INSTANCE-BASED REASONING FOR SEVERITY-OF-ILLNESS SCORES

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Introduction

Severity-of-illness scores are used for a variety of clinical and management tasks. Two scoring systems in Intensive Care are the Acute Physiology and Chronic Health Evaluation (APACHE) II scoring system [1] and the Simplified Acute Physiology Score (SAPS) II [2]. Both systems summarize a patient's condition based on physiologic parameters from the first 24h of stay at the Intensive Care Unit (ICU). The scores can be converted into an estimated probability of hospital death using an associated *logistic regression* (LR) model. This has two drawbacks. First, the LR model builds on various assumptions that are questionable for most clinical scoring systems. Second, the parameters in the model are estimated from a specific study population. When applied to a different population, these parameters may lead to unreliable predictions.
Instance-based reasoning (IBR) is a prediction method from Artificial Intelligence that overcomes these drawbacks. This method estimates the probability of death based on the outcomes of patients that closely resemble the new patient. We studied the use of IBR as an alternative to LR in scoring-based prognosis.

Methods

Data were provided by the Dutch National Intensive Care Evaluation (NICE) register [3], which contains information on admissions to Dutch ICUs. The first dataset (1559 admissions from seven hospitals) was used for development of IBR estimators; the second dataset (1868 admissions from three hospitals) was used to validate them.
We developed various IBR estimators, based on different (combinations of) predictors, e.g. SAPS II score, APACHE II score, APACHE II score + diagnosis category etc. In total, eight IBR estimators were developed. All IBR estimators were constructed with an extension to the kernel-weighted k-*nearest neighbor* (NN) algorithm. In contrast to most *k*-NN algorithms, in our algorithm the number of neighbors is determined by the density of the neighborhood. In sparse areas of the instance space, more neighbors are used. For details of the algorithm, we refer to [4].

Results

The performance of the IBR estimators was measured by the Area Under the ROC curve (AUC). The AUC for the IBR estimator based on the APACHE II score was 0.784 on the validation dataset versus 0.804 for the APACHE II LR model. For the SAPS II score the LR model was only slightly better than the IBR estimator (AUC 0.867 vs. 0.877, differences have not been tested for significance). The performance of the SAPS II LR model could not be improved by any IBR estimator, whereas the APACHE II LR model was outperformed by some IBR estimators, e.g., adding diagnostic information to the APACHE II score yielded an AUC of 0.829 (versus 0.804 for the LR model). This is partly explained by the fact that for the SAPS II model the variable selection was based on statistical analysis and for the APACHE II model on expert consensus.

Conclusion

Instance-based reasoning can be a good alternative to the logistic regression model in scoring-based prognosis.

References

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