ARNOLD MITNITSKI, Dalhousie University

System biology mechanics of aging: A stochastic dynamics model

The aging process can be represented as a process of accumulation of various health related deficits (broadly defined that include signs, symptoms, illnesses, functional limitations, laboratory abnormalities of the physiological indices, etc.) over the life course. Such data (essentially multidimensional) can be integrated into a single state variable representing the health status of the individual (a fitness/frailty index). The individual trajectories of the index are highly dynamic and show complex stochastic behavior. We present an empirical evidence of that the health trajectories of the index show the Markov property (quickly forgetting the past). Next we consider a stochastic model which allows accurately characterize the major age related patterns in deficit trajectories. This model is represented by the system of the Kolmogorov equations (either partial or different-differential) with the time dependent (i.e., age dependent) coefficients. We consider an important case when the variables can be divided by fast and slow representing two general processes: the fast process of damage/repair and the slow process of changes in the parameters representing repair (i.e. recovery) caused by the environmental damages. For the system of different-differential equations, the analytical solutions can be found under the assumption of quasi-stationarity. The statistical distributions of the quasi-stationary solutions closely resemble the patterns observed in the large-scale longitudinal databases worldwide previously considered as empirical facts and now derived from a theoretical model. The latter sheds light to the general system biological mechanisms underlying complex process of aging.