

## LOGIC, AGENCY, AND GAMES

### **Day 1 *Dynamic-epistemic logic***

Information flow: questions, observations, inferences. Dynamic, social.

#### *1.1 Knowledge update*

Three cards. *Modeling*, 'worlds'. Update as model change.

Static epistemic logic. Models and semantics. Complete logic is multi-S5.

No further laws: interaction is connections agents, groups, networks.

Snapshots, now make change explicit. PAL language and semantics.

*Recursion laws*. Completeness PAL. Application: Moore sentences.

Knowledge stable under true information? Depends. *Substitution core*.

#### *1.2 Belief revision*

Belief: weaker, or more creative? Revision, learning from errors.

Belief stable under true information? Lying with the truth.

Belief semantics. Recursion law under hard information. Conditional belief.

*Repertoire*. Other notions: stable belief. Can define conditional belief.

Complete dynamic logic axiomatizable.

Beijing gate. Soft update, plausibility order change.

Complete dynamic logic for safe belief. *General update rules*.

#### *1.3 Multi-agent settings*

Discuss: Plural actors. Multi-agent (questions, Theory of Mind). Groups sui generis: common or distributed knowledge. Logical systems. *Structured groups, networks*.

### **Day 2 *Time, preference, and games***

Games, standard example: many notions combined. From kinematics to dynamics,

#### *2.1 Temporal perspective*

Temporal long term, many update steps. Muddy children, programs, limit behavior.

*Protocols*, constraints on inquiry, learning theory. Effects on dynamic logic.

Connections dynamic-epistemic logic and temporal logics of agency.

#### *2.2 Preference*

Information and evaluation. Preference. Commands, deontic logic.

Entanglement with belief. *Combined logics*.

#### *2.3 Games in static logics*

Modal action logic. Strategies, propositional dynamic logic. Zermelo's theorem,  $\mu$ -calculus.

Add preference. Logical form rationality. BI analysis, *equilibria in static fixed-point logic*.

#### *2.4 Games in dynamic logics*

Dynamics before play, deliberation. *Assumptions about agents*.

Rationality characterized dynamically: via hard updates, and via soft updates.

During play. Forward induction and postulating rationality as long as possible.

After play. Rationalization scenarios.

### ***Day 3 Influences from computational logic***

Games and computation as agency.

#### *3.1 Zoom levels on games*

Game equivalence. Two zoom levels, actions powers. Deontic. Representation.  
What are natural game equivalences, what are corresponding logics.

#### *3.2 Logics for players' powers*

Modal logics of powers, neighborhood semantics. Dynamic game logic.  
Recent perspective: instantial neighborhood logic for games.

#### *3.3 Further perspectives*

Infinite games and temporal logic of forcing.  
Strategies and automata.  
Game algebra. Parallel operations. Proof theory.  
The challenge of compositionality.

### ***Day 4 Logic in games***

Logic itself has a long history of involvement with games.

#### *4.1 Logic games*

Evaluation games. Truth Lemma. Infinite games, recursion.  
Ehrenfeucht games. Fine-structure of invariance.

#### *4.2 Game-theoretic features*

Zermelo's Theorem, logical laws and powers.

#### *4.3 Designing new games*

Sabotage games and logics of model change. Poison games and argumentation.

#### *4.4 Logic of games versus logic as games*

How the two directions connect. The L-G carroussel.  
Strong Thesis: games as a source of alternative logics.

### ***Day 5 What's brewing today***

#### *5.1 More subtle updates: privacy and imperfect information*

Updates under privacy. Imperfect information. Knowledge games.

#### *5.2 Finer views of information*

Evidence. Finer levels. Tracking between levels.

#### *5.3 Networks and public behavior*

Networks. Oscillations. Network games.  
Long-term behavior. Logic and dynamical systems.  
Boundary of high and low rationality.

#### *5.4 Theory of Play*

Logic + game Theory + CS = Theory of Play.  
Game or play equivalences.  
Bounded agency, agent diversity.

**References** (see website) J. van Benthem, 2010, *Modal Logic for Open Minds*, CSLI Publications, Stanford University. –, 2011, *Logical Dynamics of Information and Interaction*, Cambridge University Press, Cambridge UK. –, 2014, *Logic in Games*, The MIT Press, Cambridge MA. Follow-up papers.

