'Just Enough Delivery'

# Predicting newspaper sales: JED system 'weathers' the tests

**newspaper techniques published a story in its October 1997 issue about a then-new system for predicting newspaper sales. The system, called JED for "Just Enough Delivery," was developed by researchers at the University of Nijmegen for the daily newspaper De Telegraaf in Amsterdam. Bert Kappen and Tom Heskes headed up the development of this project and in the following give an update on the system.**

The sale of newspapers is affected by many factors, such as news content, events, season and weather. Prediction of future sales requires an integrated approach that takes all these factors into account. Researchers at the University of Nijmegen recently showed that by doing so, the impact of weather on sales can be profound. Application on data provided by De Telegraaf showed that this knowledge can have significant impact on newspaper sales.

## Learning to predict

Single-copy sales strongly fluctuate. The better one can predict the fluctuations, the better the distribution, and thus the higher the revenues. In the dynamic markets of newspaper sales, it could prove to be important to have a prediction system that learns and adapts itself to the latest changes. A neural network is such a learning system, based on ideas from neurobiology. The neural architecture has a layered structure of processing units (neurons). The information at the input layer encodes the currently available information. This information is passed on through layers of "hidden" units to the output layer. Each output of the neural network corresponds to the sales of a particular outlet (or newsstand). The hidden units form a kind of bottleneck and extract the most important information for prediction.

Input variables can include any type of relevant information that helps to predict the future sales.

The neural network model is adaptive. The parameters of the network model are optimised to give the closest fit between the observed sales figures and the sales figures generated by the network on historical data. The network is then used for prediction on data that it has not seen before. The neural network discovers autonomously which variables are the most important, or more specifically, which variables mainly affect future sales. Learning is done "on-line" which means that the network is adapted, say, every month to maintain good performance despite changes in the market.

The idea to use neural networks to predict newspaper sales was pioneered by De Telegraaf. In 1996, they commissioned a dedicated newspaper prediction system from the University of Nijmegen. This system is a software system for efficient distribution of single copies.

JED learns from the historical sales figures in the past how to tune the deliveries in the future. The system has been operational at De Telegraaf since 1997 and outperforms their previous system, which was based on a classical and already quite sophisticated statistical method.

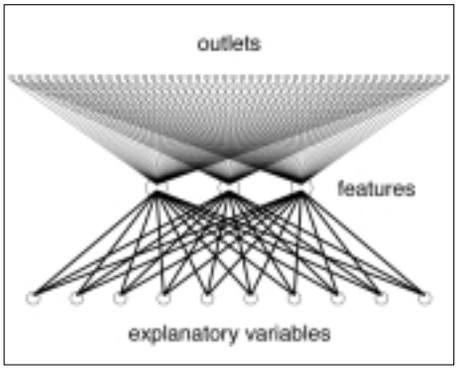


Figure 1: A basic model of a neural network where the explanatory (or input) variables could be sales figures, seasonal figures, weather information, major events, etc. that go into the JED system and it then determines which information is relevant and extracts this data to predict the number of sales for each outlet or newsstand.

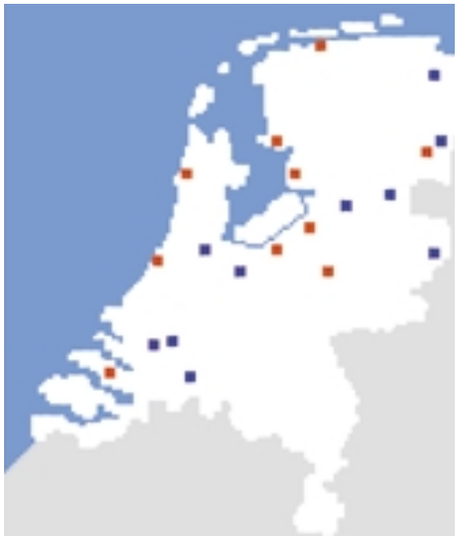

Figure 2: It appears that outlets situated along the coast and in other recreational areas (red squares) where good weather is prominent in The Netherlands respond positively in sales; whereas those outlets situated in the downtown areas of bigger cities (blue squares) where poor weather persists respond negatively in sales.

## Getting more out of the data

With computers becoming faster and faster, it now becomes feasible to apply more advanced techniques to prediction problems. In particular Bayesian methods are becoming widespread in many types of applications.

An advantage of these techniques is that more explanatory variables can be included as inputs to the model (see Figure 1). In addition to recent sales figures and seasonal variables, one might think of including information about weather figures, major events (sport matches, for example), advertising efforts (both locally and nation-wide), holidays, and so on. The new technology is implemented in the latest JED version.

For illustration, in that latest version we trained JED using, among others, weather figures like temperature, precipita-

tion, percentage sunshine, and wind velocity, as explanatory variables, all provided by De Telegraaf.

We compared the predictions of the latest version of JED with our previous system and concluded that, using the same total number of copies, distribution based on the new version will increase sales another 1.5 percent. This is in addition to the already achieved improvement of 1.7 with the first version. Improvements in the range of 2-4 percent were obtained in similar studies with a German and Swiss publisher as well. It is clear that these improvements result in a significant revenue on an annual basis.

In addition, one can check which outlets respond positively to good weather (more sales with nice weather) or instead show decreasing sales with worse weather. It appears (see Figure 2) that the outlets responding positively to good weather can be found mainly along the coast and in other recreational areas, whereas the outlets responding negatively are situated in the downtown areas of bigger cities.

In general, it is possible to analyse the neural network and to find the most predictive variables. JED comes equipped with tools that allow the user to study and understand the mechanisms that affect sales. The weather analysis reported here was obtained using these tools.

## Optimal distribution

The main purpose of JED is to predict for each outlet the expected sales as well as the corresponding uncertainty (for instance, 10 ± 4; that is predicted number of newspaper copies is 10 with an uncertainty of plus or minus 4.). How can these numbers be turned into an optimal delivery? JED offers two basic strategies. One is to specify the sales strategy (conservative, reduction of returned copies, or expansive, reduction of sellouts). JED then computes the delivery for each outlet and thus determines the total number of copies. The other strategy is to fix the total number of copies and let JED figure out where to put them.

With the latest improvements, JED leads to even better distribution, but also provides lots of information about the market of single-copy buyers.

JED is commercially available via SMART Research in The Netherlands: www.smart-research.nl/products/jed. <