Introduction to Special Issue

C. ALIPPI,[a] V. PIURI[b]

[a] *CNR CESTIA, piazza L. da Vinci 32, 20133 Milano, Italy*
[b] *Department of Electronics and Information, Politecnico di Milano, piazza L. da Vinci 32, 20133 Milano, Italy*

In recent years, neural-based techniques have been proved effective in solving several applications by outperforming, whenever the world is non-linear and unspecified, traditional algorithmic-based approaches. In fact, if the equations ruling a generic application are unknown, and the only available information is a sequence of input–output couples, then learning by examples is the last chance to solve the problem. In other cases, the application might be completely defined but the complexity of a classic solution is impractical; in such cases neural techniques can be taken into account to provide a simpler solution approximating the optimal one.

Neural networks are parallel non-linear computing paradigms that were initially developed to resemble the operation of the human brain and its ability of massively-parallel processing, partitioning complex problems, reconstructing concepts from partial information, deducing and inferring new behaviors from the available knowledge by exploiting similarity and generalization, learning from examples by analytical inspection, understanding, interpolation, and feature extraction.

Many relevant results have been achieved in time-independent applications such as in many sectors associated with image and signal processing, speech understanding, pattern analysis and classification, areas considered nowadays as "traditional" environments in which static neural networks have been proved to be universal function approximators and can be successfully integrated and/or substituted with classical ones to improve performance and generalization abilities. Other application areas such as identification, prediction and control of complex systems are becoming more and more attractive; here the presence of time is non-trivial and recurrent neural models (which exhibits dynamic behaviors) have been considered to extend the static ones. To this end, neural techniques may constitute a leading edge for industrial applications in the near future.

Due to the relevance for the excellence of industrial production processes and products, this special issue is directed to present innovative methodologies and applications of neural techniques for the solution of industrial problems in the areas of identification, prediction and control. Neural technologies in these fields constitute one of the basis for innovative design of heterogeneous products, automatic control systems, and embedded ones: some of the most exciting challenges for industry and academia in the near future.

The first basic issue in the practical use of neural networks is identification of non-linear dynamic systems to capture and autonomously reproduce the behavior of products, machinery, processes, or plants. The first two papers present some neural paradigms and their use in different application environments. "Process Monitoring and Modeling Using the Self-Organizing Map" by Alhoniemi, Hollmén, Simula, and Vesanto is mainly directed to theoretical aspects of process modeling. "Neural Modeling of an Induction Furnace Using Robust Learning Criteria" by Thomas, Bloch, Sirou, and Eustache presents in detail a practical case of complex system modeling.

A second issue is prediction of the future behavior, starting from current and past observed data. Two practical cases are examined. "NO_x and CO Prediction in Fossil Fuel Plants by Time Delay Neural Networks" by Adali, Bakal, Sönmez, and Fakory takes into account a plant-wide prediction in a complex non-linear case. "Discharge Prediction of Rechargeable Batteries with Neural Networks" by Gérard, Patillon, and d'Alche-Buc is a detailed study of the behavior of a product.

Neural processing can be useful also to perform system diagnosis from the analysis of the system model and the sampled data. "A System for the Analysis of Jet Engine Vibration Data" by Nairac, Townsend, Carr, King, Cowley, and Tarassenko is an application example for a complex field.

Correspondence to: Prof. Vincenzo Piuri.
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Quality control and analysis for the production process and products are the last cases here considered. "An Adaptive Connectionist Front-End for Automated Fettling" by Keat, Balendran, Sivayoganathan, and Sackfield presents the case of image processing in a difficult environment for identification of product's characteristics.

This issue is the result of a difficult selection process. We received 20 papers on various aspects of the neural technologies, ranging from design methodologies in specific industrial areas to practical industrial applications: the best 6 papers were selected for this special issue.

The success and the attractiveness of this issue are mostly due to the high quality both of theoretical and applied research and the experimentation performed by the authors. However, a great contribution was given also by the referees that patiently supported the selection process and provided highly valuable suggestions for improving the papers published here. We are very grateful to the referees listed below and pleased to thank them once again. Finally, we would like to thank the Editor-in-Chief for his patience and guidance during the organization of this special issue: we are very honored for having served as guest editors in this valuable journal on one of the hottest topics of this decade.

C. Alippi CNR-CESTIA
S.-I. Amari RIKEN