August 20, 2022

Dear Editor of Scientific Reports, please find enclosed the manuscript entitled:

"Enhancing diagnostic of stochastic mortality models leveraging contrast trees. An application on Italian data",

co-authored by S.Levantesi, M.Lizzi, and A. Nigri, that we would like to submit for consideration for publication in *Scientific Reports*.

The rise in longevity in the twentieth century has led to a growing interest in modeling mortality, and new advanced techniques such as machine learning have recently joined more traditional models, such as the Lee-Carter or the Age Period Cohort.

However, the performances of these models, in terms of fitting to the observed data, are difficult to compare in a unified framework. The goodness-of-fit measures summarizing the discrepancy between the estimates from the model and the observed values are different for traditional mortality models and machine learning. We, therefore, employ a new technique, Contrast Trees, which, leveraging on decision trees, provide a general approach for evaluating the quality of fit of different kinds of models by detecting the regions in the input space where models work poorly.

Specifically, using Italian mortality data, we provide an application of the method proposed by Friedman (2020), namely Contrast Trees, for evaluating the accuracy of the mortality estimates given by different models that are not treatable with standard validation methods (e.g. those based on the likelihood function). The key significance of the Contrast Trees in mortality evaluation is the supply of a unified approach allowing for assessing and comparing the accuracy of both standard mortality models and machine learning algorithms involved in mortality estimates. Moreover, in addition to evaluating the accuracy of the models, the Contrast Trees enable improving the performance of the models through a boosting procedure that reduces inaccuracies.

We sincerely hope that you will find our work of interest for the readers of *Scientific Reports* and that it may fit the purpose and the scope of this esteemed Journal.

Thank you for your consideration.
Sincerely,

Andrea Nigri
(on behalf of all co-authors)
Department of Social and Political Sciences,
Bocconi University, Milan, Italy
andrea.nigri@unibocconi.it