Intention Recognition, Commitments and the Evolution of Cooperation

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Why Intention Recognition?

- **Intention recognition (IR):** inferring intentions of a single agent (individual) or a group of agents (collective) based on their observed actions.

- Acting on environment, agents need to deal with others. **Intention recognition enables to**
  - ease interactions.
  - improve cooperation and coordination, especially when communication is limited or noisy.
  - defend from potential hostile behaviors.
Why arrange Commitments

- There are cases where it is difficult recognize others’ intentions with sufficient confidence and accuracy.

- *Commitment proposal* can help clarify intentions of others.
  - contracts, marriage, apartment rental, etc.
Combination of intention recognition and commitments

- Intention recognition promotes the evolution cooperation.
- Commitments promotes the evolution cooperation.
- Would their combination provide a better strategy/mechanism, leading to improved cooperation?
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What is Cooperation?

- *pay a cost for someone else to receive a benefit.*
- **Cooperation is abundant:** insects, hunter-gatherer societies, team work, international relationships, etc.
Explaining the Evolution of Cooperation

- Natural selection: *only the fittest survive*
  - Everyone wants to increase their fitness.
  - No one wants to pay the cost, happily accepting benefits.

- *Dilemma*: everyone would be better off cooperating with each other (*benefit > cost*).

- **Mechanisms for the evolution of cooperation**
  - direct reciprocity
  - indirect reciprocity
  - kin selection, group selection, structured population, punishment, etc.
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Commitment model

- **Commitment proposer (COMC):** before each interaction proposes its co-player committing to cooperate.
  - If the co-player commits, interact; otherwise, no interaction.

- **Other strategies**
  - *fake committers:* always defects, *commits* when being asked to.
  - *defectors:* always defects, *doesn’t commit* when being asked to.

- **Key parameters:** *punishment cost* ($\delta$) & *arrangement cost* ($\epsilon$)
  - Punishment for defaulting players, which brings compensation for the non-defaulting ones.
  - Commitment proposers have to pay an arrangement cost.
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Commitments promote emergence of cooperation

... when punishment cost is large enough compared to arrangement cost
Combination of Intention Recognition and Commitment

- Commitments can help clarify intentions of others, but arranging them might be costly.

- **Combination of intention recognition and commitments (IRCOM)**
  - utilizes intention recognition when confident enough (> confidence threshold, $\theta$).
  - otherwise, propose a commitment deal.

- **Wide range of confidence threshold where the combination is better than each, leading to greater level of cooperation.**
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Figure: The performance of IRCOM decreases when $\theta$ is too high. Parameters: $\delta = 4$; $\epsilon = 0.05$; $T = 2$, $R = 1$, $P = 0$, $S = -1$; $N = 100$. 
Intention Recognition and Commitments for Cooperation

**Graphs:**

a. IRCOM frequency

- ε = 0.05
- ε = 0.1
- ε = 0.2
- ε = 0.5
- ε = 0.75

b. IRCOM frequency

- δ = 0.8
- δ = 1
- δ = 1.2
- δ = 2
- δ = 4

**Confidence Threshold, θ:**

- 0.0
- 0.2
- 0.4
- 0.6
- 0.8
- 1.0

**Frequency:**

- 0.0
- 0.2
- 0.4
- 0.6
- 0.8
- 1.0
Conclusions

- Combination of intention recognition and commitments provides a strategy better than either one by itself.
- Commitments and intention recognition as the foundation of institution (Searl, 2010).
- Application: self-organized MAS relying on intention recognition and arranging commitments in order to guarantee cooperation.
Some future directions

• Other ways of combining intention recognition and commitments:
  • recognizing if a commitment deal will be fulfilled?
  • information about commitments of others (direct and indirect) can be used to enhance intention recognition process.
Thank you!

QUESTIONS?