

Proceedings of the 17th International Workshop on Neural-Symbolic Learning and Reasoning (NeSy)

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Preface

NeSy is the annual meeting of the Neural-Symbolic Learning and Reasoning Association¹ and the premier venue for the presentation and discussion of the theory and practice of neural-symbolic computing systems.² Since 2005, NeSy has provided an atmosphere for the free exchange of ideas bringing together the community of scientists and practitioners that straddle the line between deep learning and symbolic AI.

Neural networks and statistical Machine Learning have obtained industrial relevance in a number of areas from retail to healthcare, achieving state-of-the-art performance at language modelling, speech recognition, graph analytics, image, video and sensor data analysis. Symbolic AI, on the other hand, is challenged by such unstructured data, but is recognised as being in principle transparent, in that reasoned facts from knowledge-bases can be inspected to interpret how decisions follow from input. Neural and symbolic methods also contrast in the problems that they excel at: scene recognition from images appears to be a problem still outside the capabilities of symbolic systems, for example, while neural networks are not yet sufficient for industrial-strength complex planning scenarios and deductive reasoning tasks.

Neurosymbolic AI aims to build rich computational models and systems by combining neural and symbolic learning and reasoning paradigms. This combination hopes to form synergies among their strengths while overcoming their complementary weaknesses.

NeSy 2023 was held in La Certosa di Pontignano, Siena, Italy, 3-5 July 2023.³ NeSy welcomed

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¹<https://www.city-data-science-institute.com/nesy>

²<http://www.neural-symbolic.org/>

³<https://sites.google.com/view/nesy2023>

submissions of the latest and ongoing research work on neurosymbolic AI for presentation at the workshop. Topics of interest included, but were not limited to:

- Knowledge representation and reasoning using deep neural networks;
- Symbolic knowledge extraction from neural and statistical learning systems;
- Explainable AI methods, systems and techniques integrating connectionist and symbolic AI;
- Enhancing deep learning systems through structured background knowledge;
- Neural-symbolic cognitive agents;
- Biologically-inspired neuro-symbolic integration;
- Integration of logics and probabilities in neural networks;
- Neural-symbolic methods for structure learning, transfer learning, meta, multi-task and continual learning, relational learning;
- Novel connectionist systems able to perform traditionally symbolic AI tasks (e.g. abduction, deduction, out-of-distribution learning);
- Novel symbolic systems able to perform traditionally connectionist tasks (e.g. learning from unstructured data, distributed learning);
- Embedding methods for structured information, such as knowledge graphs, mathematical expressions, grammars, knowledge bases, logical theories, etc.;
- Applications of neural-symbolic and hybrid systems, including in simulation, finance, healthcare, robotics, Semantic Web, software engineering, systems engineering, bioinformatics and visual intelligence.

NeSy received 41 regular submissions for peer-review; out of these, 33 papers were accepted for presentation in the workshop and inclusion within these proceedings. In addition, NeSy also received 26 extended abstracts summarising recently published papers at top conferences and journals; out of these, 15 extended abstracts were accepted.

Keynote and Invited Talks

NeSy 2023 featured the following keynotes and invited talks:

Keynote talk

Leslie Valiant, University of Harvard, USA

University of Siena Laurea ad Honorem Lecture

Yann LeCun, Meta AI and New York University, USA

Invited talks

Fosca Giannotti, Scuola Normale Superiore, Pisa, Italy

Alvaro Velasquez, DARPA Programme Manager, Assured Neuro-Symbolic Learning and Reasoning, USA

Murray Campbell, IBM Research, USA

Leslie Valiant

Title: Augmenting Learning with Reasoning

Abstract: The question we ask is whether one can build on the success of machine learning to address the broader goals of artificial intelligence. We regard reasoning as the major component of cognition that needs to be added. We suggest that the central challenge therefore is to unify our understanding of these two phenomena, learning and reasoning, into a single framework with a common semantics. In such a framework one would aim to learn rules with the same success that predicates can be learned by means of machine learning, and, at the same time, to reason with the rules with guarantees analogous to those of standard logic. We discuss how Robust Logic fulfils the role of such a theoretical framework. We also discuss the challenges of realizing this on a significant scale for tasks where the performance offered exceeds that achievable by learning alone.

Yann LeCun

Title: Towards Machines that can Learn, Reason, and Plan.

Abstract: How could machines learn as efficiently as humans and animals? How could machines learn how the world works and acquire common sense? How could machines learn to reason and plan? Current AI architectures, such as Auto-Regressive Large Language Models fall short. I will propose a modular cognitive architecture that may constitute a path towards answering these questions. The centerpiece of the architecture is a predictive world model that allows the system to predict the consequences of its actions and to plan a sequence of actions that optimize a set of objectives. The world model employs a Hierarchical Joint Embedding Predictive Architecture (H-JEPA) trained with self-supervised learning. The JEPA learns abstract representations of the percepts that are simultaneously maximally informative and maximally predictable. The corresponding working paper is available here: <https://openreview.net/forum?id=BZ5a1r-kVsf>

Murray Campbell

Title: Towards a Neuro-Symbolic Benchmark

Abstract: Benchmarks are the primary tool we use for assessing our progress in AI. However, benchmarking as currently practiced is problematic in several ways. This talk will review these problems and discuss some of the principles and best practices for overcoming these issues. The talk will then consider how these principles could be applied to the development of a neuro-symbolic benchmark, i.e., a benchmark where we expect neuro-symbolic approaches to have an advantage of purely neural or symbolic methods.

Fosca Giannotti

Title eXplainable AI (XAI): paradigms in support of synergistic human-machine interaction and collaboration

Abstract: Black box AI systems for automated decision-making, often based on machine learning over (big) data, map a user's features into a class or a score without exposing the

reasons why. This is problematic not only for the lack of transparency but also for possible biases inherited by the algorithms from human prejudices and collection artifacts hidden in the training data, which may lead to unfair or wrong decisions. The future of AI lies in enabling people to collaborate with machines to solve complex problems. Like any efficient collaboration, this requires good communication, trust, clarity, and understanding. Explainable AI addresses such challenges and for years different AI communities have studied such topics, leading to different definitions, evaluation protocols, motivations, and results. This lecture provides a reasoned introduction to the work of Explainable AI (XAI) to date and surveys the literature. A special focus will be on paradigms in support of synergistic human-machine interaction and collaboration to improve joint performance in high-stake decision-making as for example methods aimed at engaging users with factual and counterfactual or other high-level explanations encoding domain knowledge and user background, methods focusing on conversational explainable AI, methods for the understanding the impact of explanation on expert users' information-seeking strategies, mental model updating, and trust calibration and the steps needed for new paradigms that can promote collaboration and seamless interaction maintaining the human responsibility of the choice through a progressive disclosure to prevent cognitive overload.

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