Modeling of the Population Growth Curve

Zongyi Hu

December 4, 2020

Abstract

The sigmoidal curve has extensive application in the real world. With some complex system lacking a specific model, it can be used[1]. In ecology, specifically, population growth is a typical application. Most cases, the curve will have successive lag, growth, and asymptotic phases. After it gets the asymptote phase which population size has gotten the K value, some data's population size will drop, which circumstance will not be discussed in the article. In this project, I used computational based methods analysed three models: polynomial(cubic) model, logistic model and Gompertz model. After fitting 285 data sets, the result shows that the Gompertz model performs better than the other two models. +(Succinct discussion).

1 Introduction

This article analysed the population (log)size against time. Addressed the basic steps choosing the Cubic, Logistic and Gompertz models[2], basically by comparing AIC and R^2.

2 Methods

2.1 Computing tools

Computational based model fitting project: git, R, python...

2.2 Data

285 data set were analysed in this article

2.3 Models

The polynomial, logistic and Gompertz model were chose to fit the data, and comparing the model by calculating AIC and R^2. To capture the lag phase, more complicated growth models, the Gompertz model[2], has been chosen in this project, which is asymmetrical compared with the logistic model. The equation of the models I used will be listed bellow: (which t is time, N_t and N_0 are the population size at time t and time 0 respectively, N_max is plateau population size, r is growth rate)

1) Polynomial Model
$$N_t = a + bt + ct^2 + dt^3$$

2) Logistic Model
$$N_t = \frac{N_0 K e^{rt}}{K + N_0(e^{rt} - 1)}$$

3) Gompertz Model
$$N_t = N_0 + (N_{max} - N_0)e^{-e^{r_{max} exp(1) \frac{t_{lag} - t}{(N_{max} - N_0) log(10)} + 1}}$$

2.4 Model fitting

3 Results

The Gompertz model performs better than the other two models in this project

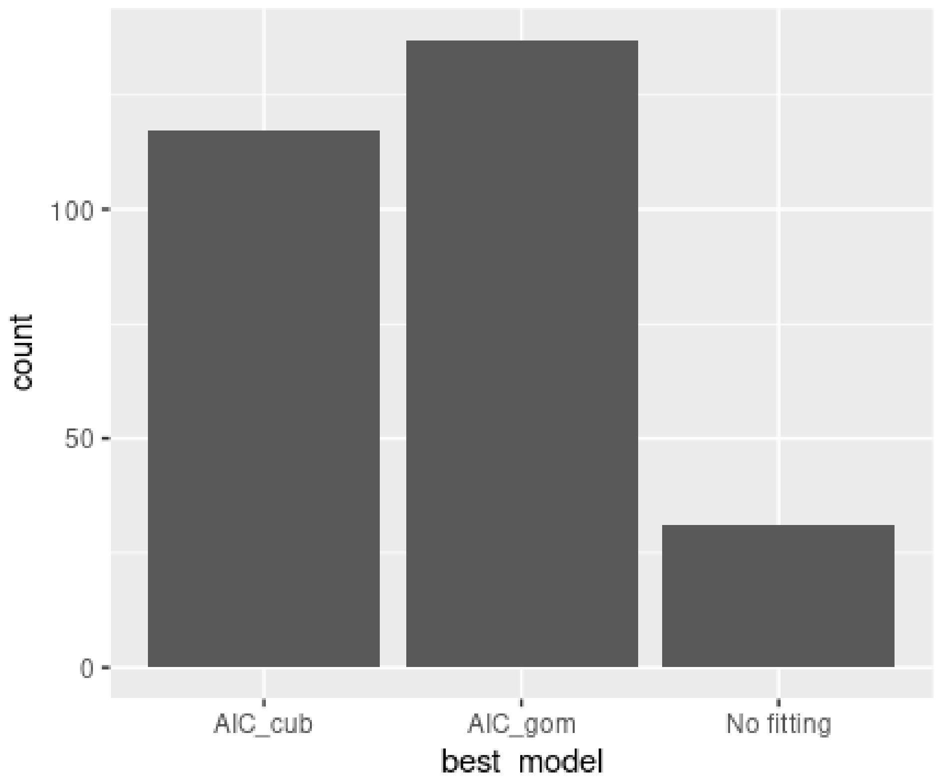

Figure 1: The frequency of the best model

4 Discussion

References

[1] Mark N Gibbs and David JC MacKay. Variational gaussian process classifiers. *IEEE Transactions on Neural Networks*, 11(6):1458–1464, 2000.

[2] MH Zwietering, Il Jongenburger, FM Rombouts, and KJAEM Van't Riet. Modeling of the bacterial growth curve. *Applied and environmental microbiology*, 56(6):1875–1881, 1990.