

Tutorial Outline

Computational Argumentation and Cognitive AI (Argumentation 2)

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The tutorial will be structured in the following four lectures. Each lecture will contain both a theoretical part and a corresponding tool systems part with hands-on use of these systems.

Lecture 1 (45 mins): Introduction: Argumentation, Reasoning, Learning, and Explainability

The first lecture introduces the basic notions that are required in the following lectures. It reviews the area of computational argumentation through the notions of acceptable arguments, credulous and skeptical reasoning via dialectic argumentation and the notion of a dilemma in reasoning and decision taking. It will also present the central role of argumentation-based reasoning in learning and how learning and reasoning via argumentation can be interlinked. Finally, it will present the strong and natural link between argumentation and explanation at a human cognitive level.

Lecture 2 (90 mins): Argumentation for Cognitive Reasoning

- **Part A: Theory of Cognitive Argumentation**

In this part of the 2nd lecture the natural link between human reasoning and argumentation will be exposed. It will present in some detail how cognitive principles drawn from Cognitive Psychology, Social Sciences and Philosophy can help develop argumentation framework whose reasoning is close to human reasoning. It will then present how this framework of Cognitive Argumentation can be applied successfully to model human reasoning in the three standard areas of reasoning studied empirically in Cognitive Science, namely Syllogistic Reasoning and the Selection and Suppression tasks.

- **Part B: Case study: COGNICA System**

The participants will be introduced to the COGNICA system that implements human conditional reasoning within the framework of Cognitive Argumentation. They will learn how to use the system to input information in controlled natural language, how to query the system and how to evaluate the conclusions reached by the system. In particular, the participants will be asked to evaluate the cognitive nature of the explanations given by the system and how they affect the human reasoning.

- **PART C: Argumentation and Cognitive Architectures**

This part of the tutorial is concerned with the link of argumentation to existing cognitive architectures. We will briefly overview the well-established cognitive architecture ACT-R. ACT-R implements a theory about human cognition and provides the simulation of various cognitive functions. We exploit these functions and model reasoning as argumentation by

mapping them to the procedural module and the declarative memory in ACT-R. Finally, we will discuss together with the participants possible ACT-R implementations of the acceptability notion in argumentation.

Lecture 3 (75 mins): Argumentation for Cognitive Learning

- **Part A: Argumentation-based Machine Learning**
This part of the 3rd lecture will introduce participants to the various ways in which argumentation has been used to date in the context of machine learning. In particular, it will review work from the machine learning literature that has utilized argumentation in an either ante-hoc or a post-hoc manner to explain either the learning data or the learned model. It will further elaborate on a list of characteristics that a language for learning or explanations should have, and will showcase how argumentation exhibits these characteristics by contrasting argumentation against decision trees and decision lists along those characteristics.
- **Part B: Case Study: NERD System and Machine Coaching**
The participants will be introduced to two systems that acquire and represent knowledge directly in the language of argumentation. The operation of the systems will be demonstrated on example data, and the participants will be explained the underlying principles that lead to the design choices implemented by the two systems. A key message to be conveyed in this part is that traditional supervised learning techniques can be naturally extended to cope with the particularities of argumentation, not only without losing the formal guarantees that one gets from learning, but also by extending and even improving upon those guarantees.

Lecture 4 (30 mins):

Argumentation-based Explainable Real-life AI Applications

The tutorial will close with a short presentation of two real-life use cases where cognitive argumentation technology is used at the center of these applications to provide an explainable and Human-centric solution. The software methodology to acquire the knowledge for these applications and the use of the Gorgias system tools will be briefly presented. The participants will then be directed to “proof of principle” system solutions of the problem to see more details.