Dear Editor,

Please find enclosed a manuscript entitled “Design Patterns for LLM-based Neuro-Symbolic Systems ”, which we are submitting for exclusive consideration of publication as an article to the special issue on "Knowledge Graphs and Neurosymbolic AI" of the Neurosymbolic Artificial Intelligence journal.

In this paper, we use and extend the modular design patterns and Boxology language of van Bekkum et al. to fit LLMs, as they are a dominating trend in Artificial Intelligence (AI) past years, and they were previously not yet well presented in the patterns. The patterns provide a general language to describe, compare and understand the different architectures and methods used. The primary goal of this work is to support better understanding of LLM-based models as well as the engineering of LLM-based systems, particularly those that are used in combination with knowledge based systems, making them neuro-symbolic systems. In order to demonstrate the usefulness of this approach, we explore LLM-based neuro-symbolic architectures and approaches as well as use cases for these design patterns.

This paper is an extension of our GeNeSy workshop paper named “Modular Design Patterns for Generative Neuro-Symbolic Systems”. The workshop organisers (Filip Ilievski, Jacopo de Berardinis, Jongmo Kim and Nitisha Jain) have invited us to submit an extended version to this special issue. In this paper, we extended the paper in the following direction:

- We only focus on LLM-based NeSy systems, not generative AI systems, which changes the scope of the work slightly
- We reviewed another 50+ papers and created (complex) LLM-based Neuro-Symbolic Design Patterns, as found in section 3.3 and further
- We added RAG as a use case

This paper should be of interest to a broad readership of the journal including those interested in neuro-symbolic systems in general, LLM-based systems and design patterns.

Thank you for your consideration of our work.
Please feel free to correspond with us by e-mail using maaike.deboer@tno.nl.

Sincerely,
Maaike de Boer, Quirine Smit, Michael van Bekkum, André Meyer-Vitali and Thomas Schmid