Using a neural network model to study oil facilities

V.V. Mokshin, A.A. Minigaliev, I.M. Kychkin

Simulation

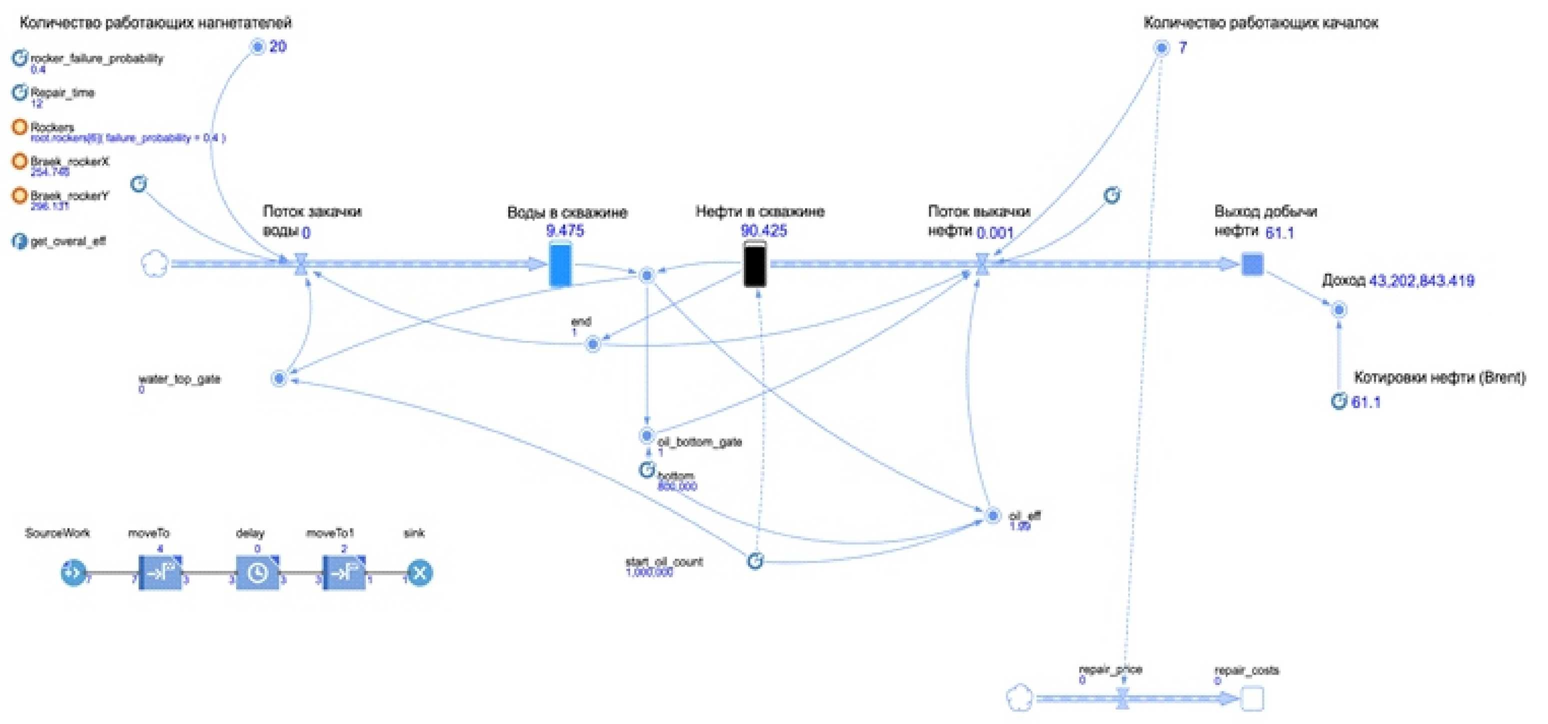

Fig. 1. Logical model of oil production

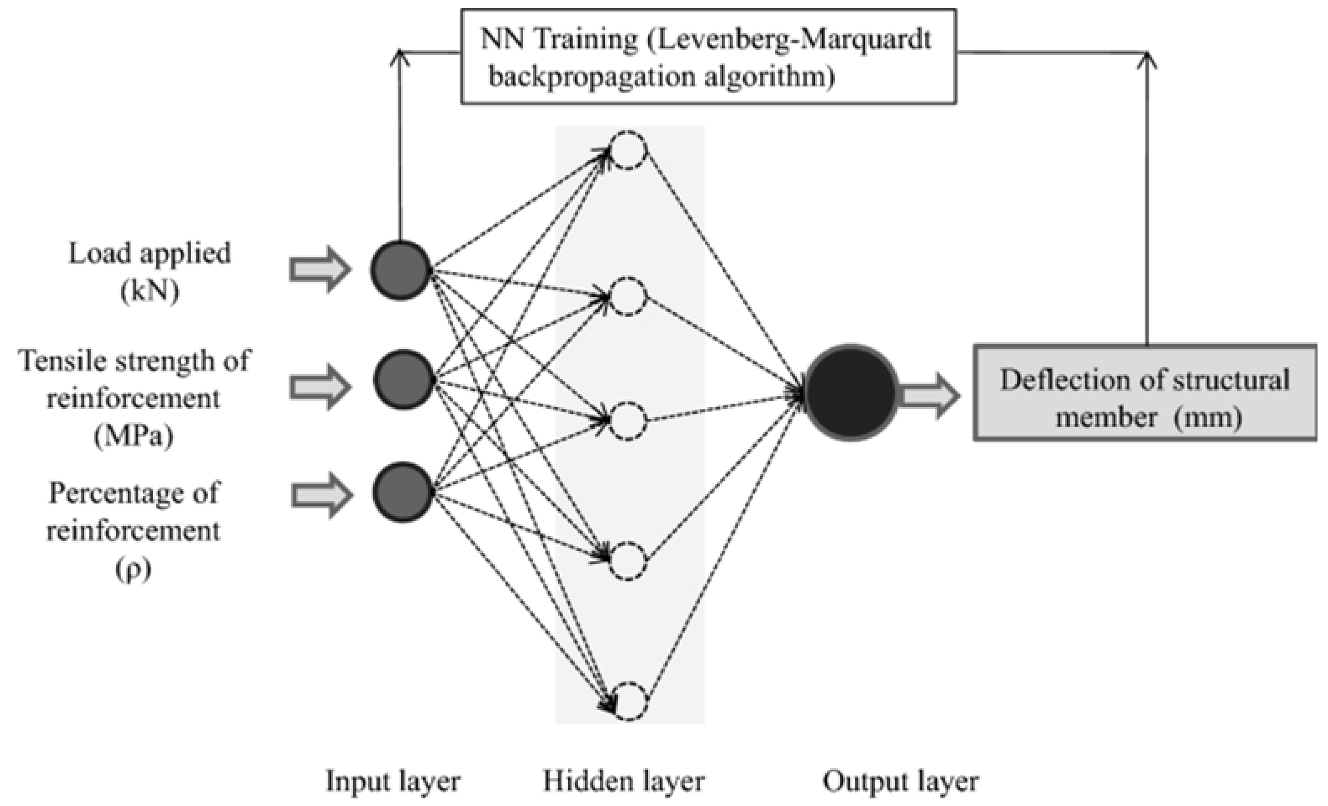

Fig. 4.. Levenberg-Marquardt method

$$J=\begin{bmatrix} \frac{\partial f(w,x_1)}{\partial w_1} & \cdots & \frac{\partial f(w,x_1)}{\partial w_R} \\ \vdots & \ddots & \vdots \\ \frac{\partial f(w,x_N)}{\partial w_1} & \cdots & \frac{\partial f(w,x_N)}{\partial w_R} \end{bmatrix}$$

Fig. 5. The matrix J, where J is the Jacobian of the function at the point w

Statistics

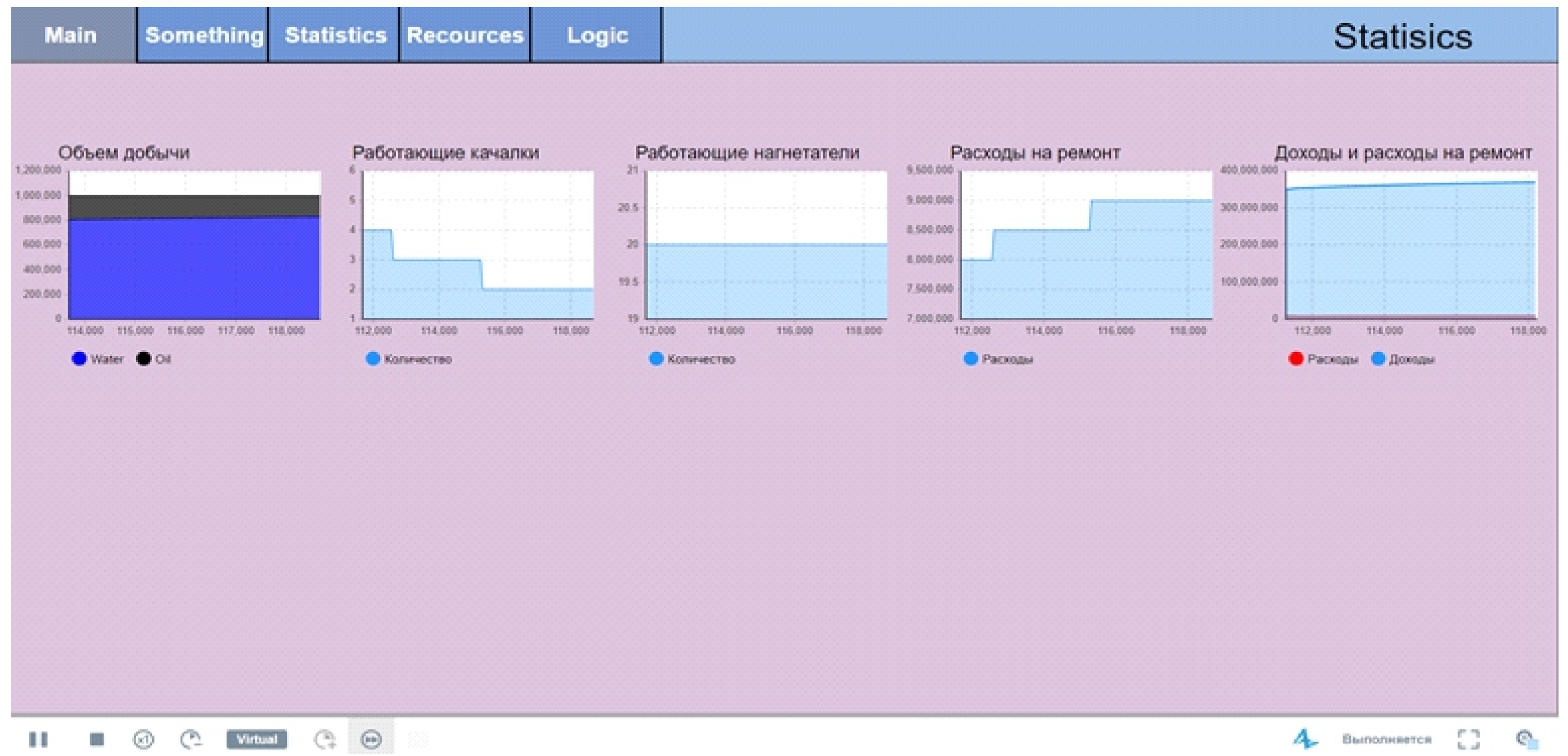

Fig. 2. Statistics tab

Training a neural network by the levenberg-markwardt method

The aim of the study is to analyze a neural network model for the study of oil facilities for monitoring well performance based on intelligent technologies and the use of deep learning.

The tasks are: modeling the process of well operation mode; analysis of the list of variables necessary for the study of the model; learning analysis and neural network testing.

The publication corresponds to the subject of the Data Science section, since the necessary optimization data were obtained in the work to form further recommendations on well management and use to calculate the main statistical characteristics, regression, correlation analysis, and consider the relationship between production and technical indicators.

A training sample is set - a set of pairs of a free variable $x \in X^M$ (network inputs) and a dependent variable $y \in Y^M$. A functional dependence is set, which is a regression model $y=f(w,x_n)$, continuously differentiable in the $W \cdot X$ area. The parameter w is a vector of weights. It is required to find such a value of the vector w that would provide a local minimum of the error function:

$$E_D=\sum_{n=1}^{N}\left(y_n-f\left(w,x_n\right)\right)^2$$

Vizualisation

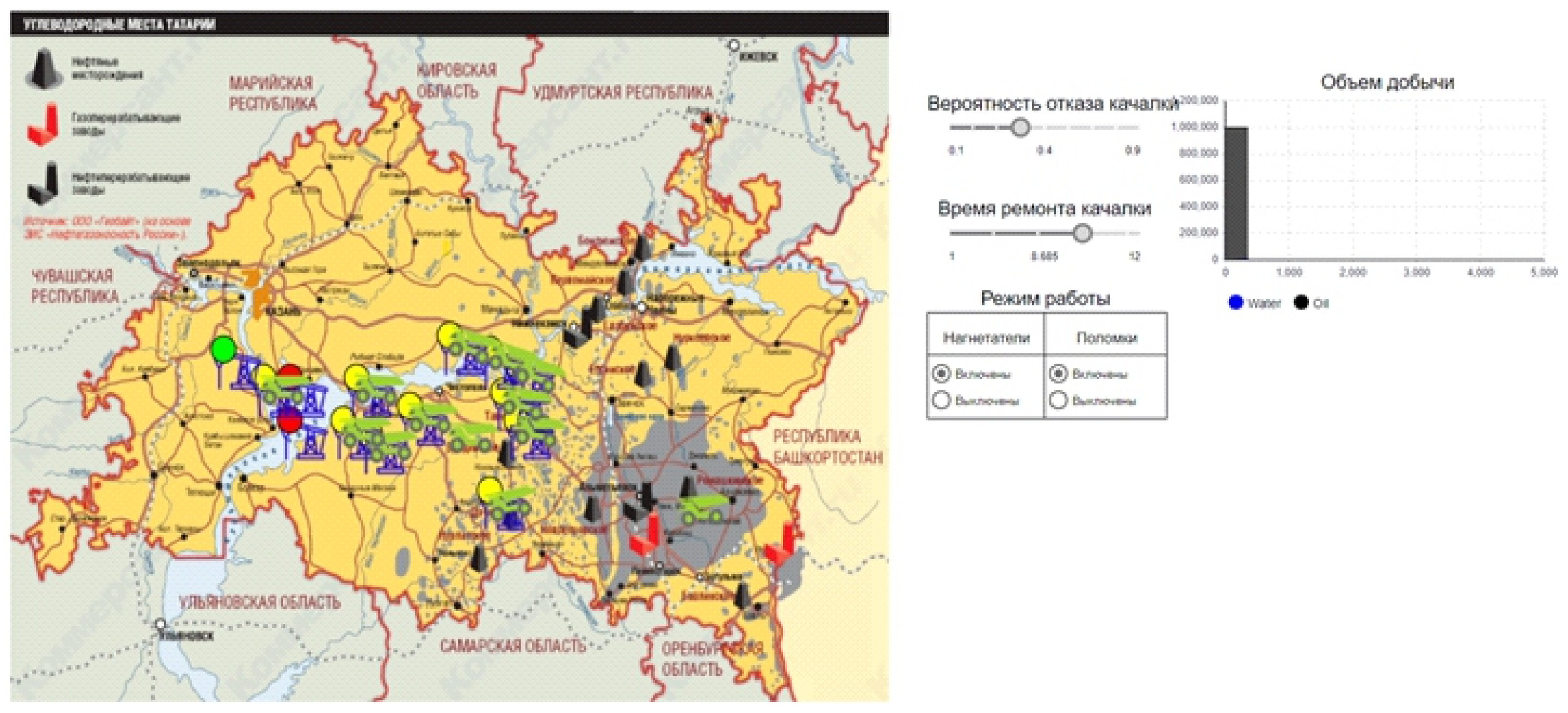

Fig. 3. Main form and visualization

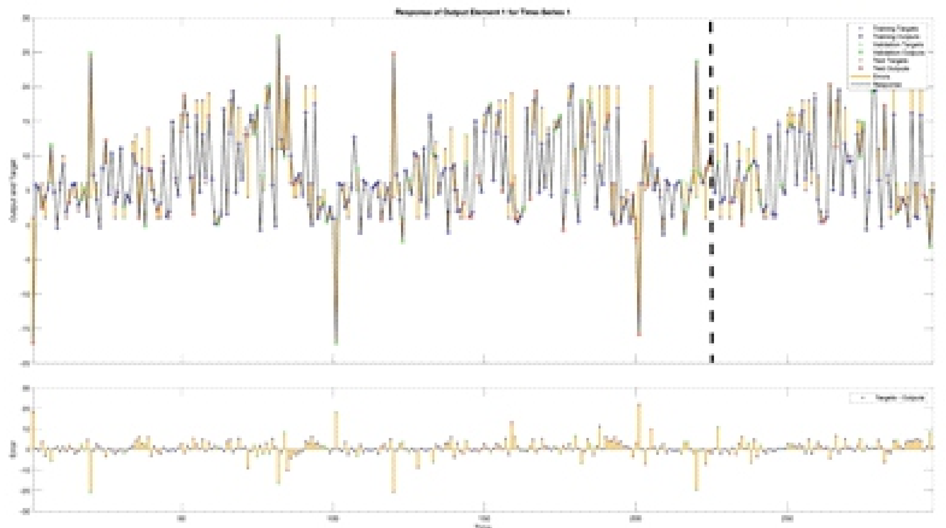

Fig. 6. Graph of trained neural network functions for Y1

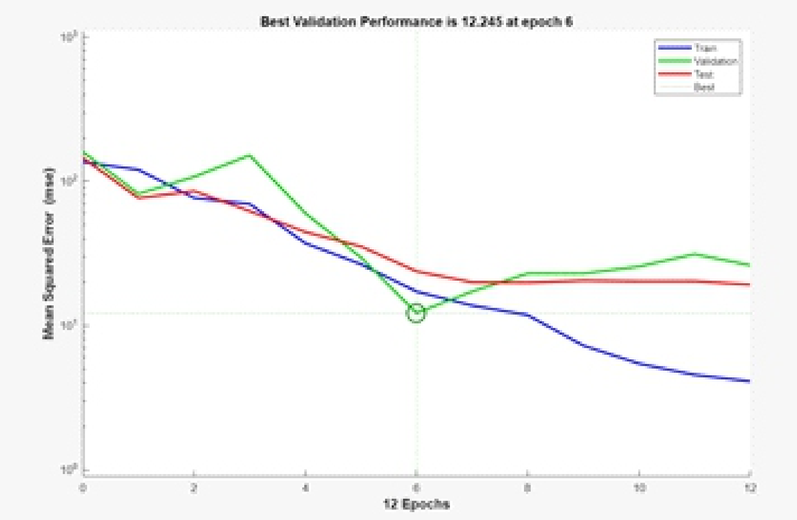

Fig. 7. Changing the learning error (Y1)

Conclusion

Thus, the result of this work is a trained neural network and its analysis for the study of oil facilities. In the course of statistics-based modeling experiments, the model was tuned, and the optimization data necessary for training the neural network were obtained. Graphs were constructed to assess the learning error and predicted performance indicators. Thus, we can say that the data obtained can be used for further work, analysis and implementation.

KAZAN NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER A. N. TUPOLEV - KAI
10 K.Marx St., Kazan,
Tatarstan 420111, Russia (www.kai.ru)