

Emergence of social networks in a model of mobile agents traveling in a complex environment

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ABSTRACT

Precisely how geographical factors influence social structure is far from clear. We explore this question using an agent-based model inspired by a related ecological problem, namely, the spatio-temporal group patterns in the society of Spider monkeys (*Ateles spp*). Our model introduces a realistic, complex environment composed of many point-like locations or “targets”, that represent, *e.g.*, trees in a tropical forest (ecological context) or cities in a country (human context). The size of targets varies according to an inverse power-law frequency distribution with exponent β . Agents do not interact among them and start from random initial locations. They have either a complete or partial knowledge of the environment and move from one location to the other. At each step, they maximize the ratio between the size of the next visited location and the distance traveled to it, ignoring previously visited locations. Agents stay at a given location during a time proportional to the location size. At intermediate values of β ($\simeq 2.5$), when large targets are neither too scarce nor too abundant, agents form the largest groups by coinciding often at a same place. The formation/splitting events of groups (fusion/fission) create a network of associations that contains weak bonds among agents that meet only rarely and strong bonds among those that repeat associations more frequently than would be expected by chance. The latter form sub-networks with the highest number of bonds and a high clustering coefficient at intermediate values of β . The weak bonds enable the whole social network to percolate. Some of our results are similar to those found in long-term field studies of spider monkeys and could have some implications on human social networks as well. We conclude that the heterogeneity and complexity of the environment in which agents live could be a possible origin of complex social structures.

Keywords

Social networks, mobile agents, spatial models, disordered media, ecology, animal societies, foraging