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A generic solution to testing model fit in piecewise path models with correlated errors given non-normality and non-linearity

Path modelling has become an indispensable tool for ecologists to understand and test hypotheses about the causal dependency between measured variables. Classical path modelling, involving only observed variables, can also incorporate so-called correlated errors, which are associations between pairs of observed variables resulting from a common latent cause. Classical path modelling assumes independent measurements, linear relationships and normally distributed variables. However, ecological data is oftentimes not normally distributed, non-linear, and clustered in time or space, limiting the application and reliability of inferences made from classical path analysis. These assumptions can be relaxed for path models that do not include correlated errors via d-sep tests by decomposing the joint probability of the variables in the path model into the product of univariate distributions conditional on their causes. However, for variables having correlated errors such a decomposition is not possible via d-separation. Our contribution, which uses m-separation of a mixed acyclic graph, is twofold. First, we provide a decomposition of observed variables of the causal model into smaller, independent sets. Second, we use copulas to model the correlated errors between non-normally distributed variables. We illustrate the technique with a case study and discuss the advantages of this technique. One major advantage of this technique is that model selection techniques based on maximum likelihood, such as AIC, can be used to select among competing models.