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Using PSI to Monitor Predictive Model Stability in the Database Marketing Industry

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ABSTRACT

Predictive models help streamline the decision-making process by improving the quality and consistency of decisions being made. In order to achieve maximum ongoing effectiveness and maintain profitability, front-end reports should be put in place to track model stability through the model's entire life cycle. Population Stability Index (PSI) applications can be developed to serve this important business need within the database marketing industry. Population Stability Indices are calculated and monitored using a methodology known as "Entropy" (Chern, 2006). The PSI application is a tool for creating front-end reports that track model stability. PSI is widely utilized as stability metric and has proven to be very effective. Moreover, by incorporating model metadata management within database marketing environments, PSI easily provides great flexibility in creating trending reports that can leverage dynamic model attribute metadata to simplify new model implementation and old model retirement. PSI helps proactively identify changes in data that may affect the performance of predictive models and allows for well-informed preemptive adjustments when necessary. PSI reporting allows for dynamic adjustments to marketing strategies and quick reactions to in-market changes thus providing a valuable edge against competitors who may have not implemented an effective application to measure model stability.

KEY WORDS

Population Stability Index (PSI), predictive model stability, PSI SAS® application, metadata management, entropy, front-end reports.

INTRODUCTION

In this paper, we focus on the value of establishing a systematic analytical reporting system with PSI as the stability metric to monitor predictive model stability in database marketing environments, and how to leverage the use of a metadata model to automate the process using SAS.

THE VALUE OF PSI

In the database marketing environment, predictive models are widely utilized to streamline decision making, in order to maximize direct marketing profitability. Building effective predictive models is key and monitoring the effectiveness and lifecycle of the predictive models on an ongoing basis is vital to the success of the business as well. That is, a monitoring system to track whether the models will perform consistently and as expected is critical for modelers and marketing program managers.

Model performance and stability can be affected by various factors such as changes in demand, creatives, data shifts in the scoring data, ETL errors, etc. From a practical standpoint, front-end reporting for monitoring model attribute stability is a necessity for facilitating informed decision making and the effective usage of predictive models (Mays, 1998).

THE VALUE OF MODEL INFORMATION MANAGEMENT

In the database marketing environment, it is common that multiple models are used simultaneously but implemented and updated at different points in time, for example, response models, conversion models, bias-reduction models, cross-sell models, risk models, etc. Over time, it can become difficult to track the campaign usage of the various models/versions. This creates a need for maintaining good documentation and model information management.

To fulfill these business needs in the database marketing environment, an application can be created that combines model information management and model attribute stability monitoring in a single modeling application. The idea is to incorporate the flexibility of a metadata-model and utilization of PSI as a metric for tracking data shifts. The advantage of this application is that first, it can effectively capture data shifts in the original model attributes, which

serves as early warning system to detect ETL errors or artificial changes in attribute definitions or formats from contributing data vendors; second, this application provides effective model information management. Third, it creates standardized canned front-end PSI reporting that is executed regularly. Combining these vital predictive model quality control processes provides a strong analytical tool for enhancing the utilization of predictive models in database marketing environments.

RATIONALE BEHIND PSI: MONITORING MODEL ATTRIBUTE STABILITY TO MONITOR MODEL STABILITY

Statistically, predictive models perform best in the model development sample. Model scores are computed using an equation in which the coefficients of independent variables are determined from the model development sample and measured score shifts are a result of shifts in those independent variables over time. In practice, model attributes have likely already shifted even prior to model implementation and will continue to shift as time goes on. Several questions are raised when model attributes and score distributions have shifted. Is the overall score shift positive or negative and has the predictive power of the model been compromised? As to this issue, further exploration of the cause of the data shift is needed. For example, assume "INCOME" as a model attribute. Also assume the relationship between INCOME and RESPONSE RATE (of an expensive insurance product such as long term care) is positive. Possible data shifts can be caused from several factors and the corresponding impact can be interpreted very differently.

FACTORS CAUSING DATA SHIFTS IN THE PREDICTIVE VARIABLES:

CASE 1: NATURE DATA SHIFTS

Income is rising as a result of a booming economy. Assume that model variable definitions/formats from contributing data vendors remain unchanged and that this change indicates more and more people become financially able to purchase this product and therefore more people enter into the top few response deciles. As a reflection of naturally occurred phenomena, it is reasonable to interpret that the data shift in INCOME is positive to direct marketing efforts for the long term care product.

CASE 2: ETL ERROR

Data errors can be introduced during the implementation or scoring of predictive models in the database marketing environment. In this case, the current PSI application is an excellent quality control tool in detecting ETL errors. For example, in the PSI reports, each distinct value of a model attribute is listed and counted and compared to the previous scoring population and the model development population.

CASE 3: DATA SOURCE CHANGE

Contributing data sources have changed. For example, income was historically provided by one vendor but is now provided by another vendor.

CASE 4: DATA DEFINITION/FORMAT/FORMULA CHANGE

The definition of the variable has changed or the possible values have been changed.

CASE 5: ACTIVE CHANGES

Other changes that can affect the scores and model performance include intentional changes to the definition of the eligible universe, creative changes, offer changes, as well as changes to selection and testing practices.

CASE 6

If we ignore the continuous changes of a scoring population over time, then PSI reports highlight the differences between the model development sample and the scoring population at model implementation. Therefore, data shifts from the model development sample to the first scored universe, upon implementation, illustrates how effectively the model development sample represented the current eligible population.

WHAT SHOULD BE TRACKED/MONITORED TO ENSURE OPTIMAL MODEL PERFORMANCE?

1. Data shifts in the predictive variables can cause significant changes in the model scores, resulting in unreliable

model scores that impact the effectiveness of predictive models.

2. Changes in demand can cause shifts. Over time, the best prospects identified by the predictive model are being fatigued due to recency and frequency of solicitations or they are converting/purchasing. Therefore, at some point in time, models need to be refreshed/rebuilt to lower the threshold in order to define enough top scoring prospects for ongoing direct marketing initiatives.

3. Changes to creatives/offers/incentives. Predictive models are built to fit the development sample (Rud, 2001). When creatives changed dramatically, models may need to be re-developed. For example, given a solicitation effort for opening a free checking account with a \$50 bonus will bring in prospects that are different from those that are not offered a bonus.

PSI AS A METHODOLOGY FOR TRACKING MODEL STABILITY

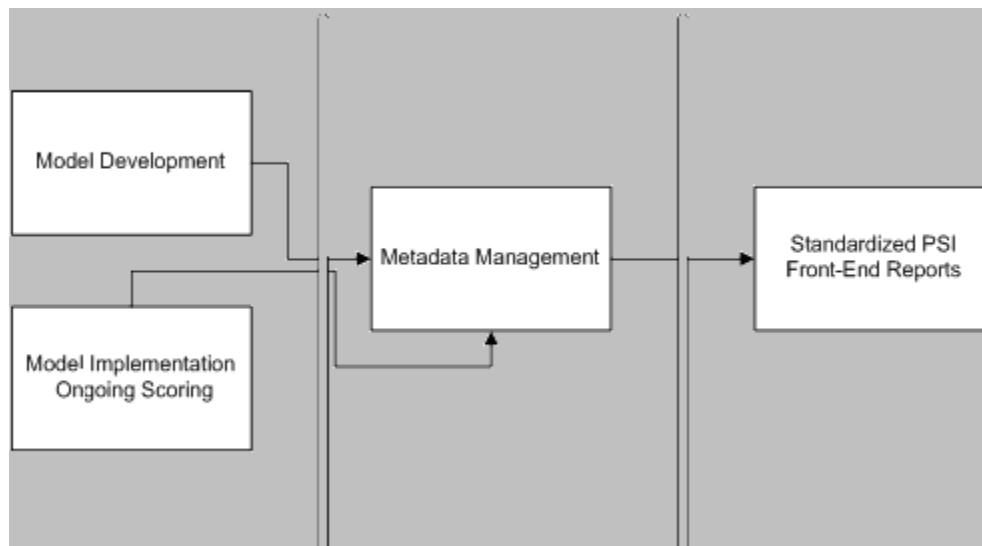
PSI reporting can fulfill the need to track both model score and model attribute stability. When significant shifts are identified, two things will be interesting to be researched. First, a model score shift analysis may be performed to track how the model scores shift across deciles; second, an analysis to determine which changing variable is most influential in causing the model score shift. Here comes the question: What is more important? Most marketers seem to be more interested in understanding the direction and magnitude of impacts to model scores due to model attribute shifts.

To address the above concerns, one solution for determining the directional impact is to check the signs of the shifted attributes and the average values of those attributes compared to those from the previously scored population or development sample. This will indicate whether the model attribute shifts are increasing or decreasing the model scores.

Though PSI as a methodology for tracking model stability has certain statistical issues beyond its scope, in practice, it works effectively as an early-warning tool for denitrifying attribute and score shifts that need to be researched and addressed in order to maintain predictive model efficacy.

AUTOMATING THE PROCESS WITH MODEL METADATA MANAGEMENT

The process is illustrated in the following flow-chart.



A robust PSI reporting system should leverage model information metadata. Using SAS, this early warning system of model score/attribute stability tracking with PSI can be easily automated and maintained. On the one hand, automation enables analytical reporting in an efficient manner; on the other hand, it provides great integrity and

flexibility by storing model score/attribute distribution information in a single location in the form of metadata, which serves as a direct input for final standardized PSI reporting.

Metadata management works both as a model information management tool and a tool to facilitate process automation. On the model information management side, model log information, for example, name of model, dates of development, model developer, overall objective, specific target, date of model development data, first campaign implementation, implementation date, selection criteria, selection business logic, preselects, model attributes information(Rud, 2001) are collected and stored as metadata for each predictive model in production, and are updated at the events of new model implementation and old model retirement. On the process automation side, the above listed model information can be used as an input to a SAS application to analyze and collect model attribute distribution information on each specific model/version. Once the PSI application is executed, all the collected model attribute distribution metadata will be stored in a single place. The next step is to use metadata to create standardized PSI front-end reports.

CONCLUSION

Overall, establishing and implementing a PSI analytical reporting system is a necessity for database marketers who use predictive modeling for selecting marketing populations. PSI is highly efficient by turning tremendous amounts of data into concise, accurate business intelligence which equips decision makers with the knowledge they need to make informed marketing decisions. SAS as a programming language can help automate this promising monitoring process.

Your comments and questions are highly appreciated!

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