DISCRETE MODELLING OF NEURONS

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Neural networks are constructed from a wide range of different views and this is reflected in a variety of results as well as mathematical techniques used in their derivation.

We consider the following system of $k$ ($k \geq 2$) difference equations in the form:

$$
\begin{align*}
    x_{n+1}^1 &= \beta x_n^1 - g(x_n^2), \\
    x_{n+1}^2 &= \beta x_n^2 - g(x_n^3), \\
    \vdots \\
    x_{n+1}^{k-1} &= \beta x_n^{k-1} - g(x_n^k), \\
    x_{n+1}^k &= \beta x_n^k - g(x_n^1),
\end{align*}
$$

where $n = 0, 1, 2, \ldots$ with $g(u) = \begin{cases} 
    a, & u \geq \alpha, \\
    0, & -\alpha < u < \alpha, \\
    -a, & u \leq -\alpha,
\end{cases}$

System (1) can be viewed as a discrete version of the corresponding $k$-neuron network model of differential equations, where $\alpha > 0$ represents an internal decay rate, $\beta > 0$ measures the synaptic strength, $x^i$, $i = 1, 2, \ldots, k$, denote the activations of the corresponding neurons and $g$ is a signal function.

Similar three-neuron model (1) with another signal function was investigated in [3]. We have studied previously one-neuron model with similar signal function in [1] and with different signal function in [2].

In our presentation we explore the dynamics of system (1). Some interesting results are obtained about equilibrium solutions and periodic solutions of this system.

REFERENCES


1This work was partially supported by the grant Nr. 345/2012 of the Latvian Council of Science.