Chapter XXXIX
Applications of Neural Networks in Supply Chain Management

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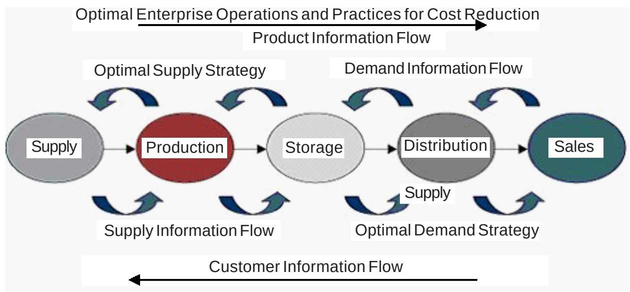
ABSTRACT

This chapter focuses on significant applications of self-organizing maps (SOMs), that is, unsupervised learning neural networks in two supply chain applications: cellular manufacturing and real-time management of a delayed delivery vehicle. Both problems require drastic complexity reduction, which is addressed effectively by clustering using SOMs. In the first problem, we cluster machines into cells and we use Latent Semantic Indexing for effective training of the network. In the second problem, we group the distribution sites into clusters based on their geographical location. The available vehicle time is distributed to each cluster by solving an appropriate non-linear optimization problem. Within each cluster an established orienteering heuristic is used to determine the clients to be served and the vehicle route. Extensive experimental results indicate that in terms of solution quality, our approach in general outperforms previously proposed methods. Furthermore, the proposed techniques are more efficient, especially in cases involving large numbers of data points. Neural networks have and will continue to play a significant role in solving effectively complex problems in supply chain applications, some of which are also highlighted in this chapter.

INTRODUCTION

The supply chain of both manufacturing and commercial enterprises comprises a highly distributed environment, in which complex processes evolve in a network of companies. Such processes include materials procurement and storage, production of intermediate and final products, warehousing, sales, and distribution (see Figure 1). The role of the supply chain in a company's competitiveness is critical, since the supply chain directly affects customer ser-

Figure 1. The flow of decisions and information in the supply chain



vice, inventory and distribution costs, and responsiveness to the ever-changing markets. Furthermore, this role becomes more critical in today's distributed manufacturing environment, in which companies focus on core competencies and outsource supportive tasks, thus creating large supply networks. Within this environment there are strong interactions of multiple entities, processes, and data. For each process in isolation, it is usually feasible to identify those decisions that are locally optimal, especially in a deterministic setting. However, decision making in supply chain systems should consider intrinsic uncertainties, while coordinating the interests and goals of the multitude of processes involved.

Nature-inspired computing offers 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 integrate effectively the various objectives of the supply chain.

This chapter presents significant applications of artificial neural networks, a major technique of nature-inspired computing, in supply chain management. Specifically, we use self-organizing maps (SOMs) to reduce the complexity of problems in two supply chain applications: manufacturing shop design and real-time distribution management. Both share the requirement for drastic complexity reduction, which is addressed effectively by clustering using SOMs. Clustering is the problem of partitioning a set of N patterns in their feature space into K clusters, so that patterns that belong to a given cluster are more similar to each other than to the rest of the patterns. The majority of clustering algorithms are based on the minimization of the distance between each pattern and the centroid of each cluster. Neural networks have been used for clustering applications (Kamgar-Parsi, Gualtieri, & Devaney, 1990) and were shown to outperform conventional iterative techniques, such as the K-means algorithm (Jain & Dubes, 1988), in terms of both solution quality and speed when the clusters are well defined. In particular, SOMs have been shown to be very efficient clustering techniques in a variety of applications (Chen, Mangiameli, & West, 1995).

The remainder of this chapter is structured as follows. The second section overviews self-organizing maps. The third section presents an important clustering application, that is, the decomposition of a manufacturing shop in manufacturing cells. The fourth section presents another clustering application in distribution, a downstream process of the supply chain. The