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Maximizing the Accuracy of Probit Models via UniODA

Barbara M. Yarnold, J.D., Ph.D. and Paul R. Yarnold, Ph.D.
Optimal Data Analysis, LLC

Paralleling the procedure used to maximize ESS of linear models derived using logistic regression analysis or Fisher's discriminant analysis, univariate optimal discriminant analysis (UniODA) is applied to the predicted response function values provided by a model derived by probit analysis (PA), and returns an adjusted decision criterion for making classification decisions. ESS obtains its theoretical maximum value with this adjusted decision criterion, and the ability of the PA model to return accurate classifications is optimized. UniODA-refinement of a PA model is illustrated using an example involving political science analysis of federal courts.

Probit analysis (PA) has gained in popularity as research in political science seeks increasingly accurate models of court decision-making.[1-8] For applications having a binary class variable and at two or more attributes, PA allows assessment of the independent relationship between class variable and attribute. Parameter estimates are obtained by maximum-likelihood, and indicate the amount of change in the cumulative normal probability function that is associated with a one-unit change in the attribute value. Goodness-of-fit of PA models was traditionally assessed using R^2 and chi-square, but this was criticized.[9] The supreme criterion for all classification models is their ability to make accurate predictions. PA does not explicitly maximize classification accuracy, but effect strength for sensitivity (ESS) yielded by PA models may be maximized by optimizing the models decision-making criterion.[10,11] This note illustrates the use of UniODA-refinement to optimize a model derived using PA.

Federal Court Decisions in Asylum-Related Appeals

To illustrate this method we consider the asylum-related appeals to the federal courts covering the period of 1980-1987, constituting 137 cases having complete data. The class variable indicated whether aliens won (N=59) or lost (N=78) their appeal. Six binary attributes used in PA included whether any organizations were involved in the appeal; the alien was from a country hostile to the USA; the alien was from Europe; the court was located in the Western USA; a high percentage of the judges involved in the appeal were appointed by a Democratic President; and whether there was a high level of immigrant-flow into the circuit. The resulting PA model correctly predicted 71.2% of the wins and 55.1% of losses, resulting in ESS=26.4.

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UniODA was then used to optimize the model: the PA model was first used to obtain *Y** for every observation, and then UniODA was conducted on those *Y** using the original class variable coding.[14] The adjusted decision criterion for the PA model was: if *Y**>0.025 predict class=1 (win); otherwise predict class=0 (loss). The optimized PA model correctly predicted 64.4% of the wins and 71.8% of losses, yielding ESS=36.2, representing a 37% improvement in this index relative to the non-refined model.

Discussion

The objective of this note was to illustrate how UniODA-refinement can improve classification performance obtained by a model derived by PA. The example demonstrated a substantial increase in the level of training accuracy (ESS) achieved by the model, a finding which is common when the decision criteria of suboptimal models are optimized via UniODA-refinement.

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Author Notes

Mail correspondence to the authors at: Optimal Data Analysis, 1220 Rosecrans St., Suite 330, San Diego, CA 92106. Send E-mail to: Journal@OptimalDataAnalysis.com.