LOGIC, COMPUTATION AND GAMES

Tsinghua University, autumn 2021

Aim Introduction to the themes of information, computation, agency, and games in logic, and in the process, showing how logic connects between several different fields.

Level This is a technical mid-level course, not a first introduction to logic. Students must have had a logic course or similar formal background [say, at the level of the on-line course http://www.logicinaction.org/, LIA]. Each week new skills are trained, and outlooks given to mathematics, computer science, philosophy, etc., including current research problems.

Reading materials (course notes, parts of textbooks, papers) will be posted on the course website, plus slides of the on-line presentations. You should skim the material lightly before each class, and read again afterwards. Many readings are from the LIA text plus the book "Logical Dynamics of Information and Interaction" (LDII), parts to read will be posted later. *Note*: The content of this course is only what was presented in class, see the posted slides.

Current topic plan

Part I *Semantic Information*

Week 1 Information and updating knowledge

- 1.1 Epistemic logic
- 1.2 Public announcement logic

Week 2 Belief revision and learning

- 2.1 Logic of conditional belief
- 2.2 Belief revision

Week 3 Richer scenarios

- 3.1 Dynamic-epistemic logic with privacy
- 3.2 Topological models for information

Part II *Correlational information*

Week 4 Dependence logic

- 4.1 Minimal modal logic of dependence
- 4.2 Topological models and measurement

Part III *Qualitative and quantitative approaches*

Week 5 Logic and probability

5.1 Combining logic and probability

5.2 Logical and probabilistic update

Week 6 Interleaving logic and counting

6.1 Hierarchy of combined systems

6.2 Backgrounds in natural language and cognition

Part IV *Temporal perspective and games*

Week 7 Logics for analyzing games

7.1 Logics for extensive games

7.2 Logics for strategic and evolutionary games

Week 8 Logics and game design

8.1 Graph games and logic design

8.2 Student Presentations

Explanation. Our theme in this course is logical features of information-driven agency. In Part I, we look at semantic information, knowledge, and the laws governing their update (Week 1), and after that, richer information spaces with plausibility orderings that support qualitative beliefs, belief revision and learning (Week 2). In Week 3, we consider more complex updates that mix private and public information, plus richer mathematical information models in topological spaces. Part II explores another key aspect of information: correlation between dependent situations or variables. We present a recent dependence logic, with extensions toward topology and dynamical systems (Week 4). Part III is about the interface of qualitative logic and quantitative mathematics that is typical for much research today in AI, cognitive science, linguistics and parts of formal philosophy. In Week 5, we discuss the growing interfaces between logic and probability theory. Next we look at a recent foundational perspective on how logic and counting interact in human reasoning (Week 6). Finally, Part IV adds longer-term perspective to information dynamics, and explores some current interfaces between logic and analyzing or designing games (Weeks 7, 8).

Class time structure Presentation Part I (40 minutes), questions (5), break (5), presentation Part II (40), questions (5). The assistant will arrange the in-class procedure.

Requirements Weekly homeworks (80% of grade), minipaper + short presentation (20%). Homeworks will contain standard questions and bonus questions, graded by point totals. HWs will be posted each Tuesday, are due the Sunday after, and will be returned graded by the next Wednesday, when short model answers will be posted that you can study.

The mini-paper should be some 4 pages, presentations about 7 minutes (some 7 ppt slides). Topics to be agreed beforehand with the teacher: further details later on the website.

Contacts There are 10 (5 + 5) minutes for asking questions during class. During the week, you can email your further questions or comments to the assistant or the teacher. Also, TA Lingyuan will hold office hours, and you can make zoom appointments with the teacher.