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The Role of Vertex Degree in Evolution on Graphs

Since their introduction a decade ago, evolutionary graphs are now a well-studied representation of structured populations. They have proven to be valuable in the investigation of the evolution of cooperative social behaviours. The exact features of graphs that promote, or work against, cooperation are, however, still elusive. There has been some interest in the role of vertex degree. Some work has shown that highly connected vertices act as promoters of cooperation while other work has shown this for those with less connections. The goal of my current work is to better understand the role of degree in evolutionary processes on graphs. I adapt the concept of reproductive value to the study of evolutionary graphs which aids in addressing which nodes are conducive to cooperation and when. I propose the simple rule: evolution is promoted on vertices with the highest reproductive value, regardless of population regulation process.

As a companion to this result, I present an example that demonstrates that arguments based solely on degree are insufficient for explaining the emergence of cooperation on graphs. It is possible for a graph to have vertices all of the same degree (ie. a regular graph) yet experience location-dependent levels of cooperation. This example emphasizes the importance of the underlying graph topology in the evolutionary process.