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1. Most Downloaded

Strehler-Mildvan correlation is a degenerate manifold of Gompertz fit

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 or environmental conditions. We argue that since, SM correlation may show up as a consequence of the fitting degeneracy, its appearance is not limited to homogeneous cohorts. In fact, the problem persists even beyond the simple Gompertz mortality law. We show that the same degeneracy occurs exactly in the same way, if a more advanced Gompertz-Makeham aging model is employed to improve the modeling. We explain how SM type of relation between the demographic parameters may still be observed even in extremely large cohorts with immense statistical power, such as in human census datasets, provided that systematic historical changes are weak in nature and lead to a gradual change in the mean lifespan.

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2. Recent Article

Seasonality can induce coexistence of multiple bet-hedging strategies in Dictyostelium discoideum via storage effect

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Abstract

The social amoeba *Dictyostelium discoideum* has been recently suggested as an example of bet-hedging in microbes. In the presence of resources, amoebae reproduce as unicellular organisms. Resource depletion, however, leads to a starvation phase in which the population splits between aggregators, which form a fruiting body made of a stalk and resistant spores, and non-aggregators, which remain as vegetative cells. Spores are favored when starvation periods are long, but vegetative cells can exploit resources in environments where food replenishes quickly. The investment in aggregators versus non-aggregators can therefore be understood as a bet-hedging strategy that evolves in response to stochastic starvation times. A genotype (or strategy) is defined by the balance between each type of cells. In this framework, if the ecological conditions on a patch are defined in terms of the mean starvation time (i.e. time between the onset of starvation and the arrival of a new food pulse), a single genotype dominates each environment, which is inconsistent with the huge genetic diversity observed in nature. Here we investigate whether seasonality, represented by a periodic, wet-dry alternation in the mean starvation times, allows the coexistence of several strategies in a single patch. We study this question in a non-spatial (well-mixed) setting in which different strains compete for a common pool of resources over a sequence of growth-starvation cycles. We find that seasonality induces a temporal storage effect that can promote the stable coexistence of multiple genotypes. Two conditions need to be met in our model. First, there has to be a temporal niche partitioning (two well-differentiated habitats within the year), which requires not only different mean starvation times between seasons but also low variance within each season. Second, each season's well-adapted strain has to grow and create a large enough population that permits its survival during the subsequent unfavorable season, which requires the number of growth-starvation cycles within each season to be sufficiently large. These conditions allow the coexistence of two bet-hedging strategies. Additional tradeoffs among life-history traits can expand the range of coexistence and increase the number of

coexisting strategies, contributing toward explaining the genetic diversity observed in *D. discoideum*. Although focused on this cellular slime mold, our results are general and may be easily extended to other microbes.

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3. Most Cited

The promise of Mechanical Turk: How online labor markets can help theorists run behavioral experiments

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Abstract

Combining evolutionary models with behavioral experiments can generate powerful insights into the evolution of human behavior. The emergence of online labor markets such as Amazon Mechanical Turk (AMT) allows theorists to conduct behavioral experiments very quickly and cheaply. The process occurs entirely over the computer, and the experience is quite similar to performing a set of computer simulations. Thus AMT opens the world of experimentation to evolutionary theorists. In this paper, I review previous work combining theory and experiments, and I introduce online labor markets as a tool for behavioral experimentation. I review numerous replication studies indicating that AMT data is reliable. I also present two new experiments on the reliability of self-reported demographics. In the first, I use IP address logging to verify AMT subjects' self-reported country of residence, and find that 97% of responses are accurate. In the second, I compare the consistency of a range of demographic variables reported by the same subjects across two different studies, and find between 81% and 98% agreement, depending on the variable. Finally, I discuss limitations of AMT and point out potential pitfalls. I hope this paper will encourage evolutionary modelers to enter the world of experimentation, and help to strengthen the bond between theoretical and empirical analyses of the evolution of human behavior.

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4. Open Access Article

مقاله ی زیر بصورت کامل قابل دریافت و درصورت تمایل قابل ترجمه می باشد

A necessary condition for dispersal driven growth of populations with discrete patch dynamics

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Abstract

We revisit the question of when can dispersal-induced coupling between discrete sink populations cause overall population growth? Such a phenomenon is called dispersal driven growth and provides a simple explanation of how dispersal can allow populations to persist across discrete, spatially heterogeneous, environments even when individual patches are adverse or unfavourable. For two classes of mathematical models, one linear and one non-linear, we provide necessary conditions for dispersal driven growth in terms of the non-existence of a common linear Lyapunov function, which we describe. Our approach draws heavily upon the underlying positive dynamical systems structure. Our results apply to both discrete- and continuous-time models. The theory is illustrated with examples and both biological and mathematical conclusions are drawn.

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