Set -1 – Dynamics of IBM's Revenue and Human Resource Expansion

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CS302, Modeling and Simulation

In this lab, we estimate the trajectory of IBM's revenue and human resource growth over time using the logistic equation's integral solution. We then compare our predictions to the actual data by calculating the mean and standard deviation to assess how accurate they were. We use modeling to investigate the relationship between the financial and human resources of multinational corporations such as IBM.

I. LOGISTIC MODEL

First-order autonomous dynamical systems have the general form of dx/dt = f (x) where x = x(t), with t being time.

$$\frac{dx}{dt} = ax - bx^2 \tag{1}$$

Eq. (1) represents the basic model of a nonlinear function, where a and b are fixed parameters. On solving this equation with initial condition x(0) = x0 and k = a/b we get the following result,

$$x(t) = \frac{kx_0e^{at}}{k + x_0\left(e^{at} - 1\right)} \tag{2}$$

The following formula gives the linearisation of human resources and revenue:

$$V \sim U^{\beta} \tag{3}$$

where

$$V = R^{-1} - k_r^{-1}$$

$$U = H^{-1} - k_h^{-1}$$

$$\beta = \frac{\rho_1}{\eta_1}.$$

where ρ_1 is the a value of revenue logistic equation and η_1 is the a value of human resource logistic equation.

II. RESULTS

The Fig. 1 shows the net revenue growth of IBM company over 75–80 years. The parameter values used to fit the revenue growth are:

$$\rho_1 = 0.145\,\text{year}^{-1}, \quad k_R = 100\,\text{billion dollars}.$$

The mean and standard deviation are calculated as:

$$\mu_r = -0.00018, \quad \sigma_r = 0.4722.$$

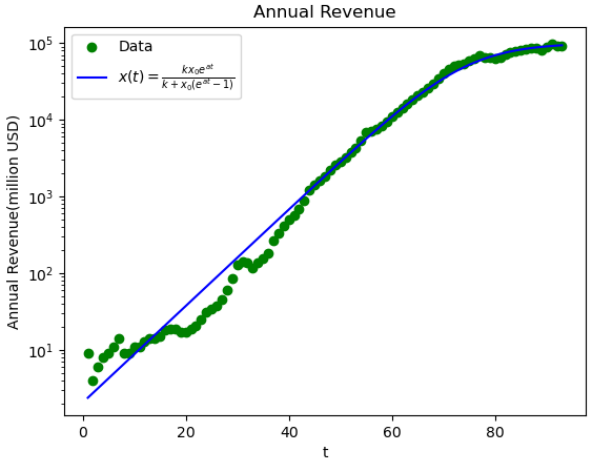

FIG. 1: The dotted graph is the annual revenue of IBM from data. The Line graph comes after plotting revenue versus time using Equation 2

The Fig. 2 shows the growth of human resources of IBM company over 75–80 years. The parameter values used to fit the revenue growth are:

$$\rho_1 = 0.09\,\text{year}^{-1}, \quad k_R = 500000\,.$$

The mean and standard deviation are calculated as:

$$\mu_r = 0.000678, \quad \sigma_r = 0.2700.$$

The Fig. 3 shows the profit of IBM company over 75-80 years. Around this time IBM suffered huge losses. Its effect is seen in the loss of human resources around the same period in Figure 2. The net annual earnings (the profit P) of IBM grow steadily up to 75-80 years which is also the same timescale as the above two graphs.

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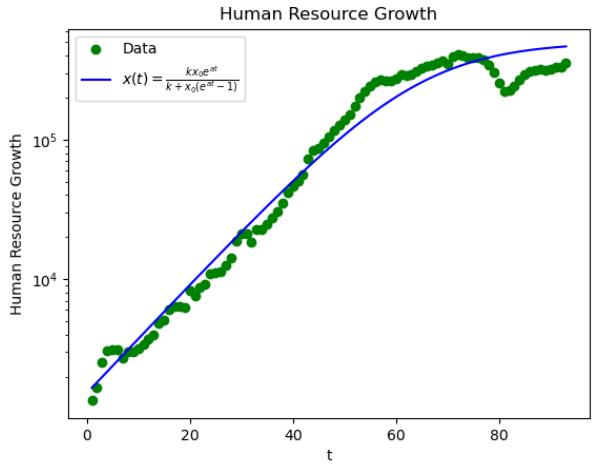

FIG. 2: The dotted graph is the human resource value from data. The Line graph comes after plotting human resource count versus time using Equation 2

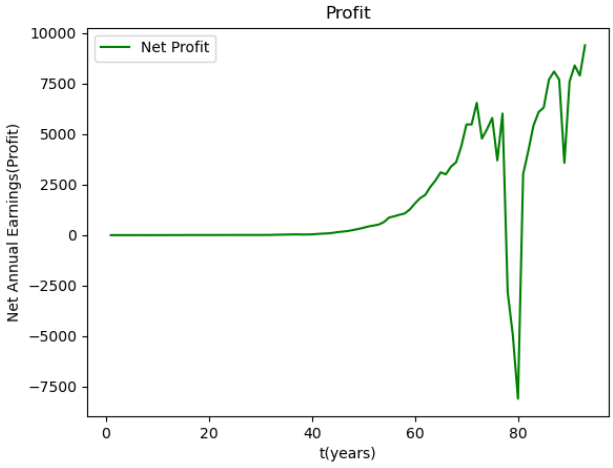

FIG. 3: Net annual earnings (the profit P) of IBM (in million US dollars) grow steadily till about 75-80 years (the early years of the 1990s).

The Fig. 4 shows the correlation of human resource and the revenue over the timescale of 75-80 years. This plot has come after using Equation 3. The H-R phase solutions are transformed to a compact power-law form as Eq 3.

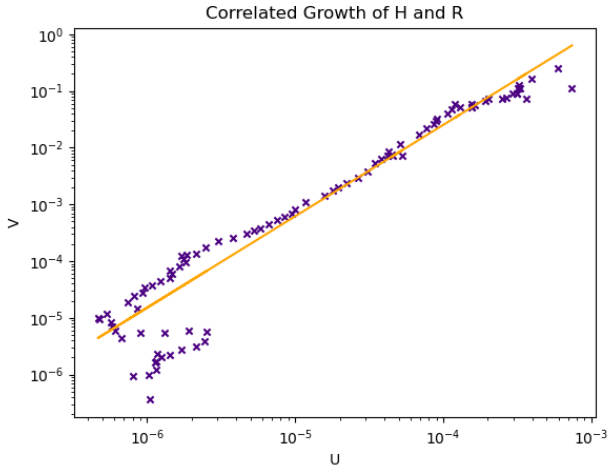

FIG. 4: Correlation between H and R. The log-log plot fits the power law ver well except the lower cusp.

III. CONCLUSIONS

- The analysis employed the logistic equation to model IBM's revenue and workforce growth, revealing a saturation point. It indicates that industrial growth will level off within 100 years, supported by current data showing year-by-year revenue decreasing.**Wiki**
- IBM's 1994 financial losses (Fig. 3) prompted significant workforce cuts in the similar timescale, likely tied to the bond and currency crises affecting the U.S., Japan, and other economies in that period.
- Another key observation is that Human resources and Revenue are highly correlated. When a company generates enough revenue, it can invest in maintaining a skilled workforce. This team boosts productivity and innovation, fueling further revenue growth creating a cycle where financial success and human resources each sustain the other's growth.

[1] Arnab K. Ray, Logistic modelling of economic dynamics, DA-IICT (2023).