APPLICATION OF NEURAL NETWORKS FOR PREDICTING EPIDEMIC PROCESSES

Piletskyi Pavlo, group number 355a
National Aerospace University – "Kharkiv Aviation Institute"

The process of studying the studied parameters in time is described by a dynamic series. Discrete and continuous time series are used in medical informatics in solving problems of epidemiology, clinical medicine (functional diagnostics), the study of morphometric data in order to predict their change.

The use of artificial neural networks to predict the level of infectious morbidity is relevant. Fluctuations in the incidence rate during the analyzed years, like fluctuations in perennial dynamics, arise as a result of the joint action of constantly active, periodically activated and irregular causes. The periods of activity of irregular random causes in the annual dynamics are distributed randomly over several years. The result of their action is the formation of "group morbidity" which is the reason for creating conditions for the occurrence of epidemic outbreaks. In order to identify patterns of occurrence of annual fluctuations, the incidence of Lyme borreliosisin the Kharkiv region was studied.

The epidemic process is of a nature in which long-term forecasting is not necessary. The epidemiological experts are only interested in the period of recession-epidemic-recession, since the dynamics of the spread of the epidemic process may change after outbreaks of disease as a result of measures taken to reduce it, as well as the natural extinction of pathogens.

Using neural networks to predict the incidence rate allows us to estimate the dynamics and tendency of the epidemic process. Neural networks compare favorably with statistical methods in that they are quite flexible and allow you to take into account an arbitrary number of external unknown factors, which is especially important in studying the epidemic process. Such third-party factors in different ways affect the change in the projected incidence rate. So, for correct prediction, a time series decomposition is necessary, i.e. forecast taking into account various external factors of trend, seasonal, irregular correction, etc. The integration of the dynamic range was carried out, which made it possible to predict the features of the course of the epidemic process.

The use of neural networks provides the following useful system properties:

- Nonlinearity. Artificial neurons can be linear and nonlinear.
- Display of input-output mapping. One of the most popular teaching paradigms is supervised learning.
- Adaptation. Neural networks have the ability to adapt their cynaptic scales to environmental change. In particular, neural networks, trained to operate in a particular environment, can be easily re-taught to work in conditions of minor fluctuations in the environment parameters. Moreover, for working in a

nonstationary environment (where statistics are changing over time), neural networks that change synaptic scales in real time can be created.

– Evidential response. In the context of the problem of image classification, one can develop a neural network that collects information not only for the definition of a particular class, but also to increase the reliability of the decision. Subsequently, this information can be used to exclude doubtful decisions, which will increase the performance of the neural network.

– Contextual information (contextual information). Knowledge is provided in the neural network itself by its activation status. Each network neuron can potentially be exposed to all other of its neurons. As a result, the existence of a neural network is directly related to contextual information.

– Fault Tolerance. Neural networks clad in electronics, potentially fail-safe. This means that under adverse conditions, their performance falls slightly. For example, if a neuron or its communication is damaged, the extraction of the filled information becomes complicated. However, taking into account the distributed nature of storing information in the neural network, it can be argued that only serious damage to the structure of the neural network will significantly affect its performance. Therefore, reducing the quality of the neural network is slow. Minor damage to the structure never causes catastrophic effects. This is obviously an advantage for calculations, but it is often ignored. To ensure fault tolerance of the neural network, training algorithms need to be put in place appropriate corrections.

The introduction of this technique in various branches of medicine will allow to assess the quality of work at all stages of medical activity, thereby predicting the trend of the level of infectious and somatic morbidity. Analysis of the incidence and the result of the forecast allow us to present a true picture of the course of the epidemic process of the analyzed infection.

The software package was developed, which allows to calculate the predictive level of incidence of Lyme borreliosis on the basis of machine learning, namely, neural networks. The adequacy of the prognosis tested is verified on the basis of actual statistics on the incidence of Lyme borreliosis. The prediction error was calculated, which is 3.8% (average absolute deviation). The training took 27 seconds.

The developed forecast shows the preservation of an unstable epidemic situation with regard to Lyme borreliosis, which requires preventive measures both at the population level and for individual protection, the main purpose of which is to minimize the risk of contact with ticks and reduce the incidence of bone. A virtual test of the effectiveness of such events will be the next stage of our study.

**Scientific supervisor –*
Chumachenko D.I., Ph.D., Associate Professor of the department. 304