Scanning Patterns in Fractal Neural Nets

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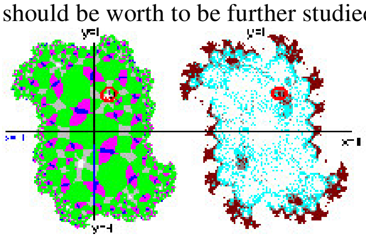
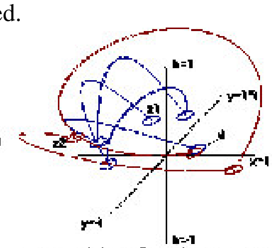
Fractal functions define how to project the complex plane to itself. As shown earlier(1), neural nets may reflect those functions directly. (Neurons will project their activity to neurons, which are determined by the fractal function. In this model, neurons replace complex numbers, their axones follow the course of the corresponding trajectories through the complex plane). Like in fractals, in fractal neural nets, a neural activity will be projected to another place within the neural net. Thus we get a topographic(“somatotopic”) projection of the net to itself. By iterating the projecting procedure, a remarkable connectivity between the neurons of the net will be established. A neuron at any place of the net might be activated by neurons at a very distance. Assuming, (as it is the case in most biological neural systems), recurrent connections between neural columns, any neuron might, by its dendritic tree, get activity from a wider part of the net. In reverse, activation spreading out from this neural column may activate these parts of the net again. These regions represent in fractal neural nets parts of Julia-sets. The neurons, respetively neural columns, of these Julia-sets are not directly, but functionally, connected with each other. Using these connections, they might be able to synchronize their activity, to form ensembles of synchronous active neural columns, which might be an important feature to represent complex concepts.
Starting with any specific pattern, the course of the iteration will lead to a degree of activity at each neural column, which is completely specific for this pattern. The starting pattern might thus be stored by a specific distribution of activity at each neural column (and within the net). The starting pattern might be reconstructed by the reversed activation of the corresponding Julia-sets. Each Julia-set will be quite different in shape to the starting pattern, but the overlapping action of the Julia-sets may reconstruct the starting pattern successfully. (This might be a good model for thinking in complex patterns).
It may be allowed to emphasize, that there are multiple options to use the specific sequences of activity occuring at each neuron of the net. Each starting pattern will cause a specific sequence of activity at each neural column, depending on the localization within the neural net, the constant vector, which is determining the course of the axons within the net and the radius of the dendritic tree. Assuming (hypothetically), neurons might be able to store the degree of the incoming activity in form of a molecular chain (f.e. a nucleic acid)(2), this memory-“string” could be used to activate the net reversedly to reconstruct the original pattern within the net. These intracellular strings might be used to compare patterns to reproduce associative senseful “answers” of the net to any presented pattern(2).
All these mechanisms could not only occur in two-dimensional neural nets, but as well in three-dimensional fractal nets, which reflect corresponding three-dimensional fractals. Some figures might illustrate these concepts and demonstrate, that they should be worth to be further studied.

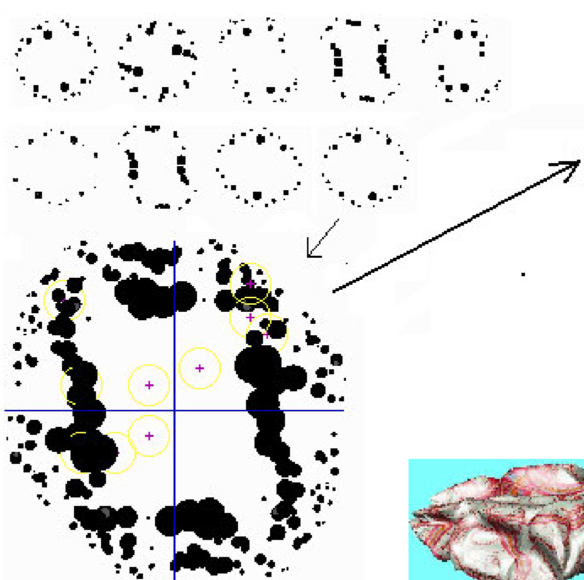


above: connectivity of the net

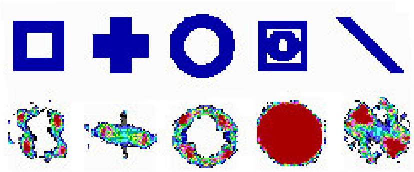


ensemble of active neurons

two Julia-sets representing the regions of the net, which may activate the encircled region and might be activated reversedly by this region

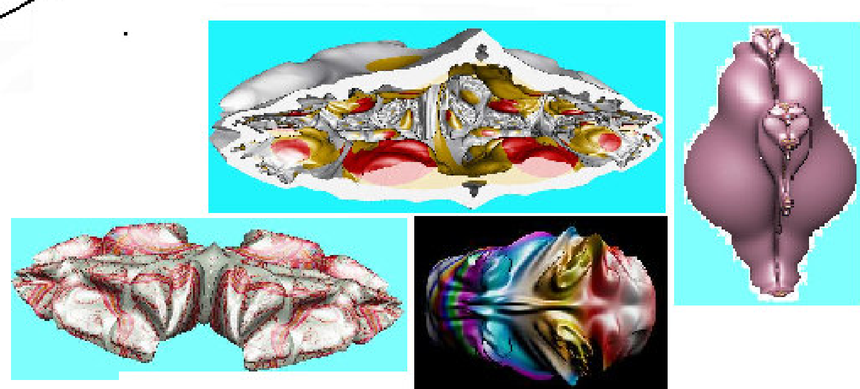


above: overlapping Julia-sets reconstruct a quadratic structure



left: starting pattern of activity

reconstructed patterns



Threedimensional Julia-sets, which may work as neural nets

References:
(1) Kromer T, Spatial neural networks based on fractal algorithms.B. REUSCH (ed.) lecture notes in computer science; Vol. **1625** (1999) pp. 603-614. 3)
(2) Kromer T, Tomography in fractal neural networks. B. REUSCH (ed.), lecture notes in computer science; Vol. **2206** (2001) pp. 917-923.