DETECTOR ARTIFICIAL NEURAL NETWORK. NEUROBIOLOGICAL RATIONALE

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On the basis of the formulated hypotheses the information model of a neuron-detector is suggested, the detector being one of the basic elements of a detector artificial neural network (DANN). The paper subjects the connectionist paradigm of ANN building to criticism and suggests a new presentation paradigm for ANN building and neuroelements (NE) learning. The adequacy of the suggested model is proved by the fact that is does not contradict the modern propositions of neuropsychology and neurophysiology.

Some modern research [1, 2] argued that ANN that are constructed on the basis of the known models of neural elements (NE) and use the connectionist paradigm of NE relationship establishing are just universal approximating devices that can simulate any continuous automatic machine to any given accuracy.

Evidently, the adequate information models of neurons –NE of ANN and the approaches to ANN building should interpret and accumulate modern concepts of neuropsychology and neurophysiology about the mechanisms of information processing by neurons and brain modules.

The key point in the development of the given models can become the resolution of the problem of so-called 'neural code'.

But what information does the 'visible' neuronal response contain? What information does it react to and how does it process this information? The impulse activity of a particular neuron seems to tell only about its excitation to a certain degree.

We will suggest the following statement that has neuropsychological grounds.

Statement 1. *Specific subjective perception of input image is connected with the excitation response of a single neuron or a group of specifically linked neurons. The excitation of a particular neuron is the essence of perception and the result of information processing.*

A set of neuronal ensembles at all the stages of information processing is called the presentation of the input image.

Information system that makes presentations which all together create a subjective

picture of the world is called a presentative system.

It is known that to excite a neuron at least two input information components are important – the fact of excitation of particular presynaptic neurons and the level of the excitation.

Thus, the following hypothesis can be formulated.

Hypothesis 1. *The main information components of any neuron response are:*

1) the location of the excited neuron in a certain structure (module) of the brain that is determined by its 'address' which is coded in the output signal;

2) the level of the neuron excitation that is coded by the frequency of generated impulses (spikes).

According to the suggested hypothesis 'address' response of the excited neuron-detector is the basic information which is fed to subsequent neurons in the reflex arch, and the frequency response in this case plays a significant role in the process of 'competitive activity' of simultaneously excited neuron-detectors defending the right to participate in the further information processing.

The following hypothesis can be suggested.

Hypothesis 2.

a). A set of excitatory postsynaptic potentials (EPSP), the total value of which, enables getting over an excitation threshold of neuron is a set of necessary and sufficient conditions for its excitation.

b). As local EPSP is connected to the excitatory level of specific presynaptic neuron, to identify whether this particular EPSP belongs to the set of necessary and sufficient conditions of postsynaptic neuron excitation is possible on the basis of the excitatory neuron address.

c). A set of 'addresses' of presynaptic neurons, the excitation of which creates a set of necessary and sufficient conditions for exciting this specified postsynaptic neuron, is made in the process of neuron learning. In the process of learning the neuron memorizes only those 'addresses' of presynaptic neurons, the excitation of which with the specified excitatory level (the frequency of excitatory impulses) will become a necessary and sufficient condition for its own excitation.

We will state the following important definition.

A set of 'addresses' of presynaptic neurons, the excitation of which is a necessary and sufficient condition for exciting a postsynaptic neuron bound to it, is called the concept (*Con*) of this neuron.

Thus, to determine whether the ‘addresses’ of presynaptic neurons belong to *Con* of a postsynaptic neuron is possible while learning either with or without the ‘teacher’. ‘Teachers’ are the corresponding neurons of other subsystems, for example, a representative subsystem. Evidently, the more often the ‘address’ of a particular presynaptic neuron appears in the process of learning in the vector of input signals, the greater the probability that this ‘address’ belongs to its *Con.*

This hypothesis absolutely agrees with Hebb's classical postulate.

Grounding on the suggested hypotheses we can make an information model of neuron detector.

References

1. S.E.Gilev, A.N. Gorban. On completness of the class of functions computable by neural networks. Proc. of the World Congress on Neural Networks (WCNN’96). Sept. 15-18, 1996, San Diego, CA, Lawrens Erlbaum Accociates, 1996, PP. 984-991.

2. Y. Bodyanskiy, I. Perova and P. Zhernova. Online fuzzy clustering of high dimension data streams based on neural network ensembles. Innovative technologies and scientific solutions for industries. 1 (7). 2019. pp. 16-24. doi: 10.30837/2522-9818.2019.7.016.