Set -1: Computation of IBM growth

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In this lab we have developed a mathematical model to study the growth of industrial organizations. The model is based on a logistic equation, which takes into account nonlinear factors affecting the growth. The equation allows for predictions of the maximum revenue and human resource content that a company can achieve. The results of this model have been found to match well with the data from the global company IBM.

I. INTRODUCTION

Over time, IBM has consistently achieved expansion in its yearly revenue, human resource, and annual profit. The utilization of graphical representations from the released data can effectively convey this progress.Such visual tools offer a succinct and straightforward explanation of the data, providing a thorough comprehension of the business' performance.

II. MODEL

Keeping into account the assumptions and other studies[1], we model the system using following equations:

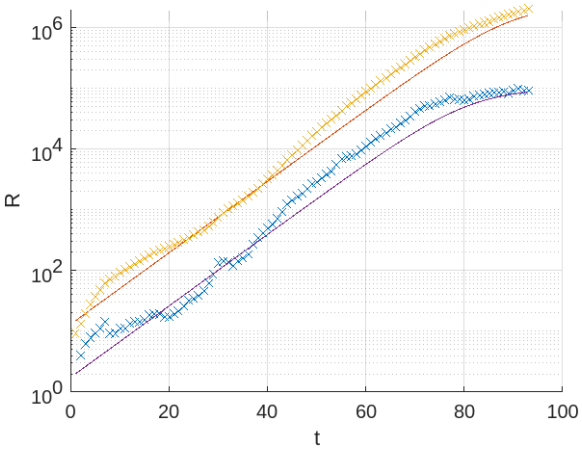
$$\dot{\phi}(t) = -\lambda\phi(1 - \eta\phi^{\alpha}) \tag{1}$$

where ϕ can be any relevant variable to guage the health of a firm, like its annual Revenue (or cumulative revenue growth) and human resource strength. The parameters α and η are, respectively, the nonlinear saturation exponent, and the "tuning" parameter for non linearity.Integration of Eq. 1 is as following:

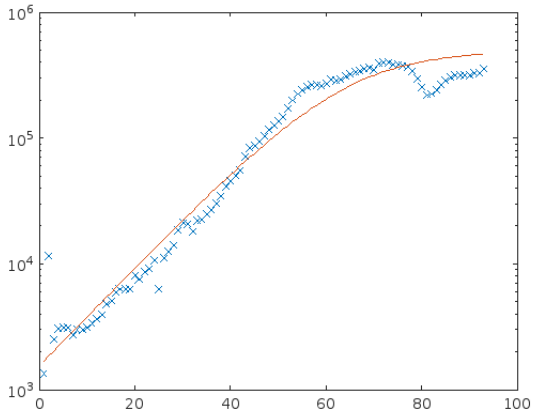
$$\phi(t) = [\eta + c^{-\alpha} exp(-\alpha\lambda t)]^{-1/\alpha} \tag{2}$$

where c is a constant used in integration. Here, time is scaled in years and yearly income is expressed in millions of dollars.

III. RESULTS



The bottom line shows the model's prediction for IBM's yearly revenue. The model matches the actual data well for certain non-linear time periods when $\alpha = 1$, $\lambda = 0.145$, and $\eta = 10^{-5}$. The top line shows the cumulative growth of IBM's yearly revenue and is predicted by $\eta = 4 * 10^{-7}$.



The model predicts the growth of human resources over time with parameters $\alpha = 1$, $\lambda = 0.09$, and $\eta = 2 * 10^{-6}$. There is a decrease in the number of human resources over a similar non-linear time period of 75 to 80 years as seen in the revenue growth.

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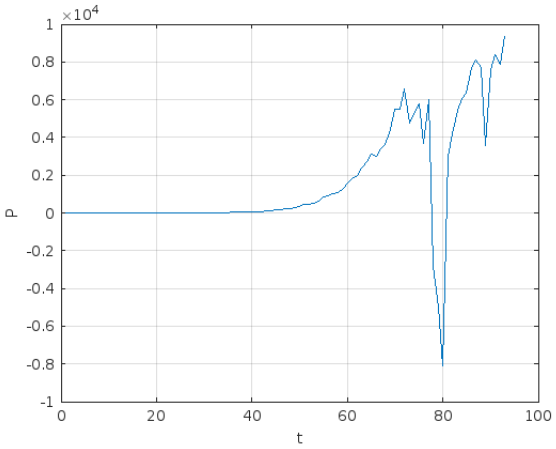
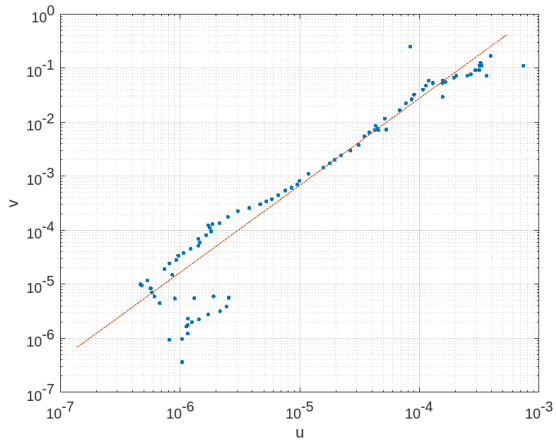


IBM's net yearly earnings (in millions of dollars) have generally increased, except for the beginning of the 1990s, after 80 years of the company's existence. During this time, the company experienced significant decreases in its net earnings, which is closely related to the start of non-linear slowing in revenue growth.

Statistical Analysis Of accuracy		
	Mean	Standard Deviation
Annual Revenue	-0.0102	0.4688
Cumulative Revenue	0.0066	0.2420
Human resources	-0.0206	0.5632



IV. CONCLUSIONS

- The models for revenue, cumulative revenue, and human resource strength appear to align well with the actual data.
- However, the model for cumulative growth appears to be the most precise, as it consistently shows a non-decreasing trend.
- The Human Resource Curve demonstrates that at the conclusion of the study period, the workforce is at its full potential. Contrary to our prediction, the present economic crisis has resulted in a decline in the workforce. The scenario can alter if the company adds more employees and modifies the organisational structure.

[1] Ray, A.K. (2010). Modeling Saturation in Industrial Growth. In: Basu, B., Chakravarty, S.R., Chakrabarti, B.K., Gangopadhyay, K. (eds) Econophysics and Economics of Games, Social Choices and Quantitative Techniques. New Economic Windows. Springer, Milano. https://doi.org/10.1007/978-88-470-1501-2_14