MODELING OF COGNITIVE PROCESSES BY NETWORK MODELS

Sergii Konovalenko

***Abstract**: The paper describes the conceptual issues of modeling cognitive processes network models at different levels. Describes possible methods construction of intelligent information processing systems based connectionism attitudes and behavior of the human mind. Proposed use of synthesis of hierarchical model based on two approaches: from neuron to concepts.*

***Keywords**: cognitive process, network model, neural networks.*

***ACM Classification Keywords**: I.2 ARTIFICIAL INTELLIGENCE – I.2.6 Learning – Connectionism and neural nets.*

Introduction

In today's world to solve various problems often used system of intelligent information processing (SIIP). The construction of such systems are usually associated with using methods and means of artificial intelligence. Modeling of thinking and the human memory can effectively solve tasks. Such information processing systems possess having such important properties as learning ability, as adaptability, helping them to solve problems or badformalization under uncertainty (incomplete data) to make decisions. The theory of neural networks in the last decade gained a lot of practical applications in various fields of science and technology. In [Moroz, 2011] proposed the use of a mathematical model of an artificial neural network to recognize the risks of violation of customs legislation, which was modeled by the possibility of the brain to detect objects on the evidence available. In [Yu.Zaychenko, 2008] uses fuzzy logic and Group Method of Data Handling for different kinds of economic problems. A modeling of cognitive functions of the human mind has always worried scientists not only to solve the problem of creating artificial intelligence, but also to create SIIP for applications and still is an important task.

Problem definition

The purpose of this paper is consideration of the theoretical and conceptual application ways of modeling cognitive processes using networks models, in connection with which there is a need in the following tasks:

1. Consider a biological model of the nervous system;
2. Identify the main approaches to the modeling of human thinking;
3. Choose the best way to create a network model of cognitive information processing.

Biological aspects of cognitive activity

Cognitive processes in the human brain are the participation of many cells (neurons) responsible for the perception, transmission and storage of information. Nerve cells acquire their unique characteristics and form a well-organized synaptic connections during development under the influence of genetic and environmental factors [Nicholls, 2001]. As a rule, initially formed the excess number of neurons, some of which later died. Providing a certain population of neurons located dense layers. For example, in the retina cells are arranged in layers:

1. photoreceptors;
2. Horizontal cells;
3. Bipolar cells;
4. Amokrinos cells;
5. Ganglional cells.

This layering is inherent throughout the nervous system. In addition, in many areas of cells grouped into spherical structures (nucleus). You must also identify types of interneuron connections:

1. Convergent;
2. Divergent;
3. Lateral;
4. Recurrent.

From this it can be concluded that a fiber parallel information processing difficult and feedback interactions.

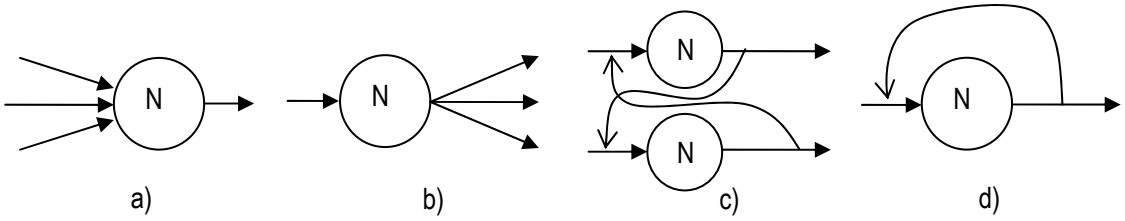

Figure 1. Types of interneuronal connections. a) convergent; b) divergent; c) lateral; d) recurrent.

To create the necessary architecture of neurons form in the required amount, what would they in turn formed a connection with the target cells (output vector). The nervous system has $10^{10} - 10^{12}$ nerve cells connected to each other. The emergence and change is the result of relationships of cell activity. Interestingly, the neurons of the deepest cortical layers are formed in the first place, and surface - and later migrate through the deep layers of the cells to the site of its location. By now shown that the formation of synaptic connections is a selective process. An interesting fact of the nervous system is the fact that many of its neurons to die during development, followed by the reduction of ties.

In total we can say that the central nervous system is a continuously operating an array of cells that continuously receive information, analyze, process, and make decisions, that is, make inferences (conclusions).

Network models for development SIIP

In the context of developing SIIP can distinguish information-processing model (Fig. 2).

The functioning systems of intellectual information processing involves himself several important steps:

1. Getting information from the external (internal) sources, e.g. reception;
2. Preparing Data (preprocessing) [Moroz, 2011], [BaseGroup];
3. Information processing;
4. Interpretation of results (postprocessing).

Each of these steps can be represented by the corresponding cells in the retina. This approach is described in [Swingler, 1996], [Haykin, 1998]. But we must remember that the cognitive abilities of a person is difficult at times to describe only the neurons. Especially when it comes to concepts such as feeling emotions, intuitive decision-making, social behavior, etc.

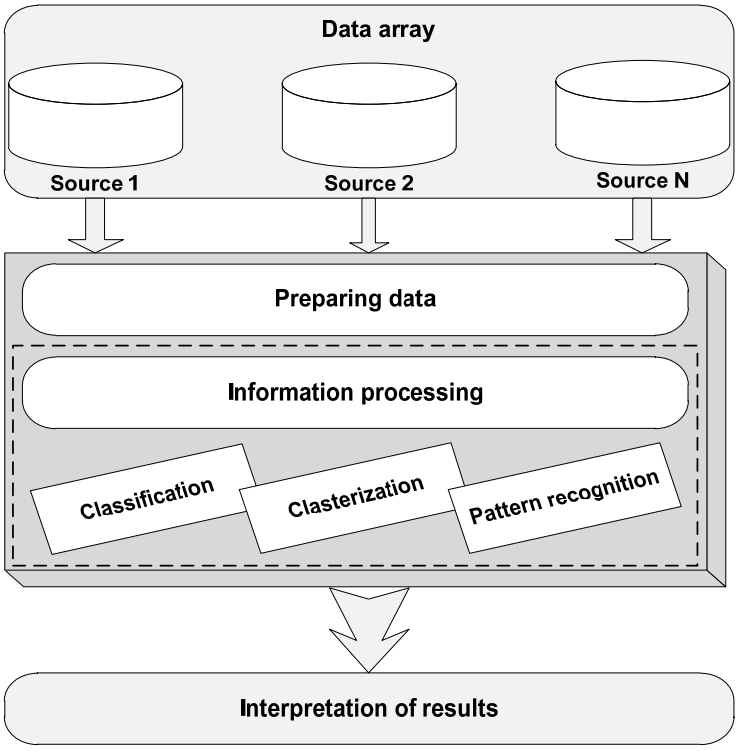

Figure 2. Model of the information processing system

Academician N. Amosov wrote that "the mind - the ability to respond to appropriate challenging external environment» [Amosov, 1969]. He said he did not expect a complete elucidation of the structure of the brain anatomy, and it is necessary to study human behavior as a whole system and model. Amosov proposed the structural focus not on individual cells, and to use their set - neural sets. Neural sets are functional units of information processing systems, which interact with each other, mimic human intellectual activity. This representation uses neural associative capabilities thinking at the level of building architecture.

Interesting associative semantic structure proposed V. Gladun [Gladun, 2000]. He developed a model of intelligent information processing as growing pyramidal networks that form in learning optimal network model. This approach shows the hierarchical ordering and unlike the neural structures does not introduce extra elements in the adaptation.

Models described above, showed good results and information processing have been implemented in application suites. You should also remember the mental maps as an effective mechanism of associative memory. Mental maps clearly show that the processing of information on the association and semantics more digestible (cognitive occur incoming data compression).

Variations network models based on computational neurons are also varied and effective [Bishop, 2007]. In [Ye. Bodyanskiy] you can see the application of the pure neural approach in its different variations, where the efficiency of the network confirmed experimentally. Creating a hybrid network models (fuzzy logic, GMDH, genetic algorithm) also shows its effectiveness [Yu. Zaychenko, 2008].

Given the above, will offer a strategy to build an effective model for intelligent processing of information based on network models. Obviously, using the hierarchy in the construction we will be able to take into account the complexity of brain activity. This can be described by the following levels:

1. Neurons;
2. Set of neurons (semantics);
3. Education system.

When creating the initial structure of the neural network can be used two ways: destructive and constructive. Since redundancy is a safety factor, it probably should be used first.

In the process of learning to include the natural learning model. Using not only the training examples, but also to model concepts such as pain (physical injury or emotional turmoil.)

In general, today higher nervous activity are not yet fully understood. And concepts such as creativity, intuition, the subconscious, etc. not fully transcribed both from a functional and anatomic point of view.

Conclusion

Following conclusions can be that for an effective system of intellectual processing of the information, which could simulate the cognitive abilities of a person, you must consider the following factors:

1. The process of formation of elementary neurons;
2. Methods of organization of neurons in the higher hierarchy;
3. Inclusion in the learning process of natural learning models.

Given the aspects of hierarchy levels of the organization network models can account for both the elementary properties of neural cells, and semantic features of human thinking.

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Major Fields of Scientific Research: Artificial intelligence, computation intelligence, machine learning