High-Dimensional Vector Spaces as the Architecture of Cognition

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Abstract

We demonstrate that the key components of cognitive architectures - declarative and procedural memory - and their key capabilities - learning, memory retrieval, judgement, and decision-making - can be implemented as algebraic operations on vectors in a high-dimensional space. Modern machine learning techniques have an impressive ability to process data to find patterns, but typically do not model high-level cognition. Traditional, symbolic cognitive architectures can capture the complexities of high-level cognition, but have limited ability to detect patterns or learn. Vector-symbolic architectures, where symbols are represented as vectors, bridge the gap between these two approaches. Our vector-space model accounts for primacy and recency effects in free recall, the fan effect in recognition, human probability judgements, and human performance on an iterated decision task. Our model provides a flexible, scalable alternative to symbolic cognitive architectures at a level of description that bridges symbolic, quantum, and neural models of cognition.