Modeling and Simulation, CS302

Lab-2

Due Date -Tuesday 4th, February.

1. **Models of innovation diffusion:** Fig. 1 shows the diffusion of innovations. Initially, the market share of a new product is zero. However, due to certain factors there are a group of people called early innovators who initially adopt the product (technology). As time progresses the product increases its market share due to many factors such as advertising, distribution of prices and contact between users and finally saturates to a maximum value. Behavior observed in Fig. 1 or some variant of it is commonly observed in a multitude of problem (e.g number of twitter users, people using smart phones, market share of apple phones etc.). In this problem we take a look at some of the models specifically for such problems.

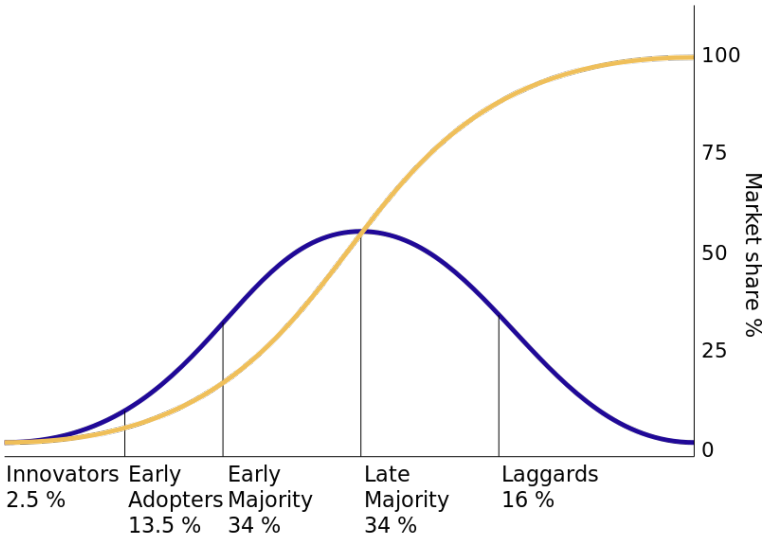

FIG. 1: The diffusion of innovations according to Rogers. With successive groups of consumers adopting the new technology (shown in blue), its market share (yellow) will eventually reach the saturation level. The yellow curve is known as the logistic function. (figure and caption taken from wikipedia)

Typically the mathematical model for such problems have the form:

$$\dot{N} = \alpha(t)(C - N(t)) \tag{1}$$

where, $\alpha(t)$ is the coefficient of diffusion, C is the maximum number of potential users of the product and $N(t)$ is the total number who have adopted the product till time t. Three models are common:

- external influence model in which $\alpha(t) = p$, where p is a constant and captures the innovators or people who adopt the product on their own without being influenced by others.
- internal influence model $\alpha(t) = qN(t)/C$, in which the rate $\alpha(t)$ now captures the adoption due to the effect of the other users.
- mixed influence model (Bass): $\alpha(t) = p + qN(t)/C$, which captures both the effects.

Let us assuming that the market share can be approximated by the percentage of users. The full (mixed influence) Bass Model has two parameters p and q. The speed at which the product is being adopted or its longevity would therefore depend on the interplay between these parameters. We attempt to develop a qualitative understanding of these through numerical analysis. Provide a systematic analysis highlighting the significance and role of the parameters. For reasonable values of the parameters you may refer to the original paper by Bass.

2. In this problem we try to see how well the different models we have looked at perform when it comes to modeling change in human population. For this exercise we will be using the data from https://en.wikipedia.org/wiki/World_population_estimates. Let us consider the data in Table 2 under the section 1950 to present. We will use the data under United States Census Bureau. To extract the data you can refer to python file available with this lab. (You are free to do it in your own way). Consider two models of population growth linear and logistic. For both the models estimate the parameters from the available data. Based on your analysis discuss which model provides a better fit. Using logistic model and the parameter values that you have obtained provide an estimate for the US population in the long run.