Networks

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Networks get more cliquey as they grow

Many real-world networks don't spring up, fully formed. Instead, they grow over time. For instance, the network of citations grows as new papers are published, citing existing papers. But is the bigger, later network simply a scaled-up version of the earlier, smaller one? Or do the structural properties of a network change as it grows? One change that's well-established in many real-world situations is that as a network grows, it becomes denser: the number of links in the network grows faster than linearly with the number of nodes.

But networks also contain higher-order structures, known as cliques, which are sets of nodes that all link to each other (like a friendship group where each pair are also friends with each other). Cliques are important because they are parts of a network that are tightly connected, such that if one node or link is removed the rest remain connected. However, how they form in a growing network is a question that has received relatively little attention. Now, writing in *Physical Review E*, Haochen Pi and colleagues show that in several real-world networks, the number of cliques grows faster than the number of links, and the number of big cliques grows even faster than the number of small cliques.

Pi et al. show that this finding can be captured by a model with two key ingredients. The first is that a new node links not only to an existing node but also some of its connections (like when at a party full of strangers, you meet someone who immediately introduces you to some of their friends). The second is preferential attachment (you are more likely to make friends with someone who already has a lot of friends). Although there are many models that could potentially capture the same patterns of clique formation, Pi et al. show this model is one of the simplest.

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Original article: Pi, H., Burghardt, K., Percus, A. G. & Lerman, K. Clique densification in networks. *Phys. Rev. E* **107**, L042301 (2023)

Related article: Leskovec, J., Kleinberg, J. & Faloutsos, C. Graph evolution: Densification and shrinking diameters. *ACM Trans. Knowl. Discov. Data* **1**, 2 (2007)

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