Proceedings of the Thirty-Fourth International Joint Conference on Artificial Intelligence (IJCAI-25)
Journal Track

A Semantic Framework for Neurosymbolic Computation (Abstract Reprint)

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Abstract Reprint. This is an abstract reprint of a journal article by [Odense and d'Avila Garcez, 2025].

Abstract

The field of neurosymbolic AI aims to benefit from the combination of neural networks and symbolic systems. A cornerstone of the field is the translation or encoding of symbolic knowledge into neural networks. Although many neurosymbolic methods and approaches have been proposed, and with a large increase in recent years, no common definition of encoding exists that can enable a precise, theoretical comparison of neurosymbolic methods. This paper addresses this problem by introducing a semantic framework for neurosymbolic AI. We start by providing a formal definition of semantic encoding, specifying the components and conditions under which a knowledge-base can be encoded correctly by a neural network. We then show that many neurosymbolic approaches are accounted for by this definition. We provide a number of examples and correspondence proofs applying the proposed framework to the neural encoding of various forms of knowledge representation. Many, at first sight disparate, neurosymbolic methods, are shown to fall within the proposed formalization. This is expected to provide guidance to future neurosymbolic encodings by placing them in the broader context of semantic encodings of entire families of existing neurosymbolic systems. The paper hopes to help initiate a discussion around the provision of a theory for neurosymbolic AI and a semantics for deep learning.

References

[Odense and d'Avila Garcez, 2025] Simon Odense and Artur d'Avila Garcez. A semantic framework for neurosymbolic computation. *Artificial Intelligence*, 340:104273, 2025.