Midterm Paper Review

Social Percolation Models

Solomon, S., Weisbuch, G., Arcangelis, L., 1999

M Ahsan Al Mahir
BuX ID: 20216007
GSuite: ahsan.al.mahir@g.bracu.ac.bd

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The paper proposes a percolation model for simulating social recommendation situations. The primary question it seeks to answer is "Why do you notice extreme market shares, close to 0% and 100% in media industry". Below we give a thorough review of the model the authors proposed as a possible explanation to this question.

☐ **Which system is modeled and simulated in your selected paper?**

To answer the proposed question, the authors came up with a Monte Carlo simulation based on the percolation theory, where people are considered as points on the lattice, and their neighbors are considered as their acquaintances.

☐ **Why is this simulation needed?**

Under usual assumptions, market share between different products should be uniformly distributed. But in reality that is not the case as many products are either hits or flops, and they do not follow an uniform distribution. The explanation the authors gave for this bi-modal distribution is that "...certain commodities markets is often discussed in evolutionary economics in terms of bounded rationality..." (p. 240)

The social percolation model they came up with presents a possible way to predict whether a product would be either a hit or a flop based on how close the quality of the product is to the percolation threshold of $2D$ lattice. So by understanding their model, industries can gear their investment in increasing their product quality based on the outcomes from the market.

☐ **What questions did the author ask to analyze the problem?**

The authors noticed that most prior researches regarding propagation of new ideas throughout a social group considered the propagation in terms of epidemiology. They instead asked whether adoption of new ideas had any external effects or not. So they possibly had asked these questions

a) How does information travel when not all information is not public?
b) How does prior knowledge about something influences the decision regarding some market product?
c) How can social acquiantances influence the buyer's decision?

d) If we think about product quality as a numeric value, then which values of the quality can make it a hit or a miss?

e) How does the quality of a product effect the preferences of a population?

f) How should the quality of a product change after it experiences hits or flops?

☐ **Classify the model of the system.**

The model is a discrete percolation model that uses Monte Carlo simulation.

☐ **Describe the abstract model the authors came up with.**

The authors created a abstract structure for the social model by considering each person being a point on a square lattice, and acquiantances being lattice neighborhood. They also considered personal preferences and product quality as numbers between $[0,1]$. They also took changes in personal preferences and product quality as numeric values into account to create a dynamic system.

The main simulation of this system is to take an initial product value and to increment time step by step to find the minimum product value that would make the product a hit.

The authors selected a $2D$ lattice to best represent social connections in a large city. But they conjectured that the result would be similar in other dimensions as well.

☐ **Describe the mathematical model model the authors came up with.**

The authors proposed two versions of the model, a simple static version to build the basis of the model, and then a dynamic model that takes changes in people's preferences and product quality in account.

The static model has the following key properties:

a) The population would be points on a square lattice of size $L \times L$. Each person will have a preference value $0 \leq p_i \leq 1$.

b) The product quality will be a number $0 \leq q \leq 1$.

c) At first there will be a subset of the populations who will have the knowledge about the product.

d) At every increment of time, the current subset of the population who has knowledge about the product will decide whether to buy that product or not, by comparing their preference value with the product value.

That is, if $p_i < q$ then they buy the product, if not then they don't.

e) If a person buys the product, then they becomes a source of knowledge, and they let their neighbors on the lattice know about the product. So after the time increment, the neighbors of the buyers become knowledgeable about the product, and can decide whether to buy the product in the next time increment.

A product is labeled a 'hit' if after enough time increments, there is a spanning connected component in the lattice. And 'flop' otherwise. Because of this, the authors claim that products that falls below the percolation threshold of 0.593, it is a flop and if it is more than the threshold, then it is a hit.

The authors improved this static model by taking into account that people's past experience with a product influences their preferences as well as the quality of a product changes when it experiences hits or flops. This dynamic model has the properties:

a) The system is updated after a product has been identified as a hit or a flop.
b) During the update, every person who bought the previous product increases their preference value by δp because they were satisfied by their previous experience, and how have a higher expectation.
c) The people who did not buy the product decreases their preference valu by δp.
d) If the product was a hit, then the production company decreases the product value by δq in attempt to minimize the production cost while maintaining their popularity.
e) If the product was flop, then the production company increases the product value by δq to reach more audience.

After several simulations of the system, the authors noted that the value q tends to the percolation threshold.

☐ **Describe the system state variables of this system.**

The system state variables for this model are

a) The $L \times L$ lattice which is stored in a two dimensional array.
b) Personal preferences p_i for each of the people on the lattice.
c) The initial product quality q
d) The values $\delta p, \delta q$ that the dynamic model uses.

☐ **Name the tools and programs the authors used for the simulation.**

The authors did not mention any programs or tools in their paper. But assuming from their plots and simulation models, it can be inferred that their work can be reproduced using python libraries `numpy`, `scipy.ndimage`, `matplotlib.pyplot` and `random`.

☐ **What was the result of the simulation? What conclusions did the authors draw from their simulation output?**

The authors concluded on a number of results. These can be listed in:

a) Firstly, the authors concluded that this percolaction model for social situations produces almost identical results as observed in reality. For example, the relationships between p_c and q can explain why some products experience hits and some experience flops.
b) They also concluded that the ideal value of a product tends to the percoaltion value. Meaning that production companies can work with real life data to better predict their desired product value by using this model.

☐ **How did the authors verify and validate their model? Write your suggestions for improvement of the model.**

The model the authors developed was intended as a possible explanation for a natural phenomena that cannot be explained by usual probabilistic methods. Their explanation for the possible

solution matches their test data, that if $q > p_c$ then the product will be a hit, and if $q < p_c$ then it will be a miss. Which is intuitively correct based on results from percolation theory.

The results matching their initial conjectures verifies their model. To validate their model, they used the model with 8 different test systems, and related the results from those tests to other scientific results. Also their model although theoretically, but correctly explains the hit-flop phenomena. Which gives validation to their model.

☐ **Describe a new problem relevant to the paper you want to solve by modeling and simulation.**

At the end of the lecture, the authors conjectured that this model can be used to estimate sales rate in products other than cinema as well. But they do not give explanation about whether this same model could be implemented for childrens' toys as in that scenerio, the neighborhood relationship between the children is not nearly as important as their parents'. So estimating childrens' product poses a new set of complexity that arises when we take both the childrens' and their parents' preferences into account. In which case, the model might need heavy modification to correctly estimate market shares.