The Entropy Approach to Adjusting the Life Table, Case Study: Iran's Life Table

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Extended Abstract

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Introduction

Survival analysis, in particular, survival distribution estimation, are essential issues in the statistical sciences. Various parametric and nonparametric methods have been proposed to estimate the survival distribution. In this respect, the theoretical survival distributions are specified and their parameters are obtained by methods such as the maximum likelihood estimator and the Bayesian estimator and we can mention nonparametric methods such as the Kaplan-Meier method, Cox regression and the life table. Also, another critical issue in survival analysis, especially in actuarial and biostatistics, is the graduation of data for which smoothness and goodness of fit are two fundamental requirements.

On the other hand, in the probability theory, there are two basic approaches to estimate probability distributions by using the concept of entropy: Maximum Entropy Principle (ME) and Minimum Kullback-Leibler Principle (MKL) or Minimum Cross Entropy Principle.

Material and methods

In this paper, we examine the approach of the two optimization models, ME and MKL, to estimate survival and probability distributions, especially for the classification of the data. In these studies, in addition to investigating parametric models, in order to achieve a compromise between the conditions of smoothness and goodness of fit, we apply a new entropy optimization model by defining an objective function combined from both of the two above principles and adjusting a coefficient that is used to ensure the degree of goodness of fitting and smoothing the estimates, as well as to show their priority in the classification of the data. We use this model to estimate the mortality probability distribution, particularly the column related to the mortality probability of a certain age (q_x) in the life table. Finally, with the help of this method, we set the life table for Iranian women and men in 2011. It should be noted that the calculations were performed using fsolve command in MATLAB software.

Results and discussion

As mentioned, in this article, we have adjusted the life expectancy table for men and women in Iran in the year 2011 using the MEMKL method. The results of using the above method were set up in a table. This table illustrates that in most cases, for a fixed number of constraints, the value of G the model increases from $\mu = 0$ to $\mu = 0.5$ and then decreases from $\mu = 0.5$ to $\mu = 1$. Also, the models are highly dependent on the value of the coefficient of modification (μ), so it is best to experiment empirically. Also, when $\mu = 0$, when the goodness of fit is of paramount importance against model smoothness, values are much smaller than at other times. Finally,

based on the chosen model, we set the Iranian men's and women's life tables for the year 2011 into one table and then plot the mortality trend of the specified ages in a graph.

Conclusion

The results showed that the estimated values of the mortality probability of men and women in Iran are very close to each other and both have an increasing trend and at the age of 75 to 80, the probability of death among women is higher than men. In general, it can be concluded that the proposed method is efficient and the coefficient of modification (μ) plays a vital role in exchanging smoothness and goodness of fit, which gives flexibility in data classification.

Keywords: Survival analysis, Information theory, Principle of maximum entropy, Principle of minimum Kullback-Liebler, Life table.

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