Logical foundations of actions and agency

- Intelligent agents, agent attitudes
- Temporal logic
- Dynamic logic
- BDI, KARO

64

Agent attitudes

- informational attitudes
  - knowledge / belief

- motivational attitudes
  - desires / goals / intentions
  - commitments / 'agenda'

65

Modal logic

- philosophical logic
- a formal treatment of intensional notions
- various 'flavours':
  - epistemic / doxastic
  - temporal / dynamic (action logic)
  - deontic
  - combinations (BDI, KARO)

66

Modal logic, ctd.

- modal logic = 'logic of $\Box$ and $\Diamond$'
- 'neutral reading': necessity / possibility
- basic property (K):

  - $\Box(\varphi \rightarrow \psi) \rightarrow (\Box\varphi \rightarrow \Box\psi)$, or equivalently:

  - $(\Box(\varphi \rightarrow \psi) \land \Box\varphi) \rightarrow \Box\psi$

67

Modal logic, semantics

- Kripke models: $M = (W, \pi, R)$
  - W: set of possible worlds
  - π: truth assignment function
  - R: accessibility relation

- $\{w' \mid R(w,w')\}$ set of accessible worlds from w

68

Modal logic, semantics

- $M, w \vDash \Box\varphi$ iff $M, w' \vDash \varphi$ for every w' such that $R(w, w')$

- $M, w \vDash \Diamond\varphi$ iff $M, w' \vDash \varphi$ for some w' such that $R(w, w')$

69

1

Correspondences

- R reflexive $\quad \Box\varphi \to \varphi$
- R serial $\quad \Box\varphi \to \Diamond\varphi$
- R transitive $\quad \Box\varphi \to \Box\Box\varphi$
- R symmetric $\quad \varphi \to \Box\Diamond\varphi$
- R euclidean $\quad \Diamond\varphi \to \Box\Diamond\varphi$

Varieties of modal logics

- Dynamic logic: no restrictions ~system K
- Deontic logic: R serial ~system KD
- Temporal logic: R refl, trans ~S4
- Doxastic logic: R ser, trans, eucl ~KD45
- Epistemic logic: R refl, trans, symm ~S5

'Naïve' BDI logic

- B($\varphi \to \psi$) $\to$ (B$\varphi \to$ Bψ)
- ¬B⊥
- B$\varphi \to$ BBφ
- ¬B$\varphi \to$ B¬Bφ
- D($\varphi \to \psi$) $\to$ (D$\varphi \to$ Dψ)
- I($\varphi \to \psi$) $\to$ (I$\varphi \to$ Iψ)
- ¬I⊥

'Naïve' BDI logic

- What is missing?

  - No *interplay* between modalities
  - No 'dynamics' / changes of BDI in *time*