CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S1421

Project Title

On Mathematical Growth Models: Representing Accurate, Meaningful, and Continuous Change with Dynamic Limiting Factors

Abstract

Objectives/Goals

Growth models have been quintessential in mainly economic and biological applications, but are also practical and could be explored more for medicine, chemistry, industry, and sociology. Those models however, are only applicable to constant or closed systems. The objective is to derive more accurate growth models that account for changes in limiting factors, made manifest by a dynamic carrying capacity, with whatever pattern might be most appropriate.

Methods/Materials

Basic forms of the logistic and exponential growth models were used as the basis of the growth models. The logistic was then built upon using other mathematical functions; basic forms of constant, step, linear, quadratic, trigonometric, series, sequences, and sigmoidal functions. Arithmetic and calculus based methods were also utilized, such as limits, differentiation, integration, first and second derivative test, etc. Data was also collected from published and public information to ensure real-world practicality of the new growth models produced. The data was compiled using a TI-84 silver edition graphing calculator and a Microsoft excel model.

Results

The three major applications provided with data points were a model of Japanese population growth (n=140, sigmoidal), cumulative oil future sales (n=56, phase-wise), and Lynx-Hare (predator-prey) population relationship (n=60, sinusoidal). All models were projected against the corresponding set of data points, and the error never exceeded 5%. Other theoretical models were derived to match estimated growth in sales with seasonality, diffusion of innovation with induced and planned obsolescence, tumor growth, symbiotic biological relationships, and more.

Conclusions/Discussion

Growth models with stagnate carrying capacity are unrealistic and can only show short-term growth. These new models with dynamic limiting factors can measure and predict growth accurately, long-term. Human population continues to expand the resources available and decreases the effects of limiting factors, which require dynamic models. The projected sales of a product based upon seasonality or a diffusion of innovation make these models practical. Application branch into medicine, chemistry, industry, and most likely, nearly everything that changes. Everything is growing and decaying, so a major step in understanding the world is to look first to how things grow and change.

Summary Statement

Over several months, I derived a novel mathematic growth model to better represent growth accounting for dynamic limiting factors over a continuous and differentiable function.

Help Received

None