

Technological Forecasting supported by Logistic Growth Curve analysis: software tool for increased usability

1. Introduction

Logistic Growth Curve (LGC) was developed by Pierre Francois Verhulst to analyze the population growth of different species. LGC can be applied in different areas such as biological, social, economic and technological (Modis, 2000). This white paper presents a general description of LGC in the context of technological forecasting, also including a brief description of a software prototype, developed to support the partners of the FORMAT project with the general aim to improve LGC ease of use.

2. Logistic Growth Curves

In technological forecasting context, LGC allows analysts to extrapolate data into the future. The main objective of this kind of analysis is to identify the different stages of growth such as initial, maturity and decline (Marchetti, 1980) (Figure 1). The results of a LGC analysis enable decision makers to be alert and/or aware of possible future changes, moreover prepare their future strategies. Figure 1 presents an example of the results of LGC analysis.

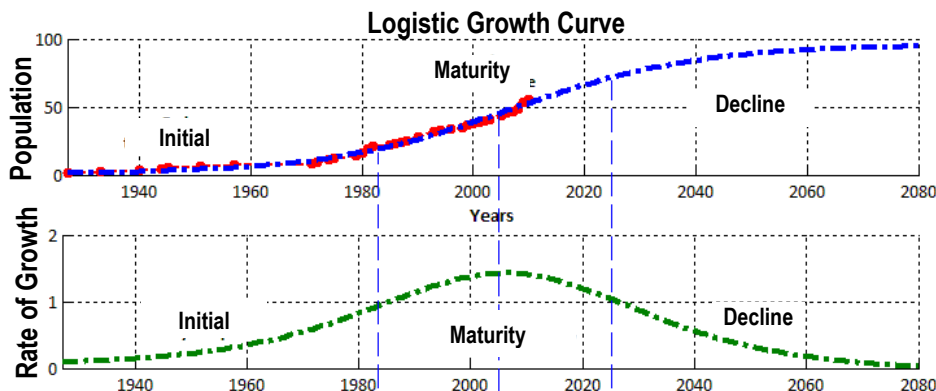


Figure 1: Different technological stages using Logistic Growth Curve; Upper figure presents LGC extrapolation and lower graph presents the related Rate of Growth.

To perform LGC analysis two input variables are needed:

- ❖ Growth variable: this variable describes the growth of a certain population.
- ❖ Time variable: this variable defines the time perspective of the growth.

There are many different logistic equations in literature (Fekedulegn et al. 1999): Meyer’s equation is one of the most frequently used to support technological forecasting analysis (Meyer, 1994). One reason of the successful of Meyer’s equation is due the meaning of its parameters (Equation 1).

$$N(t) = \frac{K}{1 + e^{\left[\frac{-\log(81)}{\Delta t}(t-t_m)\right]}}$$

Equation 1: Logistic Growth Curve (Meyer , 1994).

The parameters obtained from Meyer's equation are easy to understand compared with other equations, the description of these parameters is given below:

- ❖ Saturation Capacity (K): maximum number of species that an ecosystem can support.
- ❖ Time difference (Δt): time period in which LGC reaches a specific amount of his capacity (between 10 and 90%)
- ❖ Middle time parameter(t_m): Time in which the LGC reaches half of the population growth.

The results of the LGC based on Meyer's equation are graphically presented in figure 2. On the one hand, figure 2 shows the parameters that can be obtained with LGC analysis as K , Δt and t_m . On the other hand, figure 2 also shows the "forecasted period" or forecast time according to the obtained parameters. This forecasted period has to be used by decision makers to prepare their strategies, activities and/or decisions.

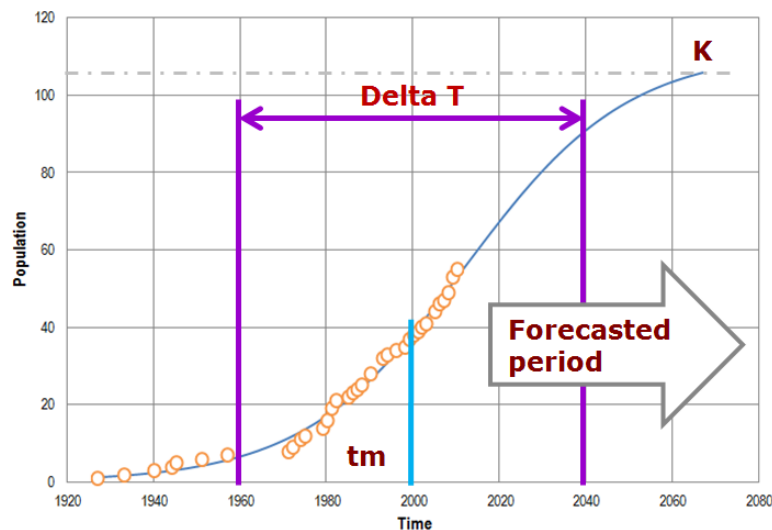


Figure2: Graphical representation of Logistic Growth Curve based on Meyer's equation and their parameters.

3. Logistic Growth Curve: Software Tools

Logistic Growth Curve software allows users apply LGC analysis in a faster and easier way. Currently there are two main software applications created with the specific scope of developing forecasting analyses based on LGC; both software use Meyer's equation in their analysis. The first one is Loglet Lab: this software was created by Yung, Meyer and Asubel (1999). The second one is Logistic Substitution Model, created by the International Institute for Applied System Analysis (IIASA). These tools allow to perform LGC analyses, but the quality of the regressions largely depends on the expertise of the users. In fact, beginners (but also several practitioners) encounter difficulties with the assessment of the reliability of the results, both because of the limited number of statistical indexes related to the quality of the regressions and due to the lack of recommendations about how to interpret the results.

Another critical issue for the application of LGC analysis within a Technology Forecasting activity is the identification of appropriate variables that at the same time must be: (i) meaningful for the specific context under study; (ii) characterized by a logistic growth of their cumulative values; (iii) with time series available from the specific industry sector.

In such a context, the FORMAT project revealed the necessity to develop a new software tool, usable both for practitioners and beginners, with detailed statistical information about the quality of the regression and general recommendations about how to interpret the results according to assumptions made in the preparation of the

analysis. The software is conceived as part of the overall FORMAT methodology, so as to combine quantitative and qualitative information for the production of the forecast.

The software, despite still at a prototype stage allows to perform regressions with LGC, Rate of Growth and Bi-LGC (comparison or decomposition of two LGC), also in the form of a Fisher-Pry transform. Figure 3 shows the main window of the application including: data table, control panel, popup menu to select different analysis and error graphs. Statistic information about the regression includes standard deviation, p-value and confidence interval for each parameter of the regressions. Moreover, information about the quality of the regression is provided also through Bayesian Information Criterion, Akaike Information Criterion and Root Mean Square Error (RMSE). Of course, all these indexes are explained to the user with implications in the context of technology forecasting in order to facilitate the interpretation of the results.

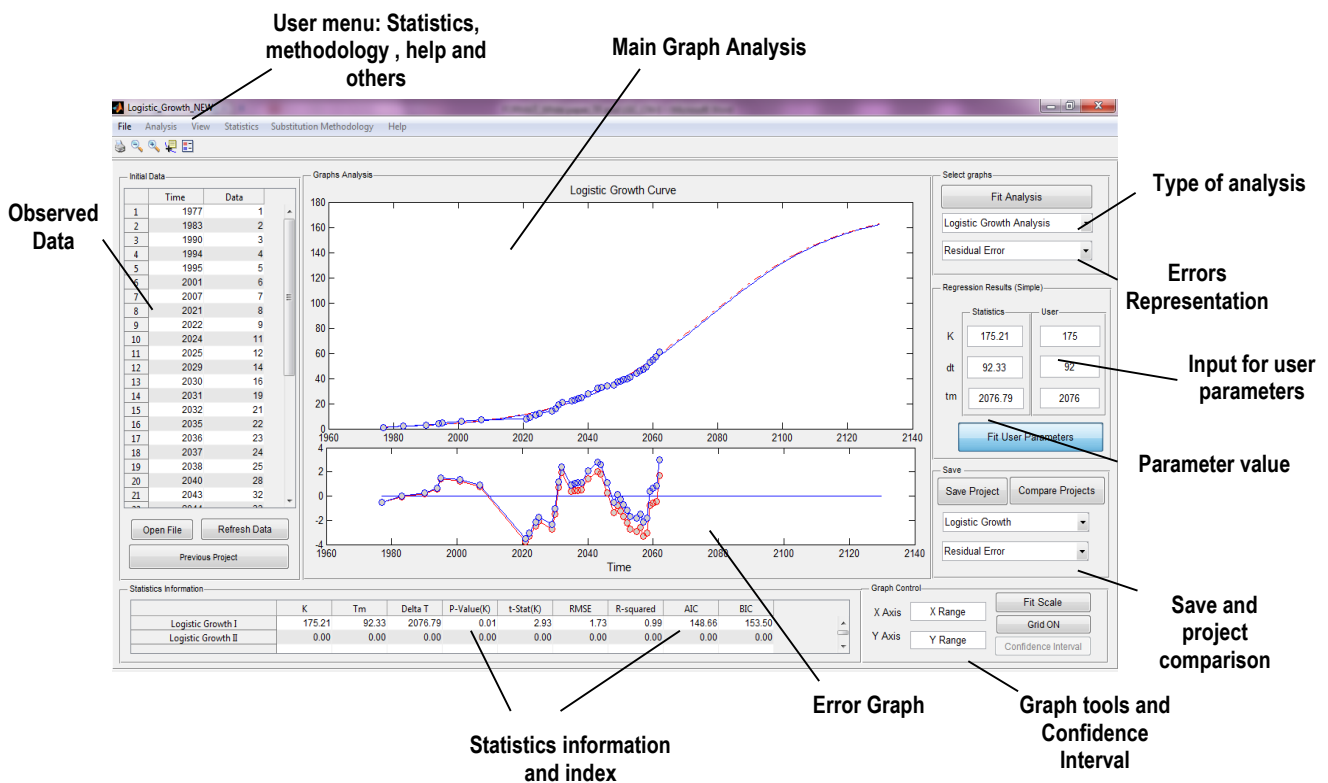


Figure 3: Software prototype for Logistic Growth Curve analysis.

4. Conclusion and further Works.

The aim of the FORMAT LGC software tool is to support decision makers in performing a technology forecasting analysis based on Logistic Growth Curve. The current software prototype is under testing within the case studies proposed by the industrial partners of the project.

Beyond the tuning of the application according to the feedback of the current experimental campaign, further developments are focused on the definition of a step-by-step procedure to guide the user in the application of this kind of analysis.

5. References

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