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A Universal Phase in minimal 3D embedding of Networks NIMA DEHMAMY, SOODABEH MILANLOUI, ALBERT-LASZLO BARABASI, Northeastern Univ — Analyzing networks embedded in 3D space is crucial for understanding brain anatomy and pathologies pertaining to physical connections in the brain. Devising physical 3D layouts for networks is also of interest for visualization purposes. Additionally, given the recent advancements in 3D printing technology, efficient and economical 3D layouts may have practical value in design and manufacturing of complex devices. The role of network topology in layouts and the limitations it imposes on the feasibility of layouts must, thus, be studied. We develop a minimal 3D layout algorithm for networks, inspired by force-directed layouts. We analyze the spatial properties of our layouts and find two phases based on link thickness and derive the phase transition criterion. In both phases, different network topologies turn out to be very similar in their volumetric properties and are not distinguishable based on volume. Relative link orientation, does differentiate the topologies when links are thin, but fails to do so at large link thickness. Thus, we discover a universal phase for 3D networks when link thickness is large. Comparing against brain literature, we find that rodent brains may be related to this universal phase at the level of connections between brain regions.

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