Chapter 5

A Computational Intelligence Approach to Supply Chain Demand Forecasting

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ABSTRACT

Estimating customer demand in a multi-level supply chain structure is crucial for companies seeking to maintain their competitive advantage within an uncertain business environment. This work explores the potential of computational intelligence approaches as forecasting mechanisms for predicting customer demand at the first level of organization of a supply chain where products are presented and sold to customers. The computational intelligence approaches that we utilize are Artificial Neural Networks (ANNs), trained with the OLMAM algorithm (Optimized Levenberg-Marquardt with Adaptive Momentum), and Support Vector Machines (SVMs) for regression. The effectiveness of the proposed approach was evaluated using public data from the Netflix movie rental online DVD store in order to predict the demand for movie rentals during the critical, for sales, Christmas holiday season.
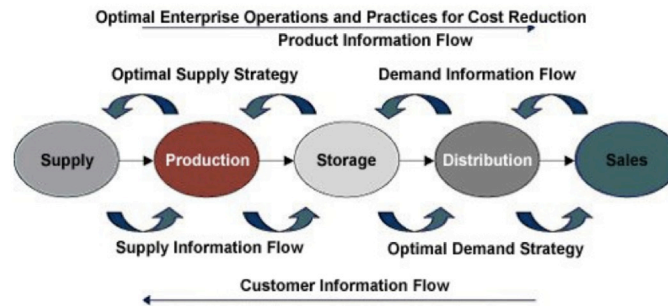
INTRODUCTION

The Supply Chain (SC) of both manufacturing and commercial enterprises comprises a highly distributed environment, in which complex processes evolve within a network of interacting companies. A typical SC includes different levels as shown in the diagram of Figure 1. As shown in this figure, and reading the diagram from right to left ("Customer Information Flow"), the first level

of organization is "Sales" where products are sold to customers; the second level of organization is "Distribution" where products are delivered from in-house or 3PL (3rd Party Logistics) warehouses to retailers; the third organization level is "Storage" where products are stored in warehouses for future distribution; the fourth level of organization is "Production" where products are produced within plants according to determined production and inventory schedules; finally, the fifth organization level is "Supply" which comprises of the

Figure 1. The multiple levels of a supply chain

suppliers that provide raw materials transported to production plants.

The optimization of SC operational procedures is crucial for businesses since these operations directly affect customer service, inventory and distribution costs, and responsiveness to the ever changing markets. To this end, decision making in supply chain systems should consider intrinsic uncertainties, while coordinating the interests and goals of the multitude of processes involved. Since supply can rarely meet demand at any given period, the demand information is distorted as it is transmitted up the chain and this can misguide upstream members in their inventory and production decisions ("bullwhip" effect) (Lee, Padmanabhan, & Whang, 1997a), (Lee, Padmanabhan, & Whang, 1997b).

Computational intelligence approaches can offer effective tools for both modeling and managing operations in the uncertain environment of the supply chain, especially since the associated computational techniques are capable of handling complex interdependencies. As a result, these computational techniques may form the basis for the development of optimization methods and systems that optimize effectively the various objectives of the supply chain (Minis & Ampazis, 2006). This chapter presents the application of computational intelligence methods in supply chain demand forecasting. More specifically, we focus on the first level of SC which is directly related to customer side demand forecasting in an uncertain environment. Forecasting the expected demand for a certain period of time for one or more products is one of the most important targets in an enterprise since it directly affects revenue as well as customer satisfaction. To this end, we utilize Artificial Neural Networks (ANNs) and Support Vector Machines (SVMs) as an approach for forecasting demand in order to create a supply chain framework with dynamic characteristics.

The remainder of this chapter is structured as follows: In the next section we present a review of previous studies on demand forecasting in SC using computational intelligence techniques. After that we analytically describe the techniques used in the present work, that is, the theoretical principles behind ANNs, the OLMAM training algorithm, and SVMs. A real-world case study utilizing data for the Netflix online DVD rental store is presented in Section "Information Sources". The section immediately after that presents the results of the computational intelligence techniques. Finally in the last section we discuss the conclusions drawn from this study.

BACKGROUND

Computational intelligence methods have already been used in a variety of SC optimization tasks. Especially ANNs, as a new methodology, have been used for optimization of transportation management, resources allocation and scheduling, for

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