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Free software creates largest neural simulation

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Singapore: Researchers from the Riken HPCI Program for Computational Life Sciences, the Okinawa Institute of Technology Graduate University in Japan and Forschungszentrum JÃ¼lich in Germany, have carried out the largest general neuronal network simulation to date.

The simulation was made possible by the development of advanced novel data structures for the simulation software NEST. The relevance of the achievement for neuroscience lies in the fact that NEST is open-source software freely available to every scientist in the world.

NEST is a widely used, general-purpose neuronal network simulation software. The team ensured that their optimizations were of general character, independent of a particular hardware or neuroscientific problem. This will enable neuroscientists to use the software to investigate neuronal systems using normal laptops, computer clusters or, for the largest systems, supercomputers, and easily exchange their model descriptions.

Using NEST, the team, led by Mr Markus Diesmann in collaboration with Ms Abigail Morrison, both now with the Institute of Neuroscience and Medicine at JÃ¼lich, succeeded in simulating a network consisting of 1.73 billion nerve cells connected by 10.4 trillion synapses. To realize this feat, the program recruited 82,944 processors of the K computer. The process took 40 minutes to complete the simulation of one second of neuronal network activity in real, biological, time.

Although the simulated network is huge, it only represents one percent of the neuronal network in the brain. The nerve cells were randomly connected and the simulation itself was not supposed to provide new insight into the brain - the purpose of the endeavor was to test the limits of the simulation technology developed in the project and the capabilities of K. In the process, the researchers gathered invaluable experience that will guide them in the construction of novel simulation software.
This achievement gives neuroscientists a glimpse of what will be possible in the future, with the next generation of computers, so called exa-scale computers.

"If peta-scale computers like the K computer are capable of representing 1 percent of the network of a human brain today, then we know that simulating the whole brain at the level of the individual nerve cell and its synapses will be possible with exa-scale computers hopefully available within the next decade," explains Mr Diesmann.

Memory of 250.000 PCs

Simulating a large neuronal network and a process like learning requires large amounts of computing memory. Synapses, the structures at the interface between two neurons, are constantly modified by neuronal interaction and simulators need to allow for these modifications.
More important than the number of neurons in the simulated network is the fact that during the simulation each synapse between excitatory neurons was supplied with 24 bytes of memory. This enabled an accurate mathematical description of the network. In total, the simulator coordinated the use of about one petabyte of main memory, which corresponds to the aggregated memory of 250.000 PCs.