

риала и размеров и уменьшается с увеличением количества деталей за счет их взаимного теплового излучения.

Список литературы

1. Lopatin I.V., Schanin P.M., Akhmadeev Y.H., Kovalsky S.S., Koval N.N. Self-sustained low pressure glow discharge with a hollow cathode at currents of tens of amperes // *Plasma Physics Reports*. 2012. Vol. 38, Issue 7. P. 583–589.
2. Коваль Т.В., Лопатин И.В., Огородников С.А., Нгуен Бао Хынг. Исследование генерации низкотемпературной плазмы в тлеющем разряде с полым катодом большой площади // *Известия вузов. Физика*. 2014. Т. 57, № 3/2. С. 122–125.

УДК 004

MODERN OPTIMIZATION PROBLEMS DECISION MADE USING NEURAL NETWORK HOPFIELD

Hatem Hassanin

Scientific advisor: Berestneva O.Gr.

National Research Tomsk Polytechnic University, Tomsk, Russia

E-mail: Hatem@tpu.ru

Annotation

The purpose of writing this paper was to study the solution of optimization problems using Hopfield neural network in Matlab environment in order to improve that Neural network as artificial intelligence best method for provide the solutions for optimization problems. This purpose can be achieved through the following steps:

1. *Formation of the basic operation of neural networks;*
2. *Allocation of the problems encountered when solving optimization problems using Hopfield neural network using Matlab [1];*

*Neural network operates cyclically. Each of the four Hopfield neural network has outputs a signal, which is input, to all other neurons but himself, however, this network cannot be taught almost anything. Network consisting of N neurons cannot remember more than $\sim 0.15 * N$ images. Therefore, the real network should contain enough impressive number of neurons. This is one of the major flaws of the Hopfield network – a small container. In addition to all the images, do not need to be very similar to each other, or in some cases perhaps looping for recognition.*

Keywords: Optimization, hemispherical, minimization of nonlinear functions, stable point, the basin of attraction.

Ключевые слова: Оптимизация, полусфера, минимизация нелинейных функций, устойчивая точка, бассейн притяжения.

The task is to consider the discrete Hopfield network with nine bipolar neurons to recognize non-ideal images of letters H. Images S^1 , this letter are shown in fig. 1, the same numbering given pixel corresponding Hopfield neural network and their vector representation [2]:

$$S^1 = (s_1^1, \dots, s_9^1) = (1, -1, 1, 1, 1, 1, 1, -1, 1),$$

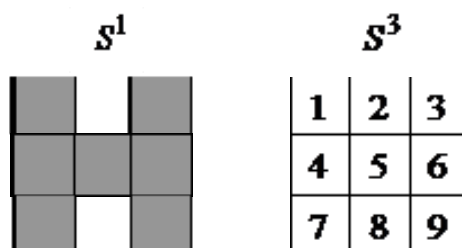


Fig. 1. Images of S^1 , S^3

Calculate the weight of the connection $w_{ij} = \sum_{k=1}^2 s_i^k s_j^k = s_i^1 s_j^1 + s_i^2 s_j^2, i \neq j$.

Calculate the weight of the connection w_{12} : $w_{12} = 1(-1) + 1.1 = 0$. Due to the general equality $w_{ij} = w_{ji}$ also get that $w_{21} = w_{12} = 0$. Similarly, the other elements are calculated.

$w_{ij}(i, j = \overline{1,9}, i \neq j)$ Weights matrix W ties the elements of the main diagonal of the matrix W at $=j$: $w_{11} = w_{22} = \dots = w_{99} = 0$. The calculation results of the matrix W given in table 1.

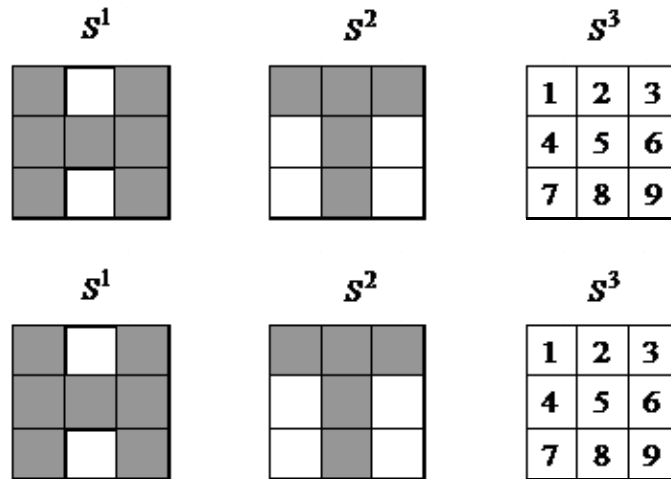


Table 1

Weight matrix relations

Neuron Number	Neuron Number								
	1	2	3	4	5	6	7	8	9
1	0	0	2	0	2	0	0	0	0
2	0	0	0	-2	0	-2	-2	2	-2
3	2	0	0	0	2	0	0	0	0
4	0	-2	0	0	0	2	2	-2	2
5	2	0	2	0	0	0	0	0	0
6	0	-2	0	2	0	0	2	-2	2
7	0	-2	0	2	0	2	0	-2	2
8	0	2	0	-2	0	-2	-2	0	-2
9	0	-2	0	2	0	2	2	-2	0

Thresholds bipolar Hopfield neural network is calculated as in table 1,

$$\theta_k = \frac{1}{2} \sum_{i,j=1}^9 w_{ij} = 4, k = \overline{1,9}.$$

We produce Hopfield network image S1 letter H, and calculate the outputs of the network after its removal at two thresholds: $\theta_k = 4$ и $\theta_k = -4$.

From the analysis of the data in table. 2 that the output image vector network repeats the image S 1 over a wide range of thresholds. We produce now S3, network image, the inverse image of S 3 (fig. 1). Is S 3I image can be viewed, as a distorted picture letter H, which has two negative components are lost. The results of calculations for this case when $\theta_k = -4$. are shown in table 3 (at $\theta_k > 2$ Image is not restored.).

Table 2

*The results of calculations of output signals after the Hopfield network
Presentation image S^1 letter H*

Neuron Number	Image components S1	Input signals of neurons	thresholds of neurons	The output signals of neurons
1	1	4	-4 or 4	1
2	-1	-10	-4 or 4	-1
3	1	4	-4 or 4	1
4	1	10	-4 or 4	1
5	1	4	-4 or 4	1
6	1	10	-4 or 4	1
7	1	10	-4 or 4	1
8	-1	-10	-4 or 4	-1
9	1	10	-4 or 4	1

Table 3

The results of calculations of output signals after the Hopfield network presentation image S 3

Neuron Number	Image components S3	Input signals of neurons	thresholds of neurons	The output signals of neurons
1	1	4	-4	1
2	1	-6	-4	-1
3	1	4	-4	1
4	1	2	-4	1
5	1	4	-4	1
6	1	2	-4	1
7	1	2	-4	1
8	1	-6	-4	-1
9	1	2	-4	1

Thus, we can conclude that the presentation of the package Matlab image S 1, S 3I network fell into a stationary point in one cycle time in the synchronous operation of all its elements.

Conclusion. Summarizing the study suggest the following conclusions:

1. Each neuron in the network Hopfield neural network receives and transmits signals to others. That is, the neurons connected to each other, depending on the type of network. Hopfield network is a single-layer network because it uses only a single layer of neurons. It is also a recursive network, because it has a feedback.

2. Solving optimization problems with neural networks using Matlab realized through image that detects or stores the network (any image input) can be represented as a vector of dimension X_n , where n – the number of neurons in the network. The output image represented by a vector Y with the same dimension. Each element of the vector can be set to +1 or -1 (can be reduced to 0 and 1, but the +1 and -1 is more convenient for calculations).

References

1. Isakova O.P., Tarasevich YU.YU., YUzyuk YU.I. Obrabotka i vizualizatsiya dannykh fizicheskikh eksperimentov s pomoshch'yu paketa «Origin» / M.: Knizhnyy dom «LIBROKOM», 2009. PP. 33.

2. Khokhlova, T.N. Ustoychivost' neyronnykh setey Khopfilda s zapazdyvaniyem / T.N. Khokhlova // Trudy sedmoy Vserossiyskoy nauchnoy konferentsii s mezhduna rodnym uchastiyem «Matematicheskoye modelirovaniye i krayevyye zadachi». – Samara: 2010. – P. 277.