Ant Social Network Analysis Using Null Models And Network Motifs

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SUMMARY

INTRODUCTION

Social network analysis has become an indispensable in analyzing complex networks, such protein-protein interactions, and ecological networks.
Among the most studied animal networks; The Ant Colony Social Network, which has inspired developers to create efficient algorithms like Ant Colony optimization.
In our study, we’re analyzing ants social network in order to test hypothesis about the nature of this network, by comparing this network to randomly generated network using the Erdos-Renyi model.

Materials And Methods

Ant Colony

The ant colony belongs to Camponotus fellah species, it was reared at the University of Lausanne, Laussane, Switzerland (10), the interactions between ants were recorded using a video camera, with a time resolution of 0.5s for 24 hours a day, for 41 days.
An interaction is defined by the existence of one ant’s front end in the trapezoidal shape representing the other ant. The edge weights represent the frequency of the interactions.

Materials And Methods

Networks

Networks were generated using the package igraph in R programming language, we generated the 41 graphs and calculated their centralities; vertex strength, vertex betweenness and demonstrated their distribution, in order to compare them with centralities of random generated graphs, we have also taken edge weights in considerations, as we have compared the weights distributions for the original and random graphs.

Materials And Methods

Null models

In general null models refers to randomly generated graphs in order to compare it to original graphs. In our study we’re using the Erdos-Renyi model to generate random graphs with the same degree distribution, this is achieved by keeping the number of vertices and edges the same as the original graphs. We have also randomized the weight distribution by generating random weights values between the maximum and the minimum values in the original graphs.

Materials And Methods

Network motifs

Network motifs refer to subgraphs that occurs in a graph more than in a random graph, evaluating and extracting network motifs has shown that it is quite useful in complex network analysis (12). In this study we have searched for the triad and quartet subgraphs, for each graph we calculated the number of specified subgraph and their weights. The weight of a subgraph is defined as the summation of the weights of the edges forming it (13). We therefore define weighted motifs, which are subgraphs with a weight in a specific range.

RESULTS

Networks

The networks represent the status of ants interactions for 41 days, the first day contains 113 vertices and the last day contains 55 vertices. The table shows the statistics of the network progress through the 41 days.
Due the important computational required, we limited our study on 3 graphs of total graphs.
Tables 1 and 2 present the statistics for the triad subgraphs in the observed networks and one of the randomized graphs.

RESULTS

	Min	1st Qu.	Median	Mean	3rd Qu.	Max.	Standard Deviation
Day 1	3.00	11.00	17.00	21.07	26.00	266.00	14.90356
Day 20	3.00	11.00	19.00	25.53	32.00	270.00	21.73357
Day 41	3.00	12.00	19.00	22.74	30.00	148.00	15.38518

Table1: Statistics of the triadic subgraphs for the original networks

RESULTS

	Min	1st Qu.	Median	Mean	3rd Qu.	Max.	Standard Deviation
Day 1	6.0	154.0	200.0	200.0	246.0	394.0	65.69649
Day 20	6.0	157.0	205.0	204.8	253.0	395.0	67.85925
Day 41	85.0	85.0	111.0	110.3	136.0	219.0	36.47035

Table2: Statistics for triadic subgraphs of the randomized networks.

CONCLUSION

Comparing the most frequent subgraphs in the networks showed a very big difference between the observed networks and the randomized one; the observed networks had most of their triadic subgraph weights below 30, with a standard deviation between 21 and 14, while the triadic subgraphs in the randomized networks had weights over 100 for the first days, and over 85 for the last days.

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