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Strehler-Mildvan correlation is a degenerate manifold of Gompertz fit

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Abstract

Gompertz empirical law of mortality is often used in practical research to parametrize survival fraction as a function of age with the help of just two quantities: the Initial Mortality Rate (IMR) and the Gompertz exponent, inversely proportional to the Mortality Rate Doubling Time (MRDT). The IMR is often found to be inversely related to the Gompertz exponent, which is the dependence commonly referred to as Strehler-Mildvan (SM) correlation. In this paper, we address fundamental uncertainties of the Gompertz parameters inference from experimental Kaplan-Meier plots and show, that a least squares fit often leads to an ill-defined non-linear optimization problem, which is extremely sensitive to sampling errors and the smallest systematic demographic variations. Therefore, an analysis of consequent repeats of the same experiments in the same biological conditions yields the whole degenerate manifold of possible Gompertz parameters. We find that whenever the average lifespan of species greatly exceeds MRDT, small random variations in the survival records produce large deviations in the identified Gompertz parameters along the line, corresponding to the set of all possible IMR and MRDT values, roughly compatible with the properly determined value of average lifespan in experiment. The best fit parameters in this case turn out to be related by a form of SM correlation. Therefore, we have to conclude that the combined property, such as the average lifespan in the group, rather than IMR and MRDT values separately, may often only be reliably determined via experiments, even in a perfectly homogeneous animal cohort due to its finite size and/or low age-sampling frequency, typical for modern high-throughput settings. We support our findings with careful analysis of experimental survival records obtained in cohorts of *C. elegans* of different sizes, in control groups and under the influence of experimental therapies

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