



Verteilte Künstliche Intelligenz – Formale Grundlagen II

VAK 03-710.03

Universität Bremen

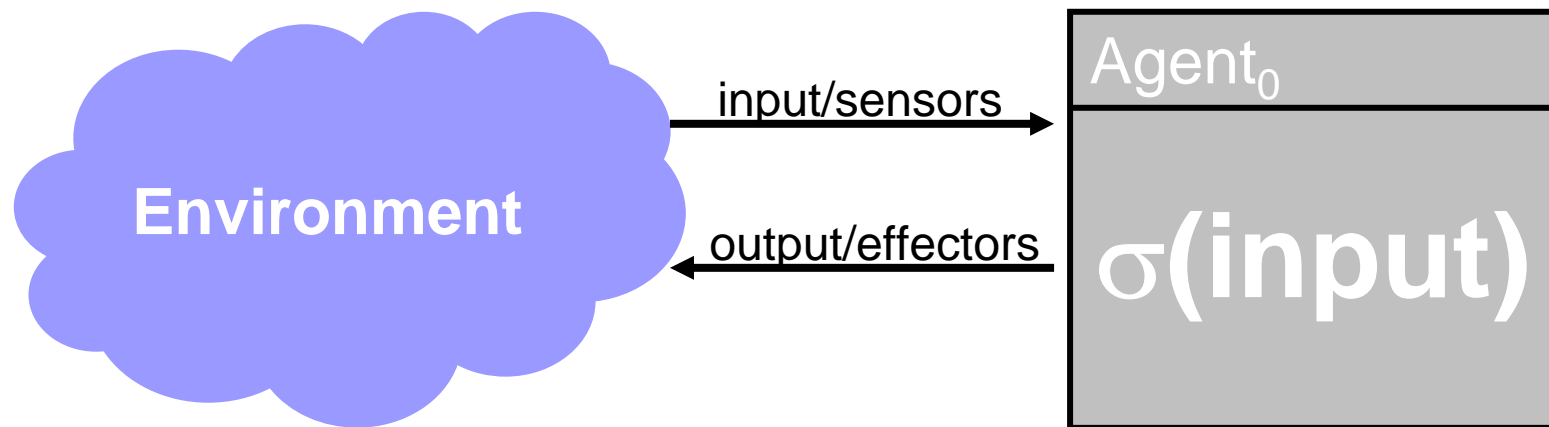
Ingo J. Timm, Jörn Witte

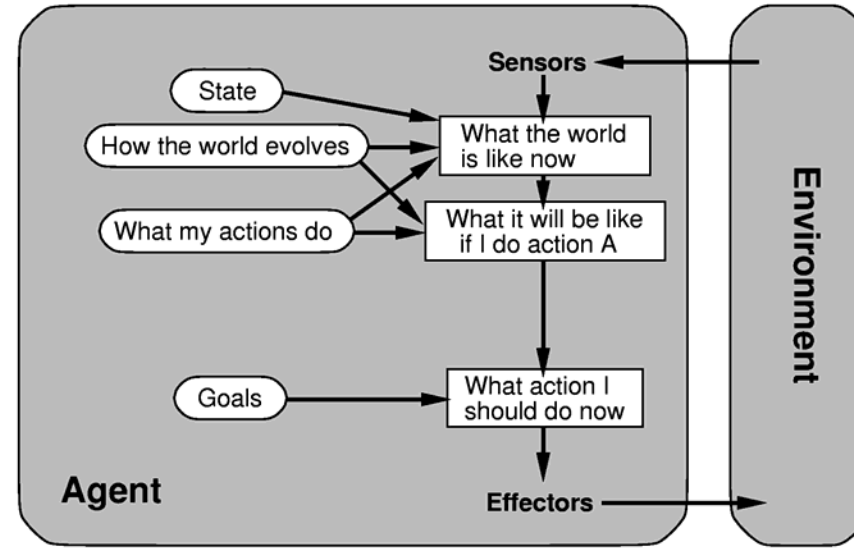
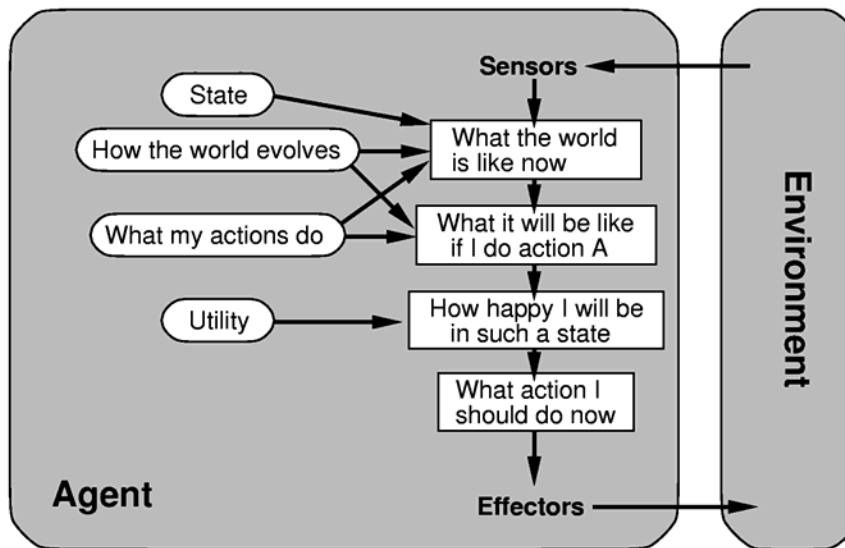
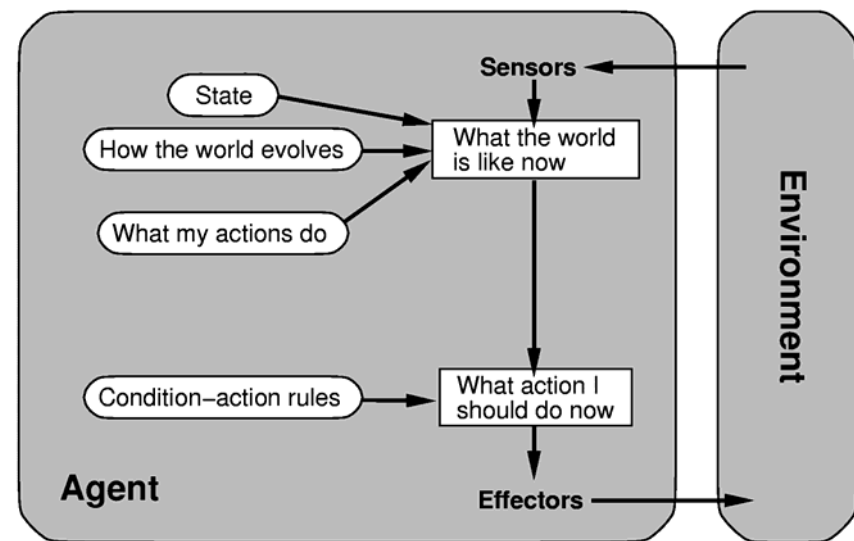
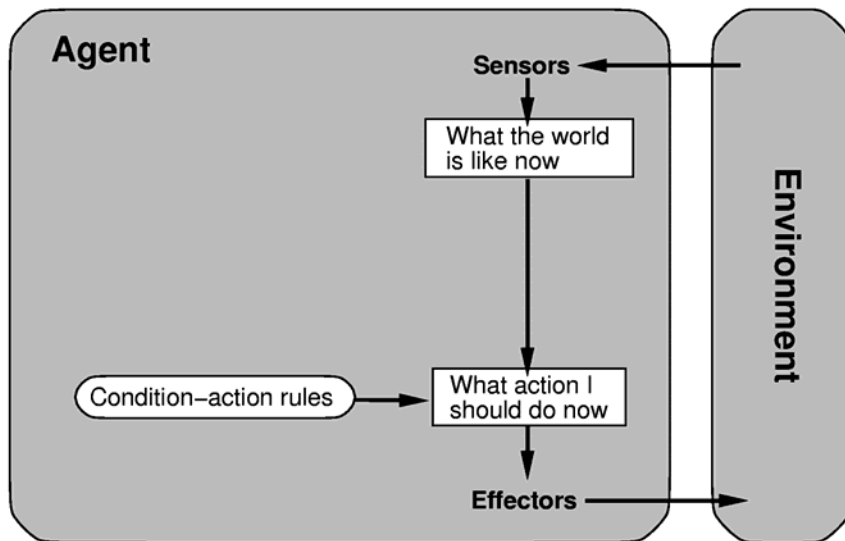


Gliederung

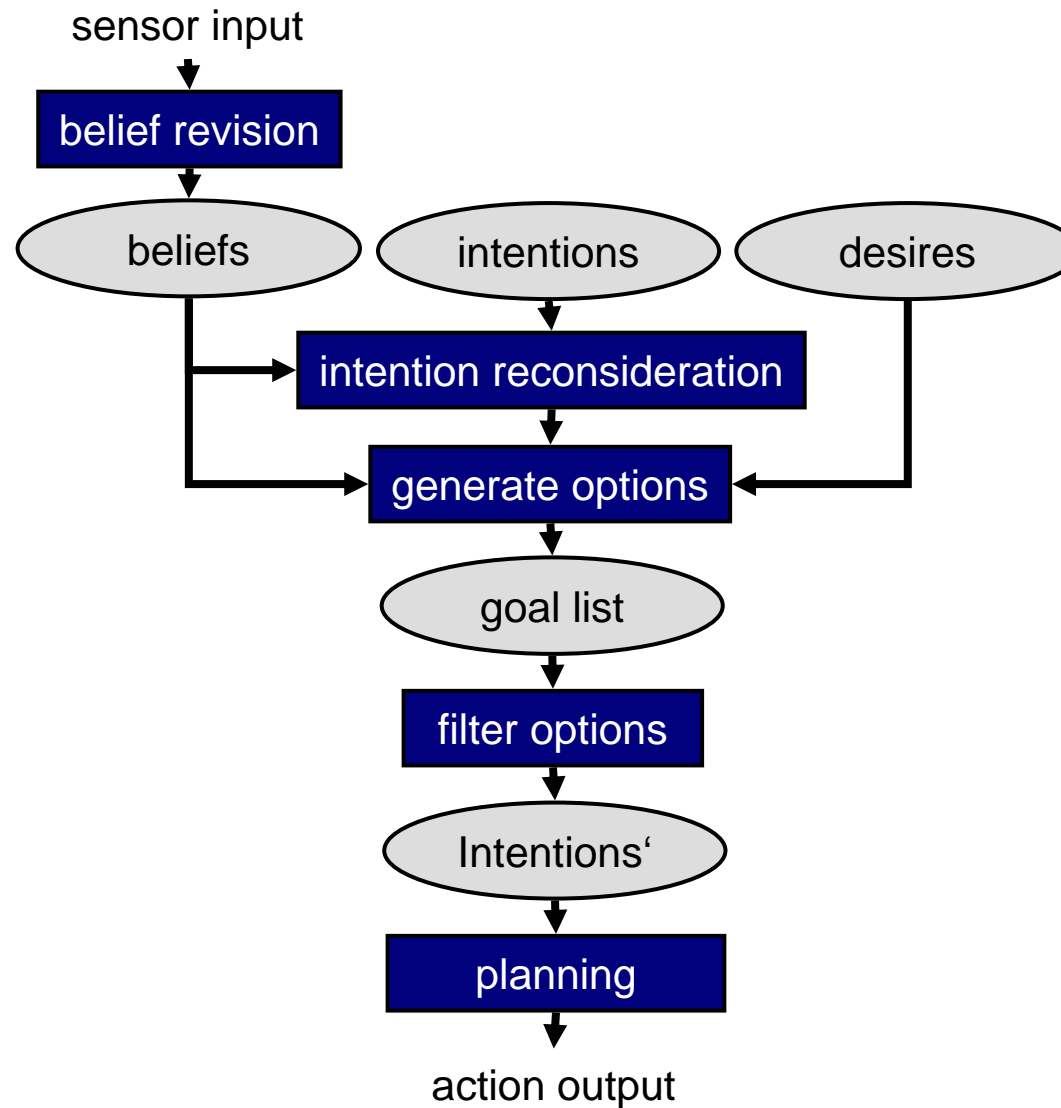
- **Rückblick: Agentenarchitekturen**
- **Logik der Diskursagenten**
 - Temporale Komponente
 - Accessibility Relationen in der aufspannenden temporalen Struktur
- **Betrachtung eines Systems von Diskursagenten**
 - Agent
 - Umgebung
 - Multiagentensystem
 - Globale und lokale Zustände
- **Formale Bemerkungen**
 - Entscheidbarkeit = Korrektheit + Vollständigkeit + Terminierung

Definition of an Agent





Ablauf in Belief-Desire-Intention Architekturen





States: *Knowledge Representation*

Knowledge on:

- Environmental beliefs
- Social beliefs
- Relational beliefs
 - Skills
 - Intentions & Commitments
 - Plans / Methods
 - Activities
 - Roles
 - Behavioural model
- Personal beliefs
- History

Required Features:

- Propositions
- Concepts
- Rules
- Uncertain Knowledge
- Non monotonic Knowledge
- Comprehensible !



Dynamics: *Belief Revision*

- *The sensors are in poor condition.*
- *The data supplied by the other agents are no longer correct or are insufficient.*
- *The factual belief the agent has available are erroneous or insufficient.*
- *The action does not correspond to its model.*
- *The laws of the universe or the psychological models of other agents are no longer adequate, or are proving insufficient.*
- *The situation is too complex, i.e. there are too many parameters, and the near impossibility of forecasting behavior.*



Dynamics: *Knowledge Revision*

- Situation Calculus
- Default Logic
- Non-Monotonous Reasoning
 - Truth Maintenance System
 - Reason Maintenance System (RMS)
 - Consistency Maintenance System (CMS)
 - Justification Based Truth Maintenance System (JTMS)
 - Assumption Based Truth Maintenance System (ATMS)
- Temporal Logic

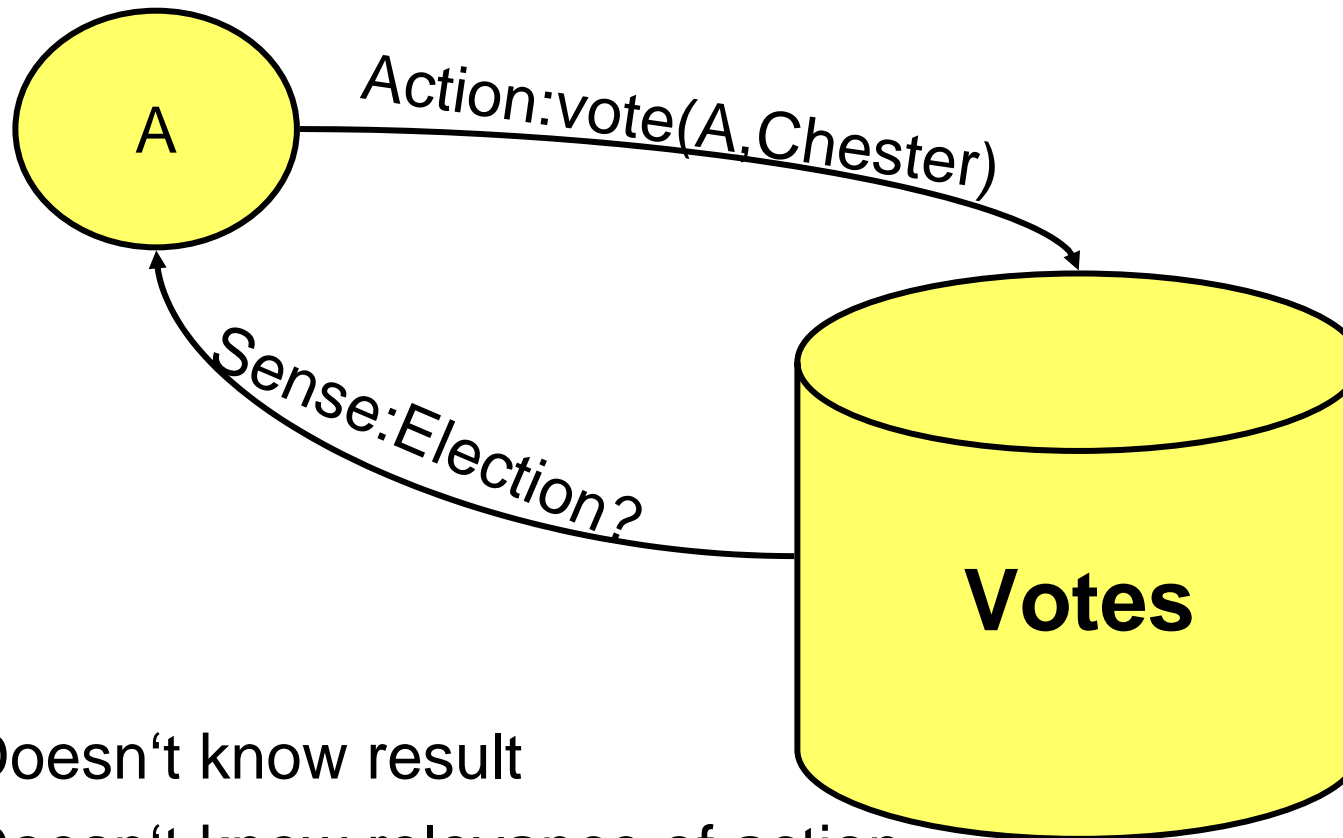


Consequence Awareness

- Extended requirements
 - ☐ Estimation of action consequences
 - ☐ Uncertain success
 - ☐ Sensing the result

- Methods to look at
 - ☐ Use of probability theory
 - ☐ Uncertain success: fuzzy sets?
 - ☐ Prediction models

The Election Example



- Doesn't know result
- Doesn't know relevance of action



*Prediction is very difficult,
especially about the future.*

Nils Bohr (1885-1962)



Formalisierung



Modallogik

- Basis: Aussagen- oder Prädikatenlogik
- Erweiterung um die Operatoren
 - Möglichkeit (possibility) □ und
 - Notwendigkeit (necessity) ◇

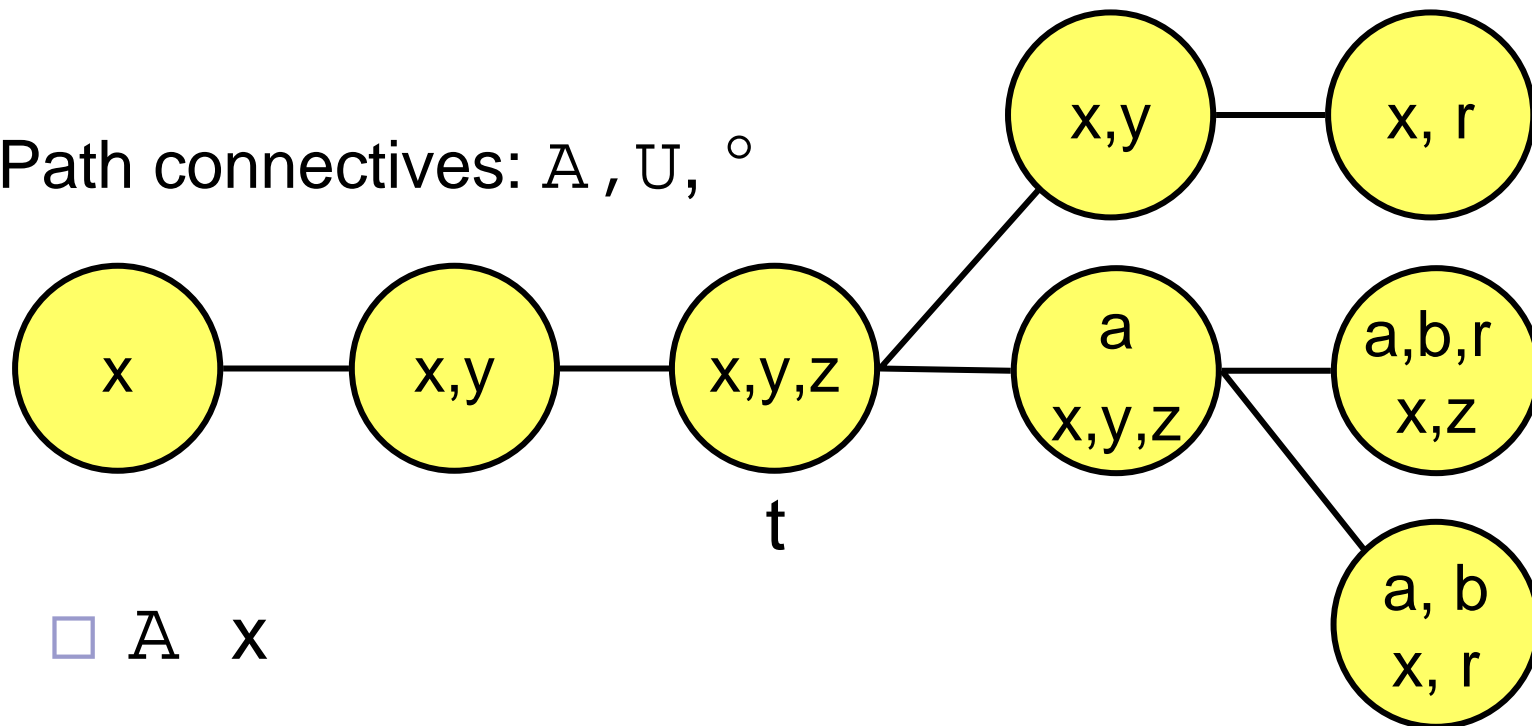


Informelle Semantik

$\mathbf{F}\Box$	$\Diamond\mathbf{F}$ (äquivalent zu $\neg\Box\neg\mathbf{F}$)
F ist notwendigerweise wahr	F ist möglicherweise wahr
F ist immer wahr	F ist mindestens einmal wahr
Agent a glaubt F	F ist konsistent mit den Überzeugungen von Agent a
Agent a weiß F	Agent a weiß nicht $\neg\mathbf{F}$
F ist in allen möglichen Zuständen wahr	F ist mindestens in einem möglichen Zustand wahr

Temporal Logics

- Path connectives: A , U , $^{\circ}$



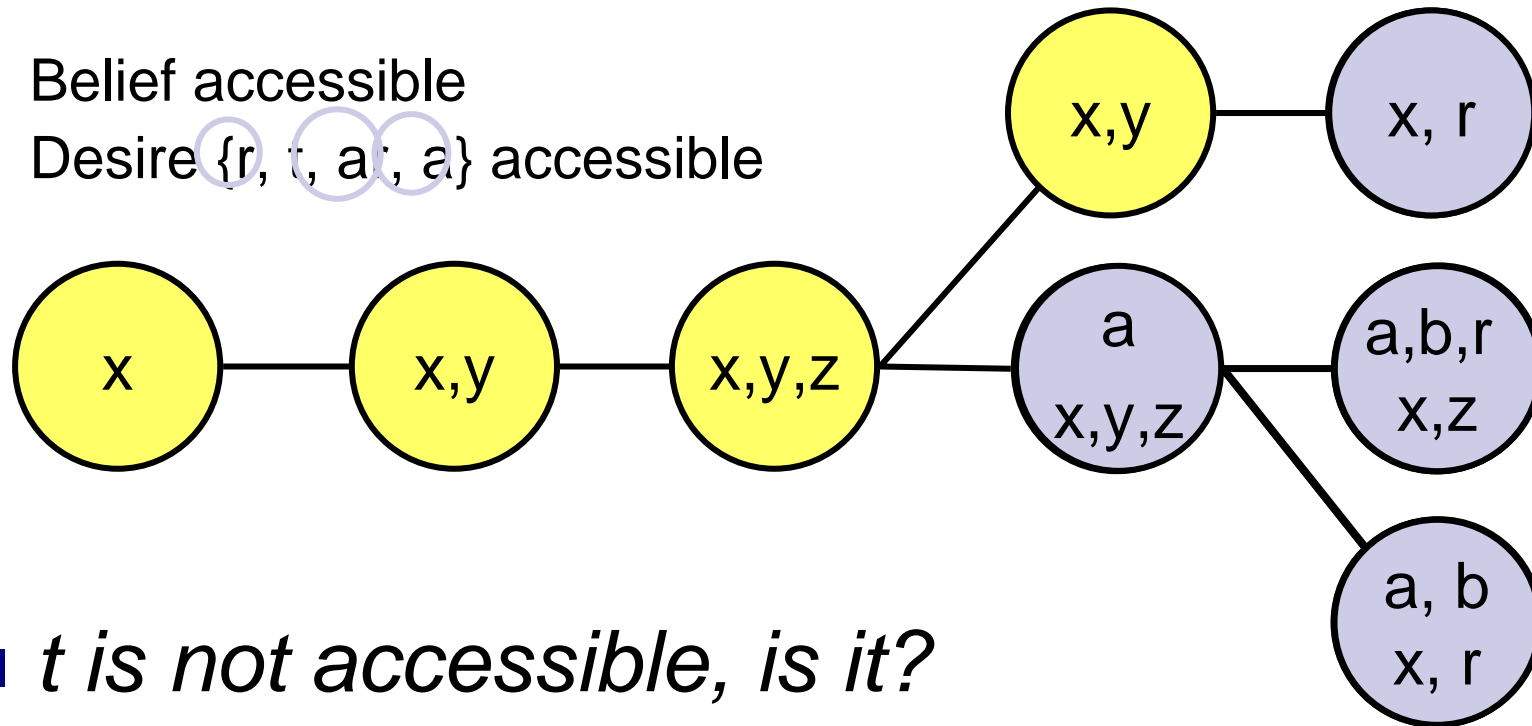
$\square A \ x$

$\square y \ U \ r$

$\square^{\circ} y$

Accessibility Relations

- Belief accessible
- Desire {r, t, a, a} accessible



- *t is not accessible, is it?*

Intention Reconsideration

Definition II.43 (Adaption der Absichten)

Eine Abbildung

$$\begin{aligned} irf : \mathcal{B} \times \wp(\mathcal{D} \times \mathcal{Pln}) &\rightarrow \wp(\mathcal{D} \times \mathcal{Pln}) \\ I' &= irf(B, I) \end{aligned}$$

heißt *Adaption der Absichten (intention reconsideration function)*, falls $\forall \langle des_1, plan_1 \rangle \in I' : \exists \langle des_2, plan_2 \rangle \in I$ mit $des_1 \leftrightarrow des_2$.

Abhängig vom Grad der Verpflichtung muss eine der folgenden Bedingungen ($\forall \langle des, \langle \varphi_{pre}, \varphi_{post}, Acts, stat, sel \rangle \rangle \in I'$) erfüllt sein:

- $B \not\vdash des$ für blinde Verpflichtung (blind commitment)
- $B \rightarrow \diamond \varphi_{post}$ für zielstrebige Verpflichtung (single-minded commitment)
- $B \rightarrow \diamond des$ für offene Verpflichtung (open-minded commitment)