Local cost minimization reproduces key topological properties of meat ant transport networks allowing for trade-off at small and large scale

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Transport networks are a fundamental means for the distribution of resources and information in many human and biological systems, their construction requires optimization of conflicting criteria such as robustness against disruptions, transport efficiency and building cost.

The colonies of the polydomous Australian meat ant *Iridomyrmex purpureus* are a striking example of natural system based on a decentralised network of trails that allows for the exchange of resources and information among spatially separated nests. As shown by Cabanes et al. (Beh. Ecol. 2014), meat ant optimal transport networks feature a trade-off between efficiency, cost and robustness, constituting a possible source of inspiration for improving human network design.

In this work we study the colony-level building rules that underlie network construction in wild colonies of meat ants. We propose a simple and biologically plausible model of network growth (Minimum linking model, MLM) that is based on local cost minimisation and leads to the same trade-off between design criteria as observed in ant colonies. When building larger networks that could represent human-made systems, the MLM shows a qualitative similarity with a Euclidean Minimum Spanning Tree, prioritising cost and efficiency over robustness at large network size. We finally show that a balance between the three considered design criteria can be reintroduced at large scale. This is achieved by defining a local extension of the original model that relaxes the condition of cost minimisation. Our local variant could therefore be a suitable source of inspiration for the construction of cheap and efficient transport networks featuring non-zero robustness, suggesting possible applications in the design of human-made networks.