Natural Solutions to Practical Problems
an Overview of Marketing, Scheduling and Information Filtering Problems Solved by
Neural and Evolutionary Techniques

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Introduction: We present a number of projects of the ALP group at Leiden
University, within marketing, scheduling and information filtering. The projects
use neural and evolutionary techniques.

1 Marketing Applications

Market Response Modelling: In market response modelling one seeks to
model the market share of a brand as a function of a number of marketing vari-
able. Since many relationships between marketing variables and market share
are thought to be non-linear, neural networks are ideal for market response mod-
elling. In our case, we modelled the market shares of five competing beverage-
brands on a European market. The variables we used as input to a multi-layer
perceptron neural network were price, distribution, out-of stock, and share of
voice (advertising share). Since only a very limited amount of data was avail-
able, a regularization technique called weight elimination was used to prevent
overfitting. Several neural network models were compared to traditional market
response models (i.e. a linear model and a multiplicative model). In all cases,
the neural network models outperformed the traditional models when absolute
variables were used. The average performance gain was 51 %. When relative
values of the variables were used, the differences were smaller, but still signifi-
cant (16 % on average). For more details, see [6] or contact Michiel van Wessel
(michiel@cs.leidenuniv.nl).

The Dimensions in Customer Behaviour: In this project we tried to de-
t ermine which factors (dimensions) influence the behaviour of customers of a
wholesale company, using only the sales lists of the wholesale retail company.
This means that we use a huge amount of very limited, though easily accessible
information.

In our model, customers and products are represented as points in a k dimen-
sional Euclidean space. The coordinates of the coordinate system express the customers' 'needs' or 'wishes' on k underlying dimensions. The coordinates of the product determine what a product 'offers' on the k underlying dimensions. In the model
we use, it is assumed that customers buy products, if the coordinates of the
products are sufficiently close to the coordinates of the customer. The aim is
now to find low-dimensional coordinates for products and customers such that
the sales lists generated by the above model match real or artificially generated
sales-lists as closely as possible. After a solution has been found, domain experts
interpret the revealed dimensions.

We used a competitive neural network to solve this problem. Results were
good on artificially generated sales-lists, less convincing but still reasonable on
real sales-lists. For more details, see [2, 6] or contact kosters@cs.leidenuniv.nl.

Data mining applications of EA and NN: Data mining application studies
have been done by the 'Stichting Marketing Intelligence and Technology (MIT)',
a foundation which promotes the use of computational intelligence techniques in
marketing applications, and in which UvA, VU and RUL collaborate. Projects
have been carried out for Hewlett-Packard, PTT Telecom, Robeco and Vitesse
Nederland. In all studies, the aim was to train and to compare computational
intelligence techniques with historical data in order to optimize future marketing
activities. The techniques used were NN, GA, decision trees and (linear) statist-
icas. For more details, see [1], or contact Guus Eiben (guus@cs.leidenuniv.nl).

2 Data Visualisation

Neural Vision - A Neural Network Based Data Projection and Visual-
isation Tool: Data visualisation by means of data projection is useful in explora-
tory data analysis. We developed a software package called 'Neural Vision',
in cooperation with Nijenrode University for the Dutch Ministry of Transport,
Public Works and Water Management. This software package is able to visualise
high dimensional data by means of a linear projection (based on a Sanger Neural
network) and a non-linear projection (based on an Samann neural network). The
data points in the projection can be coloured to visualise the distribution of the
classes or indicator values in the projection. The data can be clustered by a
frequency sensitive competitive neural network.

An illustration of the program is given in figure (1), where a linear projec-
tion is shown of the thirteen dimensional Boston dataset. For more informa-
tion, contact Michiel van Wessel (michiel@cs.leidenuniv.nl).

3 Evolutionary 3D-Air Traffic Flow Management

Air Traffic Flow Management (ATFM) is involved in planning the movements
of aircraft. A complete plan describes the trajectories of all involved aircraft. A
trajectory defines the exact position of an aircraft as a function of time, so it
corresponds to a path with additional temporal information. Two trajectories are
conflicting when at a certain time the separation between these trajectories is too
small. The minimal required separation between trajectories is approximately
30 kilometers in the horizontal plane or 600 meters in vertical direction. The
primary target is to find a conflict-free planning where all aircraft move from
their entry to their exit location. As a secondary target, one can minimise the
number of maneuvers, the additional distance traveled, and try to satisfy the
these articles in groups: that is, each article should be assigned a label which corresponds to a newsgroup. We propose an AIF system for this task based on the novel combination of weighted trigram analysis, incremental clustering, and evolutionary computation.

An incremental clustering algorithm is applied to weighted trigram representations of the documents creating a classification of the documents. In incremental clustering, the number of clusters is not determined in advance, and can change over time. To find the right weights for the trigram analysis and some parameters of the cluster algorithm we designed an evolutionary algorithm. Since the clustering has to be adaptive, the fitness of a trial solution can only be statistically approximated over time and will probably change over time. It takes some time before the fitness of a new member of the population is estimated. Therefore we split the population in two pools, one for the "unproven" members, and one for the "adults".

We found that a combination of weighted trigram analysis, clustering, and evolutionary computation is sufficient to separate a dynamic stream of documents. Furthermore, the experiments with a varying number of clusters indicate that increasing the number of clusters only effects the time needed to converge, not the accuracy rate, which would mean that the system is scalable. Also, the system is capable of processing untrained documents with an accuracy rate comparable to that of processing the trained documents. This means that the system successfully generalizes. For more information, see [3] or contact Ida Sprinkhuizen-Kuyper (sprinkhuizen-kuyper@cs.leidenuniv.nl).

References


