

The Tsetlin Machine - From Arithmetic- to Logic-based AI

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Researchers are accumulating increasing evidence that machine learning models based on correlation are brittle. These models do not distinguish between correlation and causation. Accordingly, they provide limited insight and cannot reason about the effects of actions for decision making. The traditional fields of logical engineering, causal inference, and deep learning have struggled with learning causal models at scale for several decades, each approach facing substantial obstacles. In this talk, I present the emerging paradigm of Tsetlin machines. Tsetlin machines partially unify the latter paradigms through a fundamental shift from arithmetic-based to logic-based machine learning. Like logical engineering, a Tsetlin machine produces propositional/relational Horn clauses (logical rules). However, the logical expressions are robustly learnt using finite state machines in the form of Tsetlin automata. Tsetlin machines further handle uncertainty by using multiple clauses to signify confidence. In this way, Tsetlin machines introduce the concept of logically interpretable learning, where both the learned model and the learning process are easy to follow and explain. The paradigm has enabled competitive accuracy, scalability, memory footprint, inference speed, and energy consumption across diverse tasks. Recent progress deals with classification, convolution, regression, image analysis, natural language processing (NLP), and speech understanding. At the end of the talk, I cover the Tsetlin machine research horizon, addressing the unresolved learning challenge in logical engineering, the scaling challenge of probabilistic causal models, and the correlation-reliance of deep learning. The proposed approach merges: (1) recursive logical Horn clauses for modeling all computable functions; (2) causal Tsetlin machine learning for distilling causal mechanisms from data into causal Horn clauses; (3) large-scale probabilistic causal reasoning over sparse truth tables in Horn clause form.