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At the winter meeting of this year's International Joint Conference on Neural Networks (IJCNN-WASH-DC-90), sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and the International Neural Network Society (INNS), a panel of experts described major government sponsored efforts to develop neural technology in Europe, Japan, the US and around the world.

The government panel was chaired by Harold Szu, a researcher at the Naval Research Laboratory. Szu's panel represented the countries around the world that are most actively sponsoring neural network research and development.

In summary, the Japanese government is promoting long-term basic research on the 10 to 20 year time scale for neural and other biologically inspired technologies. In comparison, the US government is already funding large projects to develop and deploy defense applications of neural networks in one to four years. In comparison, Europe has only a small defense-oriented interest in neural networks. Instead, there are many European government-sponsored programs that are oriented toward next-generation commercial applications of neural networks in two to eight years.

EC. The consolidated European Community (EC) has several programs to develop neural hardware and applications. Its PYGMALION program (see International Journal of Neurocomputing (IJN) 1

(2) (1989) 47–52) is designing a neural network workstation and modeling language with \$6 million over two years (1989–1990). The EC's companion program, called ANNIE, is aimed at applications of neural networks for industry in Europe. It is also funded with \$6 million, but over three years from 1989–1991.

A program which is already putting the EC in the forefront of next-generation information technologies is the European Strategic Program for Information Technology ESPRIT. Though ESPRIT has many facets, it has evolved to include neural-inspired designs. The original program was two years of basic research funded with \$7.2 million over 1988–1989. Its successor, ESPRIT II, will run for four more years, 1990–1994 with from \$36 million to \$48 million.

FRG. Besides its EC participation, the West German government has originated several programs, such as that of the Federal Ministry for Research and Technology. Its Bonn-based program, called Information Processing in Neural Architectures is designing neural hardware for pattern recognition, associative memories and control of autonomous vehicles. The three-year initial phase, funded with \$7 million (1988–1990), will be followed by a four-year second phase (1991–1993) with an estimated budget of \$18 million.

Another program in the FRG is that of the Ministry for Science and Research in Northrhine-

Westfalia. This Düsseldorf-based effort has originated its Neuroinformatics program. This academic program involves granting five endowed professorships for life, its three-year start-up phase to cost \$3.75 million.

Two provincial governments in the FRG, Bavaria and Hesse, have started their own programs. Bavaria has endowed two professorships and five scientific assistants for a total expenditure of \$4 million/year.

Italy. In Italy there are many small independent programs, albeit with little documentation on how much is being spent (estimated to be several millions of dollars). Both the Ministry of Education and the Ministry of Research also have large multidisciplinary projects that include neural networks. Its Prometheus has neural network related projects in two of its eight research areas (\$237 million over 8 years). Another multi-year program called Jessi (\$48 million) has just a little neural network support.

UK. The United Kingdom has been concentrating on a cooperation between academic departments and industry. The Department of Trade and Industry and its partners have spent about \$4 million on neural network projects so far plus there are significant defense department programs. The UK is also an active participant in the international Human Frontier Science Program.

Finland. The Ministry of Education in Helsinki is spending about \$200 000 annually. And the Technology Development Centre of the Ministry of Trade and Industry is also sponsoring many independent programs. In Finland, the FinSoft parallel computing research project is also investigating neural networks with about \$350 000 per year.

Japan. By far, the largest government investors in neural network technology are in Japan, which has made the biological sciences the key to their information technologies for the 21st century. Japan is

promoting basic research in the private sector with national projects and subsidy programs. It is also providing significant financial support to non-profit organizations.

Its first program to exploit the biological sciences for information processing technology is the Human Frontier Science Program. HFSP will likely run for 20 years, from 1989–2009. The Japanese government has committed \$18–24 million per year to the program. Japan has also asked the other Group of Seven countries (US, UK, France, Italy, Canada, FRG) to contribute equal amounts in return for sharing the results, but none have done so yet.

Japan is also organizing a 6th generation project to follow up the 5th generation artificial intelligence program. Though still in the formative stages, it is currently being organized by Japan's International Institute for Novel Computing. It will include 12 specialities including neural networks, biocomputing, genetic algorithms, optical techniques, molecular computers, parallel distributed approaches, linguistics, novel software, multimedia, human interface, social hypercomputing, and new logic such as fuzzy set theory. The 6th generation project will also enlist the cooperation of US universities as well as European and Japanese companies.

Besides the Human Frontier Science Program, the Japanese Prime Minister's Council for Science and Technology Assessment (STA) is also sponsoring several related programs. Its Riken Frontier Science Program, for instance, will run for 15 years with funding of \$3 million per year. A separate brain function program will run for 3 years with \$500 000 per year.

Japan's Ministry of Trade and Industry is also sponsoring a biodevices program which will run for 10 years with \$2.5 million per year. And Japan's Ministry of Education is running a similar program aimed at the elucidation of higher brain functions for 3 years at \$2 million per year. And Japan's Ministry of Telecommunications has its own smaller neural network research program funded with \$200 000 per year.

Japan has also started its own neural network organization, called the Japan Neural Network Society (JNNS) with about 450 members.

USA. In the USA there is significant government support, although most of that money is spent in the defense sector. Those governmental agencies that are not defense-related include the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the National Institute of Mental Health (NIMH), the National Institute of Health (NIH), the Post Office, the Treasury Department and the Department of Energy.

However, none of these programs is spending on neural network research in the magnitudes that the defense establishment is. In the Department of Defense there are numerous agencies spending heavily on neural network technology. Notably the Navy, the Defense Advanced Research Projects Agency (DARPA), the Army, the Air Force, the Marines, Defense Nuclear Agency (DNA) and Defense Communications Agency (DCA).

DARPA has spent over \$12 million in 1989 on defense-related research projects and plans to spend another \$12 million in 1990. The Navy also has begun a five year \$18.5 million program (1989–1994). Its vertically integrated research efforts are specifically aimed at voice recognition, automatic speech translators, image processing, automatic target recognition, missile seekers, synthetic aperture radar processing, sonar signal detection/classification and missile fuse timing.

The National Institute of Mental Health

(NIMH) is sponsoring a nondefense related program called the Mathematical/Computational/Theoretical Neuroscience Program. It is taking the opposite tact from most other programs. Instead of studying the brain to build machines, NIMH is studying artificial neural networks to elucidate understanding of the brain. The program is funded at approximately \$1 million per year.

The National Science Foundation also has a \$1.2 million per year program that focuses on algorithmic issues that may help to understand the real brain. NSF has several other programs, for instance, the Computer Information Science and Engineering Directorate within NSF considers neural networks another architectural approach and focuses on the theory of architectures. The Information, Robotics and Intelligent Systems Division has three programs that have funded neural network research in the past. The NSF's Computer and Computation Research Division has two programs. And the NSF's Microelectronics Information Processing Systems has three programs.



R. Colin Johnson is an independent writer and analyst specializing in next-generation technologies. He is author of the *Neural Network Almanac* and *Cognizers – Neural Networks and Machines that Think* (John Wiley & Sons). Mr. Johnson also writes newspaper and magazine articles for *The New York Times*, *Omni*, *EE Times*, *The Scientist*, *PC AI*, *Macintosh News* and *MacWorld* among others.