Lab -4

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CS-302, Modeling and Simulation

In this lab, we make an attempt at simulating the diffusion of newly introduced innovations in the market by the people in society. We also considered the role of internal influence in impacting the spread and adoption of the product.

I. INTRODUCTION

In order to observe diffusion of new products into our society, we simulate the model proposed by Frank Bass. We start with the assumption that the timing of a consumer's initial point of purchase is dependent on the number of previous adopters. The rationale for adoption is classified in two segments, innovator and imitator.

II. MODEL

We model the diffusion of the new product as following,

$$\frac{dN}{dt} = \alpha(t) \cdot (N_a - N) \tag{1}$$

External Influence Model

In this model, we see the effect of innovators on the newly launched technology in the market. Innovators are the people who adopt the product, on their own, without any influence from others. For this model we take, $\alpha(t) = p$. Where, p reflects the effect of innovators in the market.

Internal Influence Model

In this model, we see the effect of imitators in the market. Imitators are the people who adopt a product after being influenced from other adopters. This influence can be represented by, $\alpha(t) = q \cdot \frac{N(t)}{N_a}$. Where q is coefficient of imitation.

Bass Model

This model is superposition of the internal and external influence model. We write, $\alpha(t) = p + q \cdot \frac{N(t)}{N_a}$. Hence, we get the following equation substituting $\alpha(t)$ into Eq. 1,

$$\frac{dN}{dt} = p \cdot N_a + (q - p) \cdot N - \frac{q \cdot N^2}{N_a} \tag{2}$$

Modified Bass Model

Now we create a model in which the coefficient of imitation q is function of time. Which can be represented as shown in Eq. 3. Which shows a more realistic scenario.

$$q(t) = q_0 \cdot (\frac{N(t)}{N_a})^{\beta} \tag{3}$$

Hence, we write the differential equation as,

$$\frac{dN}{dt} = (p + q(t)) \cdot (N_a - N) \tag{4}$$

III. RESULTS

We first observe the effect of p on the rate of adoption by simulating the Bass Model with coefficient of imitation $q = 1$ and by varying the coefficient of innovation p in the range 0 to 1. Fig. 1 shows the results of the simulation. We observe that as the value of p increases, the rate of adoption increases and the time taken to reach 100% market share decreases.

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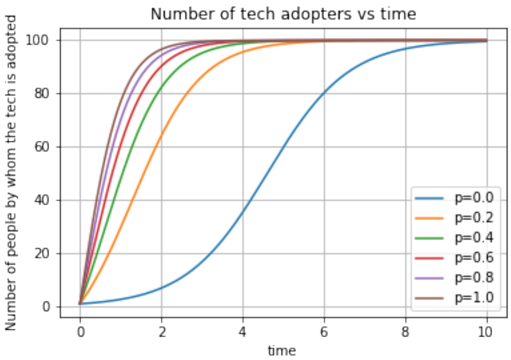

FIG. 1: q = 1, N_a=100, N_0=1

We then observe the effect of q on the rate of adoption by keeping the coefficient of innovation $p = 0.01$ and varying the coefficient of imitation q in range 0 to 4. Fig. 2 shows the results of the simulation. Here too, we can conclude that as the value of q increases, the time taken to adopt the product by 100% adopters decreases.

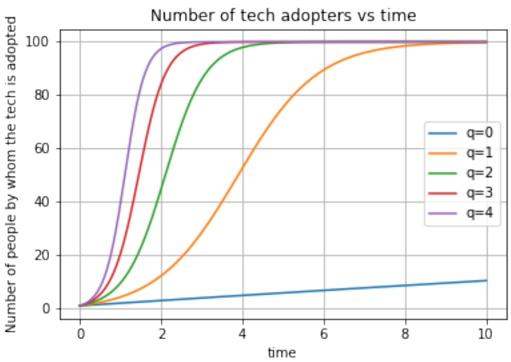

FIG. 2: p = 0.01, N_a=100, N_0=1

After modifying the Bass Model, we simulate the equation where, the coefficient of innovation $p = 0.01$ and the coefficient of imitation $q = 1$ are kept constant we vary the value of β in range 0 to 4. β represents the interaction amongst adopters. Different values of β express varying degree of interaction. And β=0 being the traditional bass model. From Fig. 3, we conclude that as the value of β is increased then the time taken to adopt the product by 100% adopters increases.

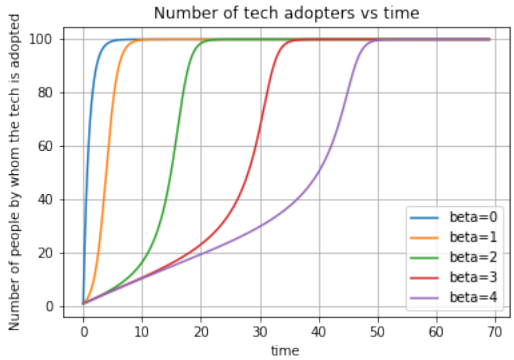

FIG. 3: q=1, p=0.01, N_0=1, N_a=100

IV. CONCLUSIONS

We observe that both coefficient of imitation and coefficient of innovation both have a great impact on the diffusion of a new technology in the market.

On considering only the external influence, we can see that as the value of constant increases, the rate of diffusion increases and maximum adoption is achieved quicker. Same behavior was observed for the internal influence as well.

We also compared the traditional Bass model against the Modified Bass Model. Traditional version represents an ideal, best case scenario, which indicates the minimum time required to reach 100% market-share. While the modified version represents a more realistic scenario for adoption.

As value of the both coefficients increases, i.e. both internal and external influence increase, we observe that the time to reach the technology to all the adopters decreases. In the case of time dependent coefficient of imitation, as the value of β increases the time taken to reach the technology to every adopter is increased.