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Dependence Measurement for Ordinal-Continuous Data

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Editorial Note

In this paper, an extension of a recent Monotonic Dependence Coefficient (MDC) has been introduced in order to deal with an ordinal dependent and a continuous independent variable. Through our proposal, the ordinal dependent variable, expressed according to subjective categories based on the Likert scale, is transformed into a variable which is measurable on a continuous scale. The encounter with phenomena linked to each other through dependency relationships takes place in several contexts, especially in Biology and Medicine. As known, statistical literature provides dependence coefficients whose employment strongly depends on the nature of the variables involved into the analysis. On the one hand, if the two variables are quantitative, the most commonly used measure is the Pearson-r correlation coefficient. On the other hand, if the two variables are ordinal, the most appropriate measures are the Spearman-rS and Kendall-τ correlation coefficients. One of the main problems in the dependence relationship measurement arises if the two variables take different nature, that is one variable is continuous and the other variable is ordinal and expressed though a Likert scale. This type of variables frequently appears in the research fields addressed to the medical diagnosis. As an example, suppose to evaluate the risk (low, medium, high) of a disease with respect to some blood parameter values which represent the risk factors. Due to the mixed nature of the variables, loss of information occurs if resorting to the Pearson's, Spearman's and Kendall's correlation coefficients. In this paper we propose a novel dependence coefficient suitable in catching the monotonic dependence relationships between an ordinal target variable and a continuous predictor. It is worth noting that our contribution is the result of the extension of a recent dependence measure (named Monotonic Dependence Coefficient-MDC) which was originally introduced by Ferrari & Raffinetti with the aim of assessing the bivariate monotonic dependence relationships in the cases of continuous variables or a continuous dependent variable and an ordinal independent variable

The same coefficient was further developed by Raffinetti & Aimar for the grouped-ordinal data scenario. In general, given an independent and a dependent variable, the MDC coefficient is computed by considering the dependent variable values reordered according to the ranks associated with the values of the independent variable.

Contrary to the Spearman's and Kendall's correlation coefficients, the rank tool is not directly involved into the computation of the MDC index allowing to preserve the data raw metric. In order to cover the case of an ordinal dependent variable and a continuous independent variable, an ad-hoc adjustment is here suggested.

In this paper a new tool for measuring monotonic dependence relationships between an ordinal dependent and continuous independent variable is presented. Typically, when one of the two involved variables takes ordinal nature, the Pearson's correlation coefficient may not be successfully applied since data are not specified according to a metric scale. Moreover, the subjectivity in the use of the Likert scale may lead to biased results. Vice versa, the employment of the Spearman's and Kendall's correlation coefficients neglects the continuous nature of one of the two variables, reducing its continuous information into its ordinal information.

The MDC adj coefficient overcomes the above drawbacks by replacing the ordinal dependent variable integer values (categories) with the average of the continuous independent variable values associated with a specific ordinal variable category. The adequacy of the proposed adjustment is also validated by the Monte Carlo simulation results.

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