

ANN a good little learner



Even supercomputers are poor competition for the human brain when it comes to forecasting stockmarket movements. But the gap is closing, report Tapen Sinha and Clarence Tan. Research overseas and in Australia



shows that artificial neural networks can be trained to predict share prices with some success, and they're becoming smarter.

A biological neural network is the mechanism through which an organism's nervous system functions, enabling complex tasks to be performed "instinctively". Even simple organisms — for example, garden slugs — have sets of instructions "programmed" into their nervous systems.

The central unit of the nervous system is a neurone. The human brain has 100 billion neurones, each connected to many others by synapses. The human nervous system has 100 trillion synapses. These connections control the functioning of the body and its thought processes. Our ability to see objects, understand speech and think thoughts depend on the workings of the biological neural network.

An artificial neural network (ANN) mimics the biological neural network, although the differences between the two are substantial. Today's computer elements can operate millions of times faster than biological neural switch time. But there is far greater connectivity — by a multiple of thousands — between neurones in the nervous system than in serial supercomputers. Moreover, the processing of information in the human nervous system is carried on simultaneously in several layers of networks. In computer jargon, there is massive parallel processing in the nervous system. Computers are still far from achieving that. Even so, the performance of digital (artificial) neural networks in some areas has been impressive.

ANNs have been applied in many fields where it is necessary to recognise patterns in data and to make predictions. They have been used in military

applications such as identifying targets in battlefields, diagnosing cervical cancer from the results of medical examinations, investigating fraudulent insurance claims, generating credit ratings from economic information, predicting future share prices from past share price data and interpreting buying and selling signals in the sharemarket.

In Australia, ANN has been used by Medicare to identify general practitioners who routinely inflate their fees. Usual methods of making such checks would be extremely time-consuming: processing a year's records might involve handling billions of items of information. ANN can efficiently accomplish this.

When is ANN useful?

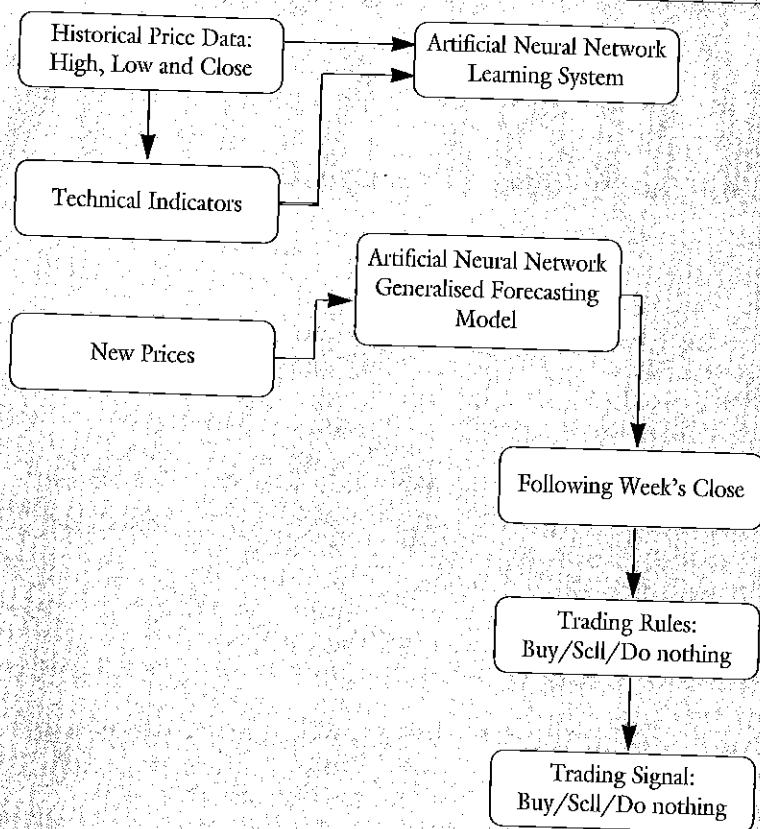
If a quantity of information is manageable and if averages matter but variation does not, conventional statistical methods, which deal with only one problem at a time, may be sufficient. However, if large bodies of data are to be scrutinised and if the volatility of the set of variables under scrutiny "matters", then ANN may provide a better alternative.

In finance, researchers know that variability does matter. ANN therefore becomes useful because it is capable of *simultaneously* finding all patterns that are produced by non-linear connections.

Some academics argue that any ANN program (for predicting a market index or a particular company's share price) has to overcome objections from Modern Portfolio Theory, which implies market efficiency. The implication of market efficiency is that it is

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FIGURE 1: SCHEMATIC DIAGRAM FOR GENERATING TRADING RULES



impossible to make a profit by using past information from time series alone.

However, if we carefully document the "evidence" in favour of stockmarket efficiency, we find:

- the evidence is mainly about not rejecting the null hypothesis about market efficiency; and
- the tests are all joint tests of linearity and normality of the model.

To put it differently, there may be non-linear (and complex) models that are able to predict the future value of shares from information about past prices.

In early ANN research, physicists were speculating about applying ANN to analysing stocks. The first such application, by Professor Halbert White of the University of California, San Diego, used daily price data for IBM stock but produced inconclusive results. However, many commercial ANN programs are now including stockmarket prediction as a part of a package.

How successful have ANN-based programs been? Most traders appear reluctant to talk about them. However, according to the *Economist* (October, 9 1993), Fidelity Investments used an

ANN-based program to pick 200 stocks out of 2000. Then human experts chose 50 in which to invest. The portfolio beat the Standard and Poor's 500 by 2 per cent to 7 per cent per quarter over three years.

Fujitsu in Japan has experimented with applications of ANN in the stockmarket. Its ANN program marginally beat the market index in Japan during a boom and it did much better than the index during a bear market. This performance matched the pattern found for human technical analysts; in this sense, over a period of several years, the ANN programs closely mimicked human experts.

ANN-based trading systems

The operation of an ANN-based trading system is illustrated in Figure 1. The example uses the system to forecast a share price using past data about the company (volume of trades, weekly highs and lows, a few moving averages). Using past data and applying ANN, buy/sell/do-nothing signals are generated.

The ANN was tested by applying it to the ANZ share price. Input to the network consisted of the high, low and closing prices of the stock and four

other common technical indicators derived solely from the price data such as the moving average, etc. The weekly high, low and closing prices of the stock from September 1, 1989, to March 5, 1993, gave a total of 184 sets of observations. The first 100 observations in the data set were used to "train" the ANN and the remaining 84 were used as the validation or test set.

The predicted values were fairly accurate for the first 50 observations outside the training set. The remaining 34 predicted values performed less well. This is to be expected: as we move further into the future, our predictions *by any means* become less reliable.

Is ANN a fad?

The problem that has plagued ANN in the past is that there were too many tall claims about its abilities to discover patterns. The reason is that ANN is an interdisciplinary tool. Therefore, if medical scan researchers use the contraction of muscle tissues as an analogy for stockmarket behaviour, they might be missing something obvious to researchers in finance.

The other problem that plagues ANN research is that most of the applications are "black box" applications; that is, we find ANN works in diverse fields, but *why* it works is not well understood. This makes many theorists nervous.

There are signs that academic researchers, who are generally dismissive of claims of market inefficiencies, are taking ANN seriously. In 1993, a large conference of researchers at the London Business School focused exclusively on the applications of ANN in finance. A similar gathering is taking place this year at the California Institute of Technology in Pasadena, California.

In a very fundamental sense, ANN is a product of recent advances in the speed of computers. If computers had the same speed today as they had 20 years ago, implementation of ANN in "real time" would be impractical.

However, even today's computers have difficulty implementing ANN because all computers process information serially (one instruction at a time). *Biological* neural networks, on the other hand, process information in parallel. We will see better realisation of ANN's full potential only when massively parallel processors (the so-called sixth generation computers) come into existence. ■