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Statistical Inference in Branching Processes and Applications in Cancer Recurrence

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A numerical approximation method and related algorithm for solving the integral equations of the following type

$$\overline{F}(t) = 1 - G(t) + \int_0^t h(uq + (1-u)\overline{F}(t-v))dG(v),$$

in the class of probability density functions (p.d.f.) $F(t)$ and $\overline{F}(t) = 1-F(t)$, with initial condition $\overline{F}(0) = 1$, where $h(s)$ is given probability generating function, $0 < u < 1$ and G(t) is also given p.d.f.

This way we can estimate the distribution of the waiting time T to cancer recurrence, satisfying these equations and the hazard function $g(t)$ representing the probability density for the appearance of a mutant cell that will possibly start a path of indefinite survival of mutant cell population, as well, given that it has not appeared yet. From the particular distribution of T we can also calculate the conditional probability that a person will not develop aggressive cancer if he has not developed it yet $P(T = \infty | T > t)$.

Numerical studies demonstrate that the proposed approximation algorithm reveals the substantial difference of the results in discrete-time setting. In addition, to study the time needed for the mutant cell population to reach high levels a simulation algorithm for continuous multi-type decomposable branching process is proposed. Two different computational approaches together with the theoretical studies might be applied to different kinds of cancer and their proper treatment.

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