Neural net technology: Ready for prime time?

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Neural network technology has received a lot of attention since 1988, when DARPA decided to spend millions of dollars to encourage neural net research. Although there has never really been a shortage of research applications, the most often asked question until recently has been: "But where are the commercial applications?"

Only a year ago it was difficult to find any good examples of commercial neural net applications in actual use. Vendors could point to lots of people using their tools, but none of them were really bragging about successfully deployed applications. During the past year, however, a number of interesting commercial applications have appeared. Although many of these should still be considered prototypes, it does appear that the technology has finally begun to move out of the labs and into commercial deployment.

Several trends have led to this commercial success. One involves hardware: Neural net applications are no longer confined to PCs or specialized hardware. Neural nets can now be found on a wide variety of platforms, including mainframes, where they assist with such tasks as credit card and bank card fraud detection.

Other trends become more apparent when you consider how commercial neural net technology has evolved from the earliest products: development tools and environments for building and deploying applications. Over time, commercial products have evolved through hybrid neural net/expert system tools, domain-specific tools, "off-the-shelf products," and neural net chips. These last two are closely associated; although chip development is at the cutting edge of neural net technology, such chips hold great promise for deployment in a wide range of commercial applications and products.

While general-purpose neural net (and hybrid) tools are vital to the technology's commercial development, the most important trend is the use of neural nets in domain-specific products and off-the-shelf applications. A number of domain-specific products are now available, and like their expert-systems counterparts, they are marketed as alleviating the hassles of developing applications for specific domains. Together, domain-specific products and off-the-shelf applications form the fastest growing market for neural net products.

The deployment of neural net technology to supplement otherwise "unintelligent" information systems is especially important, particularly from a vendor's viewpoint, and should profoundly affect the technology's commercial success. For example, products using neural nets to add inbound fax routing and fax-based data entry capabilities to fax machines are now available. The arrival of pen computers, in particular, has created not only a new market niche for handprinted-character recognition products, but also the opportunity for a real "killer application" of neural net technology: a cursive or connected-script handwriting recognition system (ideally silicon-based).

Stages in the evolution of neural net technology

Neural net development products — Tools and environments for building and deploying applications.

Hybrid neural net/expert system tools — Tools combining the pattern matching and classification capabilities of neural nets with rule-based expert systems.

Domain-specific products — Tools for developing applications for specific domains, such as process control, chemical analysis, "database mining," and vision systems for product inspection.

"Off-the-shelf products" — Applications for sale using neural net technology for handwriting character recognition, optical character recognition, fraud detection, forecasting airline seating demand, help desks, mortgage processing, and process control); and

Neural net chips — Chips and tools for creating silicon-based neural net algorithms and computing platforms for commercial products, vision applications, and massively parallel/high-speed computers.

Most important, applications using chip-based neural nets are being deployed in commercial products. For example, Synaptics has developed one of the most innovative neural net implementations of optical character recognition (OCR), long regarded as a promising area for neural nets. The Onyx check reader, developed by Synaptics for Verifone, is the first commercial OCR product to use a neural net chip. When a user slides a check through the device, much as one slides a credit card through a card reader, the system reads the code at the bottom. The system is intended for use by customers at the point of sale in stores, supermarkets and restaurants, not by experienced employees in the back office.

At the heart of the Onyx check reader lies Synaptic's I-1000 neural net vision chip, which performs low-level recognition tasks in conjunction with a simple backpropagation neural net software system. Although this is a very constrained OCR application intended to read only machine-printed numbers, not hand-printed characters, the device is reported to be considerably less expensive than, and far superior to, competing devices. It is smaller, costs less, and performs better than existing systems, and it uses no moving parts (such as motors or moving lenses). The device even performs well even with "noisy" data, which can include different fonts, different background shadings, poorly printed numbers, and the occasional damaged check. According to Synaptics, its accuracy is said to be so good that it is not even fooled by a color copy of a check. Onyx is currently in beta testing, and all indications are that it is performing as intended.

We're not necessarily going to see an immediate explosion in the number of applications based on neural net chips. Instead, chip technology will gradually be incorporated, and we'll probably begin to see more applications like Onyx over the next two to three years. Other recent commercial neural net applications include:

- *Process Insights* — A hybrid neural net/fuzzy process-control modeling application in use at Eastman Kodak's refinery in Longview, Texas. This application has proven so successful that it is being marketed as a commercial product by MCC spin-off Pavilion Technologies.
- *Intelligent Arc Furnace Controller (IAF)* — A hybrid system consisting of neural net models and an expert system component for optimizing electrode positions for more accurate heat distribution in scrap metal furnaces. Now deployed in a number of steel plants, the application is being sold by Neural Applications Corp. IAF has saved about $2 million a year for each furnace it has optimized, and was named one of the six top US engineering achievements of 1991 by the National Society of Professional Engineers.
- *Data Capture and Deposit System* — An intelligent character recognition system for state income tax forms and remittance checks. The system, based on HNC's Quickstrokes Automated Data Entry System, allows all taxpayers' checks to be deposited on the day received. It has been deployed at the State of Wyoming's Department of Revenue. Avon's order processing center is using a similar system for automating handwritten customer order forms.
- *Papnet* — A commercial pap smear analysis product developed and sold by Neuromedical Systems. The neural net component detects and classifies possibly abnormal cells on slides, which are then passed to a pathologist for further analysis.
- *Target Marketing System* — A sales support system that culls a marketing database of dormant customers. The system helps telemarketers to contact the best potential customers by weeding out those who are less likely to reorder. The system was developed by Churchill Systems, of Troy, Michigan for Veratex Corporation.
- *Airline Marketing Assistant/Tactician* — This application, developed and sold by Behavheuristics, forecasts passenger demand and optimally allocates seating inventory among available fare classes. Its customers include Nationair Canada and USAir.
- *Credit Card Fraud Detection System* — These mainframe-based systems determine whether a credit card transaction might be fraudulent by comparing it to the card holder's previous pattern of charges. Commercial products are available from Nestor and HNC, and applications are in use at several financial institutions in the US and Europe, including Mellon Bank and First USA Bank.
- *Teleform* — This Windows-based product sold by Cardiff Software converts a fax machine into a remote data-entry terminal. It uses Nestor's handprint recognition system to automatically decipher hand-printed forms and convert them into data that can be passed on to a spreadsheet, database, or other application.
- *Areas Automated Property Valuation System* — This model-based application sold by HNC evaluates residential real estate. Foster Ousley Conley is using it to evaluate residential property in all California metropolitan areas.

Neural nets are proving to be a viable technology, but they are no more a panacea than are other computing techniques. But several recent products have proven that practical commercial neural net applications are a real possibility today.

In the past, many neural net gurus have represented neural nets as somehow separate or independent of other advanced computing techniques. While this attitude made for great arguments, it's far from the truth. Most successful neural net applications are either used in conjunction with, or to augment, other advanced techniques (most often expert systems). Whether integrated into domain-specific products, or off-the-shelf applications, or developed as in-house systems, neural nets are beginning to solve otherwise unsolvable problems and are providing a way to enhance the performance of more traditional data processing systems.

Neural nets are beginning to enjoy more commercial success mainly because the vendors that began by selling

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- Medical instruments that present an interpretation of data rather than data itself.
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- Expert systems for monitoring spacecraft subsystems, and embedded in the existing spacecraft ground control systems.
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Embedded systems are introducing new conceptual, research, and engineering issues into AI, including system design with multiple levels of sophistication, abstraction, and intelligence; integration of AI techniques and conventional hardware and software; and dealing with noisy and continuous real-world data.

The special issue will promote awareness of this new branch of AI and to raise key issues and possible solutions. Topics include:

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- Techniques for embedding AI in existing and complex system environments
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generic tools are now offering products for specific application domains. While companies were hesitant to buy generic neural net tools and train their systems developers to use them, they are willing to purchase tools and applications to solve specific problems. This shouldn't really come as a surprise, it just reflects an overall trend in computing: Why build a custom application if one is commercially available that includes integration and support services? In addition, many of the more successful applications are really just a component that enhances or supplements other components in commercial products; these are being offered by companies that do not consider themselves neural net product vendors.

What will lead to further commercialization of the technology? The last International Joint Conference on Neural Networks to take place in the US is over. Literally. It appears that the two former joint sponsors — the International Neural Network Society and the IEEE Neural Networks Council — no longer wish to work together. This in itself is unfortunate. While previous IJCNNs never really offered a good forum for business people, they did give observers a good overview of the technology. Hopefully, one of the new conferences resulting from the breakup of IJCNN will be for business managers and developers responsible for implementing advanced technologies in commercial settings.

Neural nets are proving to be a viable technology, but they are no more a panacea than are other computing techniques. Neural nets have their own peculiar problems and drawbacks: a steep learning curve, a lack of standard development methodologies, demanding preprocessing requirements, and integration issues. All these problems need to be addressed, and will be in time. Meanwhile, as several recent products have proven, practical commercial neural net applications are a real possibility today.

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