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Stacking Evidence across tests in R&D

CQM is a consultancy company with over four decades of experience in industrial R&D projects. One of its long-standing customers has developed consumer products for many years and seeks to reduce the test effort and improve decision making in development projects for a certain class of products. In these development projects, different types of tests are performed on prototype designs, from A (cheap) to D (expensive). The relatively cheap tests A, B assess the prototype early on in the projects, and the more expensive tests C, D involve a trained panel of assessors for confirmation. CQM co-develops with the R&D department a method for stacking evidence, which allows predictions of outcomes of expensive tests (C or D) conditional on observed test results, typically the cheaper ones. These predictions help in deciding to stop the project or form a prior in a Bayesian analysis of future test D. As a consequence, the approach is expected to reduce overall costs for the expensive tests, and has motivated substantial investment in its development.
The model is based on historical development projects, where typically the 4-vectors of test results (A,B,C,D) have missing entries in historical dataset. The approach uses Bayesian inference for a multivariate model of test results (A,B,C,D), capturing conditional dependencies as in Bayesian networks, and incorporating measurement models akin to structural equation models. Strong priors based on expert opinion are needed to complement scarce data, but the multivariate nature poses challenges. In addition to the technical modelling aspects, I will discuss practical learnings from employing Bayesian analysis in an R&D organisation, including communication, prior specification, and the gradual development of statistical intuition.

Special/ Invited session

Classification

Both methodology and application

Keywords

Bayesian statistics, Bayesian network, SEM

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