Physics-Informed User Preference Estimation

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1 User Preference Empirical Observation Question

Question a. Based on the view time and click rate attributes, an economist decides to estimate the preference equation (i.e. utility equation) for each user. After some experiments, the author decides that the user-preference can be estimated as the following equation:

$$p(t) = \frac{1}{1 + e^{-2*vt+2*clr}} \tag{1}$$

where p is the probability whether the user will buy the item, vt is view time and clr is the clickrate value. Therefore, the user preference to buy an item is the above probability function. Use this probability to generate the user preference and include in your current machine learning model. Compare the performance.

Question b. Despite the economist's attempt, other team members are skeptical of this estimation. To combine the economist approach and make the user-preference for general to ease other team members' skeptics, a mathematician decides to formulate the problem as follow.

Assume the user preference to buy an item for each user follows a differential equation

$$\frac{du}{dt} = f(u(t), F(t)) \tag{2}$$

where u is the preference of the user and F is the external factor containing click rate and view time. Since we do not know the function f, the mathematician assumes that the function f can be

approximated with an operator G and function F, where G is an operator capturing the relationship F and u. Therefore, the equation (2) can be rewritten as follow

$$\frac{du}{dt} = GF \tag{3}$$

We can think of F is a matrix containing click rate and view time values. Therefore, using data generated for the user preference by the equation (1), estimate the variable G, and obtain the user-preference vector.