Logic and Artificial Intelligence

Lecture 0

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Practicalities

- Course website: http://ai.stanford.edu/~epacuit/classes/logicai-cmu.html
- Weekly readings will be posted
- Slides will be posted
- Pay attention to the schedule (midterm, canceled classes, etc.)

- Weekly lecture + discussion
- Office Hours: Wednesdays 11 - 12 and by appointment (e.j.pacuit@uvt.nl)
- Office: Room 161B, Baker Hall
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1. Problem sets (40%)
   - distributed periodically throughout the semester (4-6 total)
2. Midterm exam (20%)
3. Final exam (40%)
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Practicalities: Literature

- Contemporary research papers published in academic journals and chapters from recent books (consult the schedule for details).
- No required textbook. This means:
  - Ask questions! Don’t let me go too fast!
  - Watch out for differences in notation
  - Important to work through the problem sets (what will be on the exams??)
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What is this course about?
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More accurate course title: **Logics of Rational Agency**
We are interested in reasoning about rational (and not-so rational) agents engaged in some form of social interaction.
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- Philosophy (social epistemology, philosophy of action)
- Game Theory
- Social Choice Theory
- AI (multiagent systems)
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*What is a “rational agent”? What are we modeling?*
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What is a “rational agent”? What are we modeling?

- has consistent preferences (complete, transitive)
- (acts as if she) maximizes expected utility
- reacts to observations
- revises beliefs when learning a surprising piece of information
- understands higher-order information
- plans for the future
- asks questions
- ????
We are interested in reasoning about rational (and not-so rational) agents engaged in some form of social interaction.

- playing a (card) game
- having a conversation
- executing a social procedure (voting, making a group decision)
- ....

Goal: incorporate/extend existing game-theoretic/social choice analyses
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There is a jungle of logical frameworks!

- logics of informational attitudes (knowledge, beliefs, certainty)
- logics of action & agency
- temporal logics/dynamic logics
- logics of motivational attitudes (preferences, intentions)
- deontic logics

(Not to mention various game-theoretic/social choice models and logical languages for reasoning about them)
We are interested in reasoning about rational (and not-so rational) agents engaged in some form of social interaction.

- How can we compare different logical frameworks addressing similar aspects of rational agency and social interaction?
- How should we combine logical systems which address different aspects of social interaction towards the goal of a comprehensive (formal) theory of rational agency?
- How does a logical analysis contribute to the broader discussion of rational agency and social interaction within philosophy and the social sciences?
Game Theory
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“Game theory is a bag of analytical tools designed to help us understand the phenomena that we observe when decision-makers interact.” (pg. 1)

Game Situations

Economic “data”: feasible options (i.e., actions), desirability (i.e., utilities), structural properties of the interactive situation (i.e., game forms: extensive, strategic, simultaneous moves, stochastic, etc.)
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2. **Humanistic view**: real people in interactive situations

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1. **Classical view**: idealized world with *perfectly rational agents*

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   “We adhere to the classical point of view that the game under consideration fully describes the real situation — that any (pre) commitment possibilities, any repetitive aspect, any probabilities of error, or any possibility of jointly observing some random event, have already been modeled in the game tree.” (pg. 1005)

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2. **Humanistic view**: real people in interactive situations
   - The mathematical structures are *models* of interactive situations.
   - The appropriate notion of equilibrium is part of the specification of the model.

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For example, in a parliamentary democracy with three parties, the winning coalitions are the same whether the parties hold a third of the seats, or, say, 49%, 39%, and 12% respectively. But the political situations are quite different. The difference lies in the attitudes of the players, in their expectations about each other, in custom, and in history, though the rules of the game do not distinguish between the two situations.

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What about a logical analysis?

Which aspects of social situations should we focus on?

- Knowledge, Beliefs, Group Knowledge, Preferences, Desires,
- Ability, Actions, Intentions, Goals, Obligations, etc.

- One grand system, or many smaller systems that loosely “fit”
  together?

- Combining systems is hard! (conceptually and technically)

- Logics of rational agents in social situations.

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- Normative vs. Descriptive Logic and Artificial Intelligence

11/15
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Ingredients of a Logical Analysis of Rational Agency

- What are the basic building blocks?
  - The nature of time (continuous or discrete/branching or linear), how (primitive) events or actions are represented, how causal relationships are represented and what constitutes a state of affairs.

- Single agent vs. many agents.

- What are the primitive operators?
  - Informational attitudes
  - Motivational attitudes
  - Normative attitudes

- Static vs. dynamic Logic and Artificial Intelligence
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Ingredients of a Logical Analysis of Rational Agency

⇒ informational attitudes (eg., knowledge, belief, certainty)

⇒ time, actions and ability

⇒ evaluative/motivational attitudes (eg., preferences)

⇒ pro-attitudes (eg., intentions)

⇒ group notions (eg., common knowledge and coalitional ability)

⇒ normative attitudes (eg., obligations, reasons)
Next Lecture: Introduction to Epistemic Logic