Mena Leemhuis

**Institute for Symbolic Artificial Intelligence,
Johannes Kepler University of Linz, Austria**

Analogical Proportions meet Geometric Embeddings: From Symbolic to Neurosymbolic Approaches on Analogical Reasoning

Abstract. Projects such as the Abstract Reasoning Challenge show that though nowadays machine learning approaches achieve promising results in many application areas, they still lack basic abilities, particularly for analogical reasoning. The aim of this talk is to give an overview of analogical reasoning and its use in AI systems. I will focus on a special type of analogy, namely analogical proportions, i.e., statements of the form "a is to b as c is to d" (written "a:b::c:d", for example "cat is to lion as dog is to wolf").

Though there are subsymbolic approaches for solving analogical proportions, these lack interpretability and trustworthiness. Therefore, in the first part of the talk, I will introduce several symbolic techniques for solving analogical proportions, ranging from Boolean to algebraic to cognitive viewpoints. In this context I will also present several application areas of such approaches in AI other than classical intelligence test questions in the style of the Abstract Reasoning Challenge.

In the second part of the talk, I will shift the viewpoint to a neurosymbolic one. Though, symbolic viewpoints on analogical proportions are necessary to ensure interpretability and trustworthiness, they lack other, non-symbolic abilities. Analogies are by nature highly intuitive, sometimes emotionally-driven and dependent on the target audience, all of which are aspects better handled subsymbolically. This directly motivates to use neurosymbolic approaches to combine the intuitive, subsymbolic part with the formal guarantees of the symbolic part. I will give a short overview of options for neurosymbolic approaches on analogical proportions and present my research area of ontology embeddings. These are based on representing the ontology geometrically, thus, e.g., by modeling concepts as convex objects in a space and logical operators between concepts as geometric operations between the concept representations. This enables the combination of subsymbolic regularities such as saliency information and similarity with symbolic information in form of an ontology. In such a context, it is possible to

represent an analogical proportion geometrically but remaining grounded in an ontology.

Speaker Bio. Dr. Mena Leemhuis is a postdoctoral researcher with tenure track at the Institute for Symbolic Artificial Intelligence at the Johannes Kepler University of Linz, Austria. From September 2024 to February 2026, she was a postdoctoral researcher at the KRDB research centre for Knowledge-based Artificial Intelligence at the Free University of Bozen-Bolzano, Italy. Her research interest lies in the field of neuro-symbolic AI, particularly on the connection between ontologies and embedding techniques.

https://menaleemhuis.github.io/

Place & Time.

Building O27, Room 441
Tuesday, June 30, 2026
10:15-11:45 am