

Definition (Herzig & Varzinczak, AiML 2005)

\mathcal{T} is modular iff for every static law φ , if $\mathcal{T} \models_{\text{PDL}} \varphi$, then $\mathcal{S} \models_{\text{CPL}} \varphi$

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Monotonicity

$$\mathcal{T} \models_{\text{PDL}} \mathcal{T}'$$

Postulates

Monotonicity

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Preservation

$$\text{If } \mathcal{T} \not\models_{\text{PDL}} \Phi, \text{ then } \models_{\text{PDL}} \mathcal{T} \leftrightarrow \mathcal{T}'$$

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If $\models_{\overline{\text{PDL}}} \mathcal{T}_1 \leftrightarrow \mathcal{T}_2$ and $\models_{\overline{\text{PDL}}} \Phi_1 \leftrightarrow \Phi_2$, then $\models_{\overline{\text{PDL}}} \mathcal{T}'_1 \leftrightarrow \mathcal{T}'_2$, for $\mathcal{T}'_1 \in (\mathcal{T}_1)_{\Phi_2}^-$
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If \mathcal{T} is modular, then \mathcal{T}' is modular

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Contribution

- Better semantics for action theory change
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 - ▶ Minimal change
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 - ▶ Correct w.r.t. the semantics
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