# Social Default Theories

Chiaki Sakama
Wakayama University

LPNMR 2009, Potsdam

# Social Default Theories: Syntax

- A propositional language is considered.
- Every formula has an **annotation** representing an agent identifier.
- $\mathbb{F}$ is the set of all formulas, and $\mathbb{F}_i$ represents the set of all formulas having the annotation i ($\mathbb{F}_i \subseteq \mathbb{F}$).
- A **social default theory (SDT)** $\mathcal{S}$ is a tuple of theories $(\Delta_1,\ldots,\Delta_m, \Gamma)$ s.t.
  1. $\Delta_i$ ($1 \leqq i \leqq m$) consists of default rules of the form

     $$\alpha : \beta_1,\ldots,\beta_n \,/\, \gamma$$

     where $\alpha \in \mathbb{F}$, $\gamma \in \mathbb{F}_i$, and each $\beta_j$ ($1 \leqq j \leqq n$) is a formula from some $\mathbb{F}_k$ ($1 \leqq k \leqq m$).
  2. $\Gamma$ is a set of default rules of the form $\alpha : \beta_1,\ldots,\beta_n \,/\, false$, called **social constraints**.

# Social Default Theories: Semantics

- A set $E$ of formulas is a **social extension** of an SDT $\mathbf{S} = (\Delta_1, \ldots, \Delta_m, \Gamma)$ if $E$ is an extension of the default theory $\Delta_1 \cup \cdots \cup \Delta_m \cup \Gamma$.
- $\mathbf{S}$ is **rational** if every $\Delta_i$ is consistent.
- For any social extension $E$ of a rational SDT $\mathbf{S}$, there is an extension $G$ of some $\Delta_i$ in $\mathbf{S}$ s.t. $(E \cap \mathbf{F}_i) \subseteq G$.

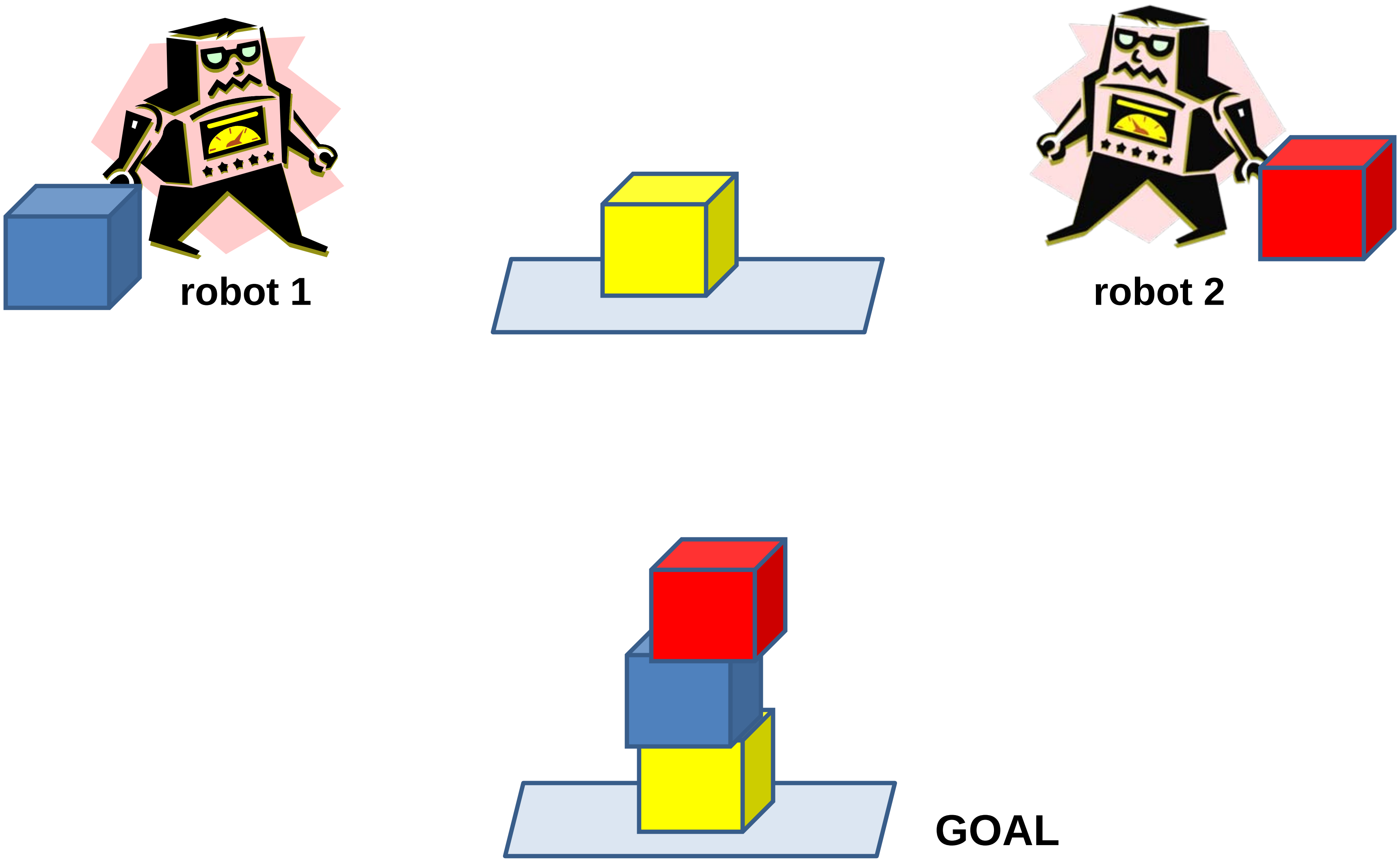
# Cooperative Planning in SDT

- A **cooperative planning framework** is a tuple $(\mathbf{S},\mathbf{A},\omega)$ where $\mathbf{S} = (\Delta_1,\ldots,\Delta_m, \Gamma)$ is an SDT, $\mathbf{A} \subseteq \mathbf{F}_1 \cup \cdots \cup \mathbf{F}_m$ is a set of **actions**, and $\omega \in \mathbf{F}$ is a **goal**.
- A set $\Phi \subseteq \mathbf{A}$ is a **solution** of a cooperative planning framework $(\mathbf{S},\mathbf{A},\omega)$ if

  $$\Delta_1 \cup \cdots \cup \Delta_m \cup \Gamma \cup \{ :\neg\omega/\mathrm{false}\}$$

  has an extension $E$ s.t. $\Phi = E \cap \mathbf{A}$.

# Example



# Example

- An SDT $\mathbf{S} = (\Delta_1, \Delta_2, \Gamma)$ where $\Delta_1$ consists of defaults:

  $$\frac{X\text{-on-}Y^1_{(T)} \wedge Z\text{-to-}X^1_{(T)} : \neg W\text{-to-}X^2_{(T)}, Z\text{-on-}X^1_{(T+1)}}{Z\text{-on-}X^1_{(T+1)}},$$

  $$\frac{has\text{-}X^1_{(T)} : X\text{-to-}Y^1_{(T)}}{X\text{-to-}Y^1_{(T)}}, \quad \frac{X\text{-on-}Y^2_{(T)} : X\text{-on-}Y^1_{(T)}}{X\text{-on-}Y^1_{(T)}},$$

  $$\frac{X\text{-on-}Y^1_{(T)} : X\text{-on-}Y^1_{(T+1)}}{X\text{-on-}Y^1_{(T+1)}}, \quad has\text{-}blue^1_{(0)}, \quad yellow\text{-}on\text{-}floor^1_{(0)}$$

  where uppercase letters represent variables which are shorthand of their instances, and (T) means time steps.
- $\Delta_2$ has similar rules and $\Gamma=\{\}$.
- The set of actions is put $\mathbf{A} = \{ X\text{-to-}Y^1_{(T)}, X\text{-to-}Y^2_{(T)} \}$ where variables represent their instances.

# Example

- If the goal $\omega$ is to be achieved at time 3, it is represented as

  $$\omega = \text{red-on-blue}^{1}_{(3)} \wedge \text{blue-on-yellow}^{1}_{(3)} \wedge \text{red-on-blue}^{2}_{(3)} \wedge \text{blue-on-yellow}^{2}_{(3)}$$

  stating that two robots recognize the goal to be accomplished at time 3: the red block is on the blue one which is on the yellow one.

- A solution of a plan then becomes

  $$\Phi = \{ \text{blue-to-yellow}^{1}_{(1)},\ \text{red-to-blue}^{2}_{(2)} \}$$

  representing that the robot 1 moves the blue block to the location of the yellow one at time 1, and the robot 2 moves the red block to the location of the blue one at time 2.

# Final Remarks

- SDT is used for **social default reasoning** in multiagent systems.
- SDT can represent a variety of social attitudes of individual agents, such as **considerate agents**, **self-interested agents**, and **grouping agents**.
- SDT is also used in **negotiation** between agents.