CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
S0312

Project Title
Spreading the Word: Simulating the Effect of Population Influence Structure on the Propagation of Ideas

Abstract

Objectives/Goals
Though the propagation of ideas in human society is among our species' most unique and valuable characteristics, little quantitative attention has been devoted to understanding factors that might influence it. My objective is to - by analogy to processes used in mathematical population biology - conceive and write a computer simulation of a process that transmits ideas seeded in a population according to a stochastic weighted-consensus rule and to develop a numerical approximation technique. The process occurs on an underlying population influence structure represented as a directed and weighted graph. With this model we analyze the effect of various population influence structures on the likelihood and speed with which a new idea will spread throughout a population.

Methods/Materials
2.5 GHz Personal Computer, 1 GB RAM. Simulation coded in C++: Establish a population of size N=100 (each member is in one of two states - "0" for the old condition, "1" for new) that begins with some "1" entries. Create a population influence structure as a graph in which each node is an individual and each directed, weighted edge represents the level of influence of one member on another. Repeat 10,000 times to generate a reliable average fixation probability and time: choose a random individual to consider changing status with a probability equal to the proportion of overall inward influence that comes from individuals in the different state.

Results
Both regular and non-regular structures with symmetric influence generate behavior equivalent to a fully-mixed population. The presence of a single agent who is insensitive to all makes a dramatic impact on the fixation probability. The presence of several agents who are relatively insensitive to their neighbors' influence protects ideas that originate among those agents. Finally, when considering how best to use a certain quantity of influence to promote an idea's progress, we found an interesting dependence on the nature of the population, suggesting that success requires an understanding of the population and use of the most appropriate strategy.

Conclusions/Discussion
Overall, the results from the simulations performed in this project offer support for our hypotheses. A population's influence structure does exert an effect on idea propagation. Further, numerical approximations by Markov processes very closely matched the simulation results, providing an efficient alternative.

Summary Statement
We used a stochastic weighted-consensus rule akin to the Moran process in Biology to simulate the effect of population influence structure on the likelihood and speed of an idea's propagation. A numerical approximation was also developed.

Help Received