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Selfadaptation of Artificial Neural Networks

Today, most artificial neural networks have a more or less fixed architecture. Usually, the network is divided in layers, every layer is connected to the predecessor- and postdecessor-layer. In widespread neural architectures, this layers consist of a fixed number of neurons and can not be extended if the existing network is already trained. Network architectures, which allow to add new neurons to the network during the training phase, are for example the cascade correlation networks. [Fahl90] Nevertheless these networks are fixed in the number of and connection between the layers. Every artificial neural network contains only one type of neurons, it is not possible to mix up two or more different neuron types like perceptrons and RBF-neurons. These neurons are always strongly simplified, and rarely show similar behaviour to the natural neurons.

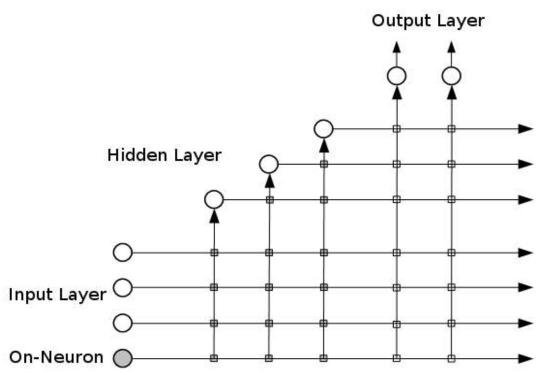

Fig1: Cascade Corelation Network

Natural neural networks can obviously adapt the number of neurons and its connections very freely. In infant brains short after birth, the neurons are not very strongly connected, but the connections build up very fast [Hers88]. Even new neurons can be created [Hers88] and neurons can be removed due to apoptosis from the existing network.The connections in these networks are very variable, no layers can be detected and connections rarely seem to be orderd. Neurons are often connected to neurons in other brain regions via axons, that bridge rather high physical ranges.

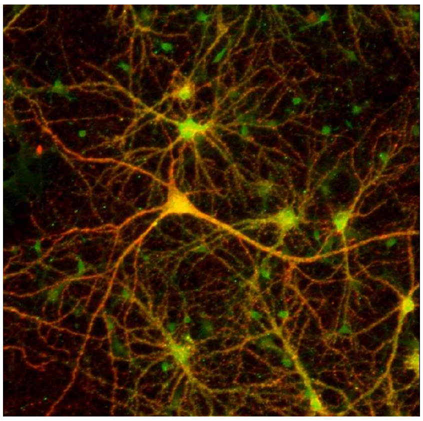
Fig2: Neural network from a mouse brain

Structures of neural networks in the brain are similar to other grown structures in nature, like filamentous fungi, growth of tree branches or plant roots. Especially the structures of the hyphae in the mycelia of filamentous fungi seems to show analogies to grown natural neural networks. [Hemp05]

Today artificial neural networks have become a niche of the modern research, many of the hopes researchers had in the 1980s and 1990s did not fulfil, and industrial use of neural networks is restricted to very few applications. [Ande92]. Reasons are, that these networks have a high complexity to learn, and need high resources to work. Existing networks have a high generality but are less specific for applications. Natural brains have specific regions with specific types of neurons for many specific tasks. The networks are highly selfadaptable and can adapt to new situations fast. This capability results in high robustness.

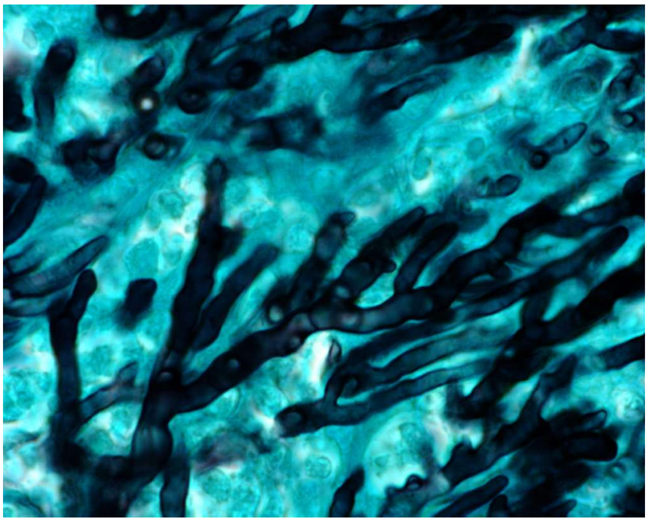

Fig3: Hyphae in thy mycelia of *Aspergillus fumigatus*, a filamentous fungi

Aim of resarch in neural networks should be to become inspired by this natural capabilities. As a roadmap for research in artificial neural networks scientists should work closer to the natural draft and not concentrate on building neural applications which are more artificial. The more or less fixed network architectures should be overcome. Unfortunately, it is easy to look into existing natural neural networks in brain transections but it is not possible to look at the growth or development of the neural networks. In this case other natural network like structures like fungi mycelia could be analysed.

First of all natural neural networks should be analysed carefully, common network structures should be determined. At the same time, types of neurons in brains should be determined and modeled close to the biological neurons.

Secondly the growth of filamentous fungi should be observed under different conditions, especially the growth toward food, as a directed aim. Some slime mold (Mycetozoa) can even solve mazes during growth. [Naka00] Those observations should also be compared to brain transections from animals at different timepoints. So a model for the progessive crosslinking of neural networks should be obtained and then modeled as specific selfadaptable artificial neural networks. This networks should be quite specific, because they can choose from a collection of different types of neurons during selfadaptation, and build up networks for specific tasks. Resultig networks will be very robust, because the loss of one or more neurons can be compensated simply by letting the lost neurons grow again. The network can also adapt to change of environmental influences by rearrangment of the network structure.

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