Neural Analysis:
Artificial Intelligence Neural Networks Applied to Single Source and Geodemographic Data

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SUMMARY

This work demonstrates the learning ability and capacity of artificial intelligence neural networks, and how they are effective in providing information from large data sources. The combination of new techniques of data collection and the appropriation of technology from scientific fields supplies vast capabilities to consumer marketers.

At the center of this approach is the artificial intelligence neural network. The impact of adopting this method of data understanding warrants special attention and emphasis, hence the term - - Neural Analysis.

OVERVIEW OF NEURAL ANALYSIS

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Two general opportunities of neural network analysis are addressed:

- Geodemographic Data
- Single Source Data

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Neural network technology (NNT) use human-like trial and error learning methods to detect patterns existing within a data set. An attractive aspect of this approach is no assumption, statistical or other, is made concerning the data structure. Additionally, neural nets have the ability to ignore data that is not significant and emphasize that data that is most influential. A neural network acquires its intelligence by training with a set of variables or features represented by a variety of encoding methods. This knowledge is then applied as a prediction when patterns in new data are presented to the network.

Marketers are beginning to find single source data as a rich resource. It is now well documented in the literature that single source data provides a most reliable asset in the creation of a number of reports, including but not limited to baseline, tracking, and forecasting.

The sales and marketing variables from single source data are ideal input features for training a neural network. Patterns and relationships existing are learned by the network. The neural net is now able to use its knowledge to aid in the creation of an analysis product that contains information unavailable by traditional methods.

Geodemographic systems enjoy growing popularity as a fresh way to examine consumer's purchase behavior, media viewing habits, and product ownership. Regardless of the geodemographic systems used, the natural design of neural networks brings sharp focus to the meaning inherent in this data.

A combination of case history presentation and theoretical modeling are used to illustrate the specific advantage of each two important architectures of neural networks.

NNT AND CONSUMER MARKETING

There is a virtual dearth of NNT applications for consumer marketing within the NNT literature. With the possible exception of a few target marketing (direct mail) treatments, NNT solutions for marketing problems have not been documented. Of course, the practical application of NNT to marketing is a most recent development.

The experience of the author is that neural networks offer a distinct advantage in extracting the knowledge present in marketing data. In a neural analysis, data may:

- contain multiple time periods
- be discreet or continuous
- follow any distribution
- represent events, magnitudes, or attributes

Neural networks:

- ignore multicollinearity
- are unparameterized models

Since no restrictions for data exist in NNT, this technique is appropriate in development of marketing strategy.

The theory and computational aspects of neural networks are widely accessible and therefore is not presented here. General speaking, a neural network is comprised of elements or neurons. Each neuron is a mathematical representation of an aspect of the processing function. A series of neurons represent input data from real world observation. This information is passed to a group of "hidden" neurons which detect the relevant aspects of the input. Output neurons collect results from the hidden neuron and make information available to the network operator. Output may be estimates, groupings, or classifications.

At the crux of the neural net is an ability to establish a reasonable set of weights connecting each group of neurons to other groups of neurons.

As it determines the best set of weights, the neural network is said to be learning. Following the learning step NNT applies its accumulated knowledge to new data that is presented.

GEODEMOGRAPHIC DATA AND NEURAL ANALYSIS

This is a history illustrating how the combination of geodemographic data and NNT was able to solve a unique problem for Amoco Oil Company. In November, 1992 Ms. Lori Bush, Marketing Specialist for AMOCO, made the decision to develop a site selection/store evaluation model for a new retail franchise. Her confidence in NNT led to the success of this project.

AMOCO owns and operates twelve retail **s**pecialty **c**onsumer **o**utlets (SCO) in the southern area of the USA. To protect the proprietary aspect of this history, the name of the chain of stores will not be identified here; we will instead use the term SCO. The strategic positioning of these SCO is a component of a new convenience store concept developed at AMOCO. Each SCO provides services directed to compete in the marketplace with:

- Gasoline filling stations
- Car washes
- Traditional convenience stores (7-11, White Hen, etc.)
- Fast food establishments
- Deli's

Findings

This study resulted in two major findings. A neural network model is able to discriminate clearly in the selection of proposed sites for new SCO stores. And, both internal and external data relating to SCO are well suited for processing and analysis with neural network technology.

The trained neural network is able to rank the proposed sites by projected sales volume. The relative position of the sites is meaningful, as is the dollar estimates of sales. Even though there are only twelve stores to use to train the neural network, the actual dollar projections of the model have significance.

Based on store sales and gasoline potential (separately and combined), three sites rank well. At the other end of the spectrum, three of the proposed sites do not show a likelihood of generating the revenue volume required for success. Since the remaining sites are not pulled to one end or the other the prudent action may be to reject them.

A high degree of confidence can be placed on these results. However, this is intended to augment the other available site evaluation intelligence and not be interpreted as a single method for choosing a new site.

Method

In order to aid in the evaluation of the available eight sites for a new SCO, a model using NNT was developed. The NNT model is comprised of two separate neural networks. One neural network is designed to focus on performance measured by in-store sales while the other is concerned with gasoline volume. Two features are appraised by each net: 1) competitive presence [using weights, provided by management, to reflect the degree of impact for particular establishments e.g. fast food/deli, C stores, gasoline stations, etc.] and 2) population density of households most likely to be considered Split Second customers.

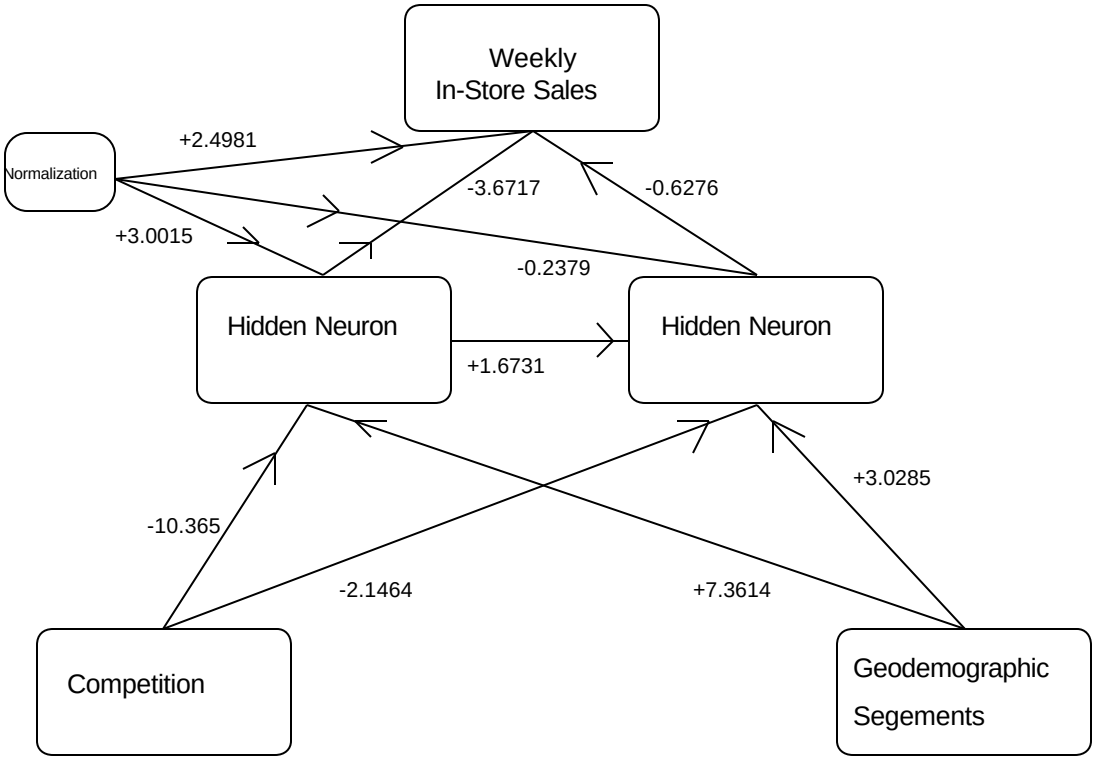
Data presented to the model is a total of all competitive sites within a two mile drive from each outlet and the sum of all households that are classified in any of eight geodemographic clusters in a three mile radius from each store.

Previously conducted primary survey research tells us that these clusters describe more that 75% of all SCO Shoppers.

Average weekly in-store sales and average gasoline volume from the sixteenth week of 1992 to the sixteenth week of 1993 comprise the actual performance data used by the two neural networks.

During the training phase of the model development, each of the two neural networks learned the patterns existing within the data until being able to correctly predict results 84% to 87% of the time. Learning was halted at this point to avoid over training. At this level of accuracy, a neural net has 1) acquired the knowledge of relationships existing in a data set and 2) has the ability to generalize that knowledge to future events. The following chart is a visual representation of the neural network model for store sales. Weights derived by the network are displayed for each neuron connection.

SCO NEURAL NETWORK
IN-STORE SALES



Site Selection

Analyzing the model estimates in conjunction with the details of the input features creates an additional view of site potential. For example:

- The model has indicated three sites as potential generating revenue levels high enough to be profitable. If it is necessary to discriminate further, the proportion of population and competitive presence serving as the input to the neural network model will serve as a rich information source.

- Two sites, have a competitive trade area slightly lighter in C-stores. Additionally, the one property is located in an area with 47% of population belonging to one geodemographic cluster. This characteristic also is present in a second store population.

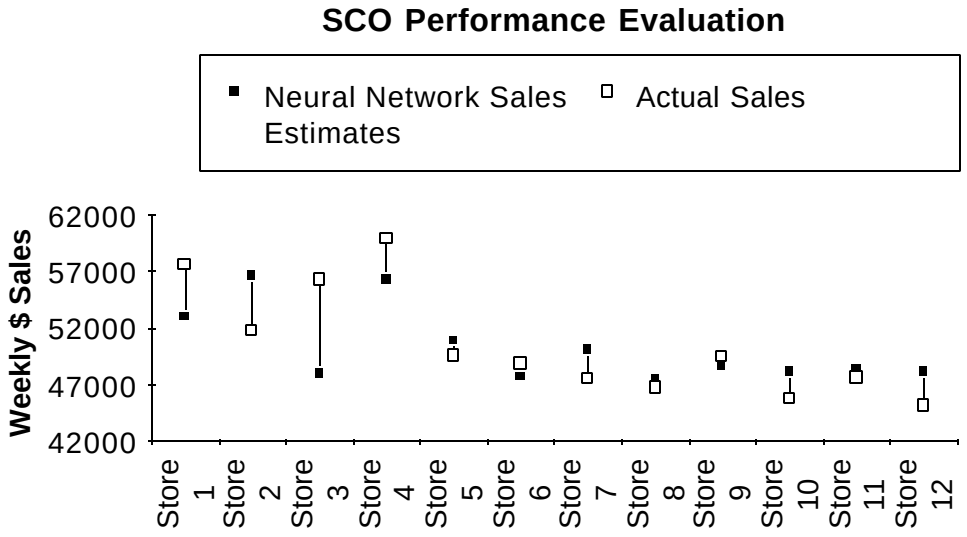
Store Evaluation

One additional outgrowth of the development of this model is a mechanism suitable for evaluating individual store performance. The working model was applied to each of the current stores in order to produce an estimate of sales. By plotting the NNT sales estimates and actual store sales as shown on the enclosed chart, we determine how stores are performing, visa via the NNT expectations.

Looking at the four stores which have been operating for the longest time, only one does not perform to the expectations of the group as a whole. The other three oldest stores, have actual weekly sales levels exceeding the neural network model estimates.

A review of the composition of the model input feature data set reveals a particular level of understanding of the differences in store performance. Competition is distributed relatively equally across all four stores. However, there is a heavier concentrating of C-stores in one of the trading areas. It is possible that this factor is responsible for the less than expected in-store sales here.

A graphic is presented which displays each store's sales and estimate:



Conclusion

NNT is a powerful and flexible marketing instrument. This project clearly reflects the capability of NNT to provide meaningful results even when a rich data source is absent. There are a number of opportunities to use NNT in developing marketing strategies aimed at increasing profits for SCO.

FRAMEWORK FOR SINGLE SOURCE DATA AND NNT

There is nothing more promising for modeling the consumer environment than the application of NNT to single source data. This section is founded in the liberal use of theoretical modeling and neural network models developed by the author.

Shaping information based decision making requires a blending of components:

- Data -- information sources
- Analytical technology
- Institutional flexibility
  - Imagination
  - Commitment to the process

Using NNT with single source data brings two of these components to the table. NNT is able to track and interrelate the events, patterns, and relationships presented by single source data.

Theoretical Modeling

Theoretical modeling is an organized procedure aimed at clear thought. This style of research is well defined (Moorthy, 1993), and it is gaining in popularity. With theoretical modeling, a model is simply a setting or laboratory in which a question is investigated. Characteristics of theoretical modeling include:

- A Super model depicting an overall circumstances
- Sub-models used to derive logical implications
- Structure for a mathematical description of how something works
- A variety of treatments
- A robust environment

Until use of NNT is commonplace with is own history in the marketing discipline, theoretical modeling will provide one of the primary avenues for development of NNT marketing applications.

Self Organizing Feature Maps

Neural networks can be organized in a number a ways. The previous example in this paper employed just one type of neural net. This net is a layered network. That is, data is received in one layer, evaluated in a second layer, and output in a third layer. This topology is effective for forecasting, prediction, and pattern recognition.

A second type of neural net that will be very useful is known as a *self organizing map*. This net has the ability to form groups or clusters of cases that have similar attributes. Furthermore, with some new techniques developed by the author, this neural map will create clusters resulting from changes in the emphases of individual attributes.

Single Source Modeling

In Curry (1993), the following set of six objectives of a single source system is presented:

1. Measure causal factors (price, product, promotion) at their point of effect (in the home or in-store)
2. Trace how and when these factors affect consumer behavior
3. Identify where each signal originates (with the manufacturer or with the retailer)
4. Collect data at strategic points in the product movement pipeline (factory, warehouse, retail, and home)
5. Analyze these data to identify how marketing forces interact with household geodemographics and retail trade behavior to influence consumption patterns
6. Deliver actionable information to management in three client segments: manufactures, retailers, and advertising agencies

Nothing is better suited to meet objectives 2, 3, 5, & 6 than NNT.

Relationships and patterns discovered by a neural network are those that exist exclusive of other factors. For example, in the case of a model where the input features are media measures and consumer attitudes with an output feature of total sales, the resultant model is useful in examining the media effect.

Other factors are certainly at work in the marketplace - - competitive activity, local promotions, changes in the weather, the unique behavior patterns of individual consumers, etc. Without respect to media these market forces continue their dynamics over time.

Therefore the neural network understands its task is to discover the singular behavior of media. Learning takes place. And, the acquired knowledge the neural network makes available allows interpretation of the influence of media. Ever-present is the realization of the external forces, but media casuals are view with higher level comprehension.

Suggestions have been made to incorporate the use of single source data to select television programs for spot advertising placement (Assael and Poltrack, 1993). NNT is the ideal method for addressing this advance in media evaluation and purchase. One possible approach is to employ multiple neural networks to a single source database containing consumer purchase history, demography, and television viewing habits.

First a neural network is designed to create a set of probabilities for individual purchase likelihood. A second neural net with a self organizing feature map structure will create clusters of household/individuals. These clusters are built around the communality of likely to purchase a brand. Each cluster is profiled for media habits and a third neural network will estimate the existing patterns between brand purchase and viewing of a specific television program.

Furthermore, a supermodel for media selection should also use NNT to examine scanner data at the retail level for an understanding of the patterns of product movement by trade areas. This information is a baseline for selecting rich areas of potential at the local television market. After time a comparison of actual sales/share is contrasted to the NNT estimates in order to assess the lift incurred from more selective media purchases.

These models are intended to provide a guideline for further research into the application of neural networks with marketing data. There is no longer any question of the abilities of NNT. It is now the task of practitioners to avail themselves of this remarkable new offering. Neural Analysis opens the door for true information based decision making.

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