

Special Issue

Formal Methods in the Loop: Trustworthy AI Pipelines

Message from the Guest Editors

Large language model-based systems have demonstrated capabilities in applications ranging from conversational agents and code assistants to multimodal content generation. A new generation is emerging, characterized by agent-oriented AI, context-aware AI, and AI with reasoning. However, most systems still operate as black boxes, raising a question: can we trust their answers? Explainable artificial intelligence (XAI) aims to make AI systems understandable and trustworthy. Formal methods provide formal tools for specification, verification, and reasoning, enabling explanations with guarantees of correctness and reliability. This Special Issue brings together the formal methods, theoretical computer science, and AI communities. Topics include:

- Formal methods and mathematical foundations of AI;

- Explainable, verifiable, and trustworthy AI;
- AI using formal methods;
- Context-aware and/or agent-based systems with formal guarantees;
- Principled and structured vibe coding approaches;
- AI ethics, accountability, and fairness;
- Critical thinking using AI, and critical use of AI;
- Human-in-the-loop AI with control frameworks;
- Digital twin technologies with formal foundations.

Guest Editors

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About the Journal

Message from the Editor-in-Chief

Machine learning deals with understanding intelligence to design algorithms that can learn from data, gain knowledge from experience and improve their learning behaviour over time. The challenge is to extract relevant structural and/or temporal patterns (“knowledge”) from data, which is often hidden in high dimensional spaces, thus not accessible to humans. Many application domains, e.g., smart health, smart factory, etc. affect our daily life, e.g., recommender systems, speech recognition, autonomous driving, etc. The grand challenge is to understand the context in the real-world under uncertainty. Probabilistic inference can be of great help here as the inverse probability allows to learn from data, to infer unknowns, and to make predictions to support decision making.

Editor-in-Chief

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