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Aging and Retirement

The Mathematical Mechanism of Biological Aging

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Abstract

Despite aging being a universal and ever-present biological phenomenon, describing this aging mechanism in accurate mathematical terms — in particular, how to model the aging pattern and quantify the aging rate — has been an unsolved challenge for centuries. In this paper, we propose a class of Coxian-type Markovian models which can provide a quantitative description of the well-known aging characteristics – the genetically determined, progressive and essentially irreversible process. Our model has a unique structure, including a constant transition rate for the aging process, and a functional form for the relationship between aging and death with a shape parameter to capture the biologically deteriorating effect due to aging. The force of moving from one state to another in the Markovian process indicates the intrinsic biological aging force. The associated increasing exiting rate captures the external force of stress due to mortality risk on a living organism.

The idea of the paper is developed from Lin and Liu (2007). A big difference is that, in this paper, our model uses a functional form for model parameters, which allows a parsimonious yet flexible representation for various aging patterns. Our proposed mathematical framework can be used to classify the aging pattern and the key parameters of the model can be used to measure and compare how human aging evolves over time and across populations.

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