

Emergence of Euclidean geometrical intuitions in hierarchical generative models

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Abstract: In this study, we aim to understand the origins of human intuitions about Euclidean geometry by simulating geometric concepts acquisition with unsupervised learning in hierarchical generative models. Specifically, we build a deep neural network that learns a hierarchical generative model of sensory inputs. The results show that hidden layer activities can support the categorization of different geometric objects and distinguish among various spatial relationships between geometric figures. Specifically, hidden layer activities can be decoded to compare line orientations, detect right triangles, and judge whether two triangles are similar or not. We further analyze the response profiles of hidden layers units and find some units resembling parietal neurons in the brain. Using unsupervised deep learning, the current modeling work provides a possible explanation of how Euclidean geometrical intuitions might emerge from daily visual experience, which has significant implications for cognitive psychology and computational neuroscience.