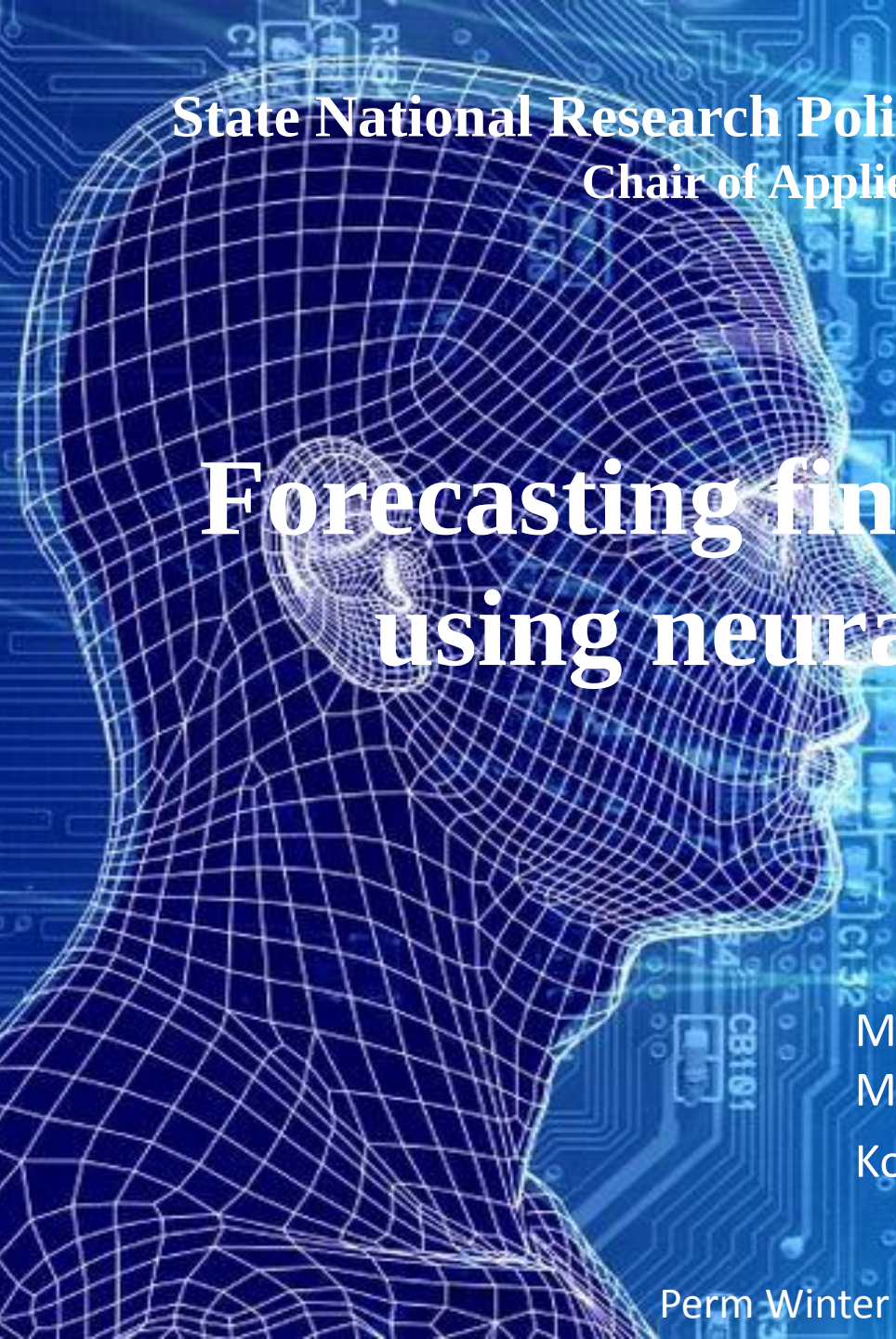
State National Research Politechnical University of Perm
Chair of Applied Mathematics



Forecasting financial markets using neural networks

Master Student of Applied Mathematics and Mechanics Faculty
Koksharova Anna

Perm Winter School 2013

Aim:

An acquirement of theoretical and practical skills of effective forecasting of the financial markets, i.e. studying the experience of forecasting of the financial markets (using example of the FOREX), methodologies of the theory of neural networks, the main approaches, and also creation of the system of predicting movement of the prices.

Tasks:

1. to study the basic provisions of the theory of neural networks;
2. to determine the solution forecasting stages;
3. to create the forecasting models for the currency rates;
4. to make an analysis and forecasting of the market changes on the basis of dynamical rates of GBPUSD for 2010 - 2012;
5. to compare the efficiency of different neural networks approaches;
6. to draw the conclusions on the basis of the received results;
7. to estimate the models' application prospects.

Mathematical problem definition of forecasting

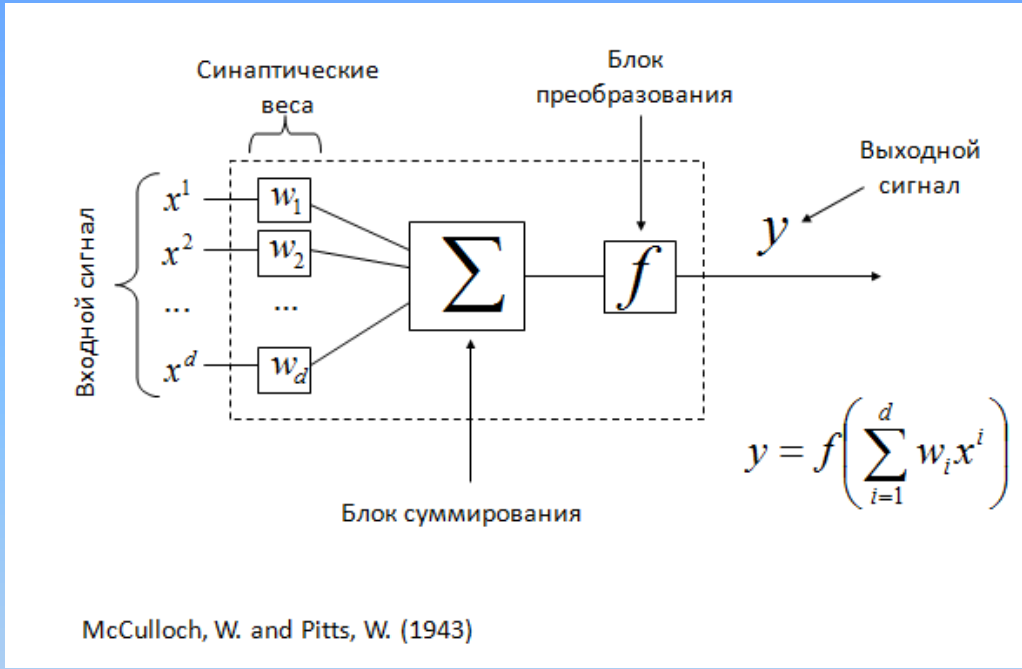
Z(t) – time series.

Given: $Z(t_1)$, $Z(t_2)$,..,Z(T)

Find: Z(T+1),..,Z(T+P)

$$Z(t) = F(Z(t-1), Z(t-2), \dots) + \varepsilon_t$$

Artificial neuron (model)



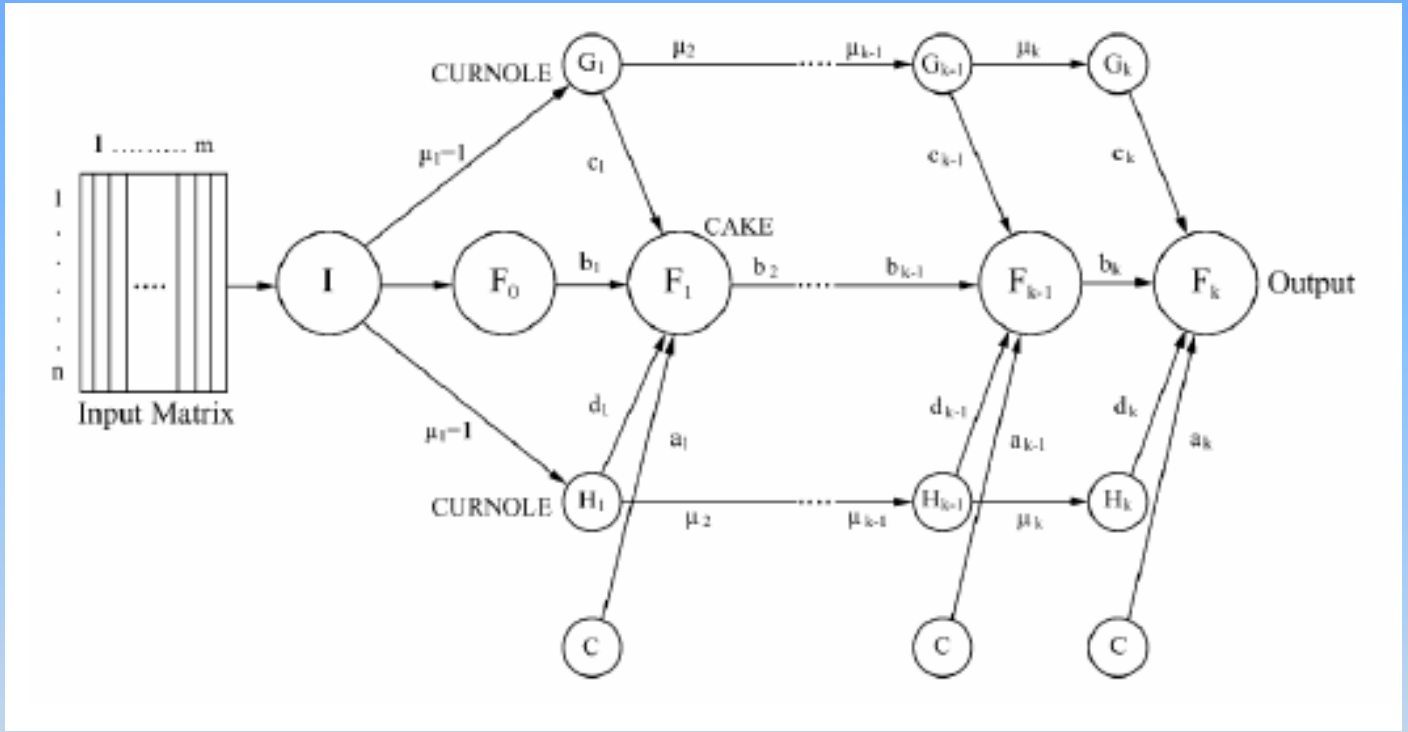
McCulloch, W. and Pitts, W. (1943)

Sigmoidal function:

$$f(x) = \frac{e^{-ax} - 1}{e^{-ax} + 1}$$

$$f(x) = \frac{1}{1 + e^{-\alpha x}}$$

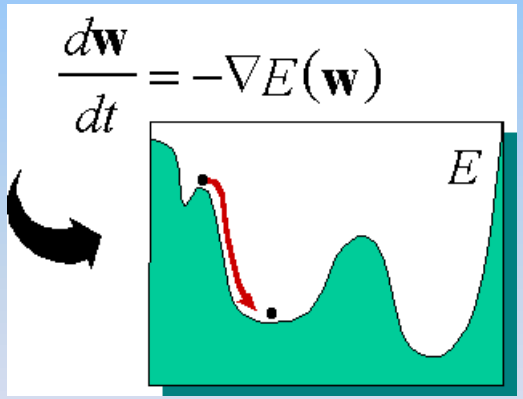
DAN2 (Saidane & Ghiassi, 2005)



$$F(X_i)=a_k+b_k*F_{k-1}(X_i)+c_k*G_k(X_i)+d_k*H_k(X_i)$$

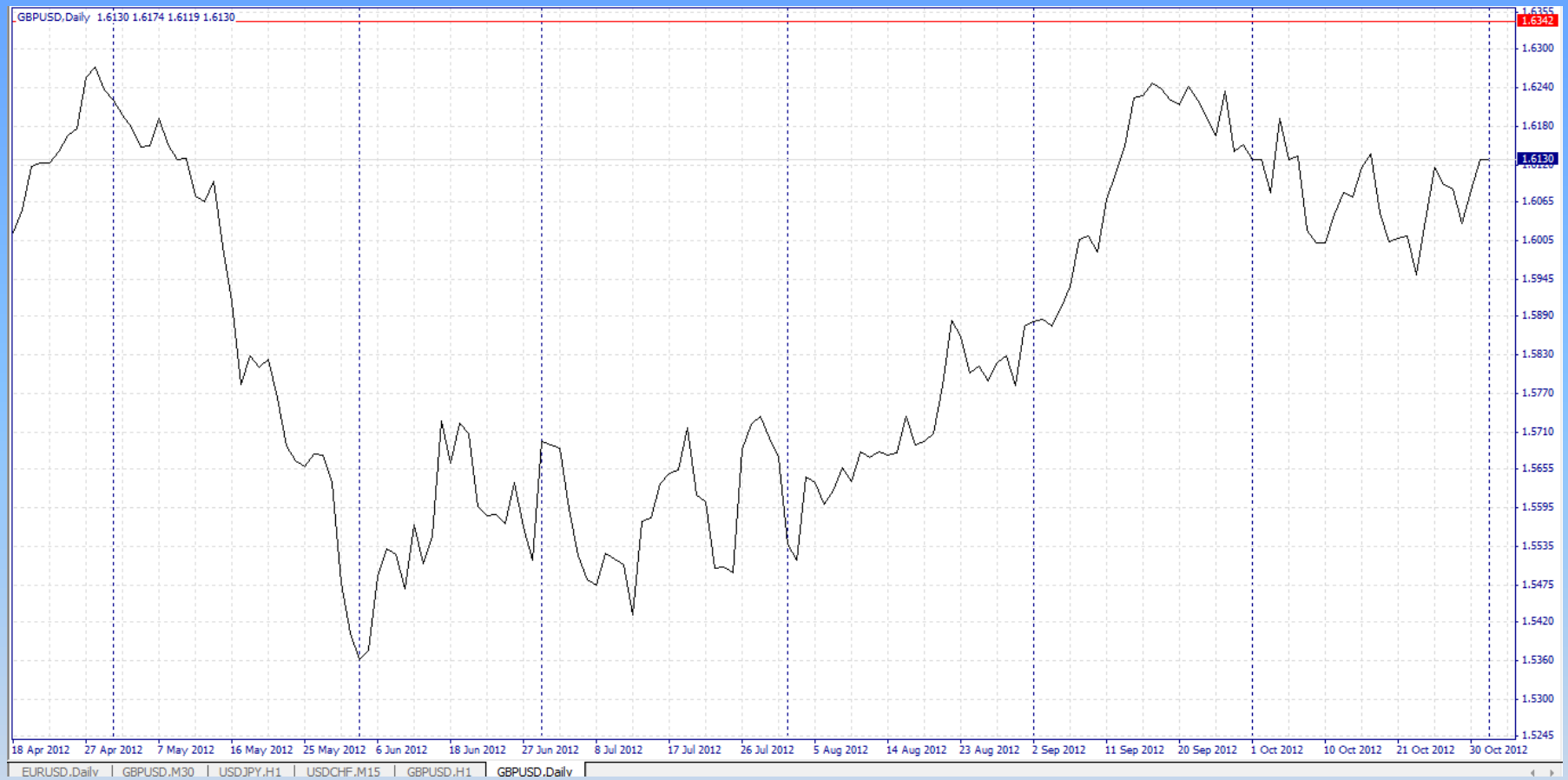
Task solution stage

- Determination of time frame and database;
- Determination of input values and preparation of data;
- Creation of training and testing sets;
- Creation of neural network;
- Training of the network



- Decision-making

Annual dynamic of rates GBPUSD



Task: to forecast the extreme values of foreign exchange rates for one period forward

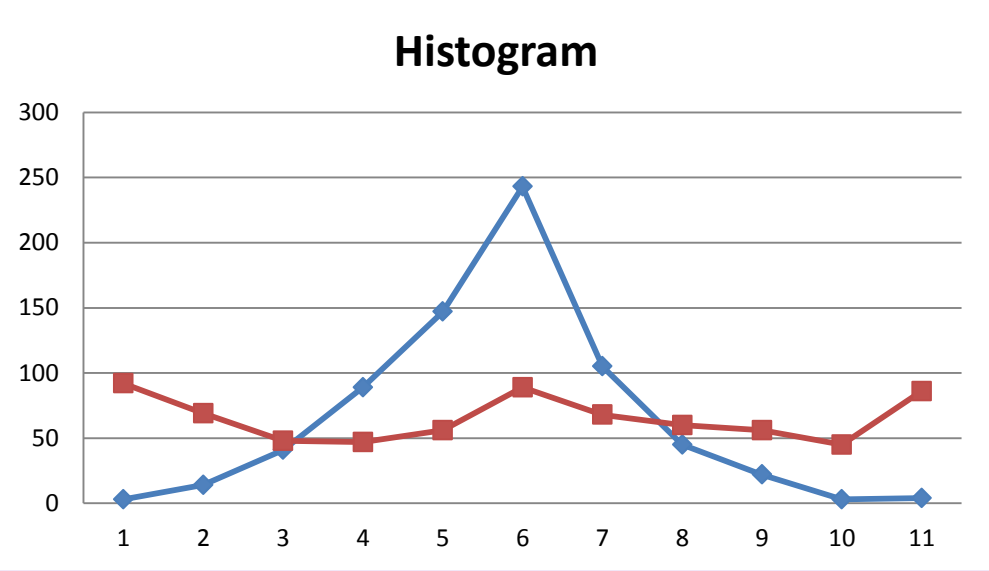
Database: daily exchange rates of GBPUSD for 01.2010 – 11.2012

Conversion of input data

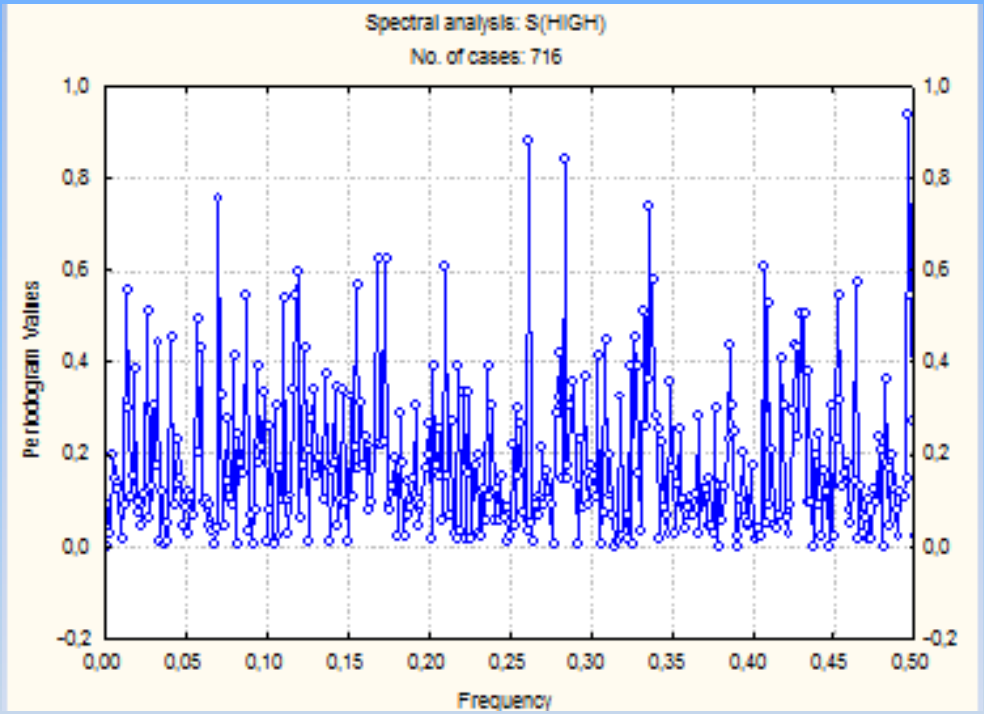
$$\Delta High_i = High_i - High_{i-1}$$
$$\Delta Low_i = Low_i - Low_{i-1}$$
$$\Delta Close_i = Close_i - Close_{i-1}$$

$$S(\Delta High_i) = \frac{1}{1 + e^{-1,5*100*\Delta High_i}} - 0,5$$
$$S(\Delta Low_i) = \frac{1}{1 + e^{-1,5*100*\Delta Low_i}} - 0,5$$
$$S(\Delta Close_i) = \frac{1}{1 + e^{-1,5*100*\Delta Close_i}} - 0,5$$

$$N = 1 + 3,322 * Lg\ n,$$



Dimension of an entrance



P=3

N=k*P

Hypotheses

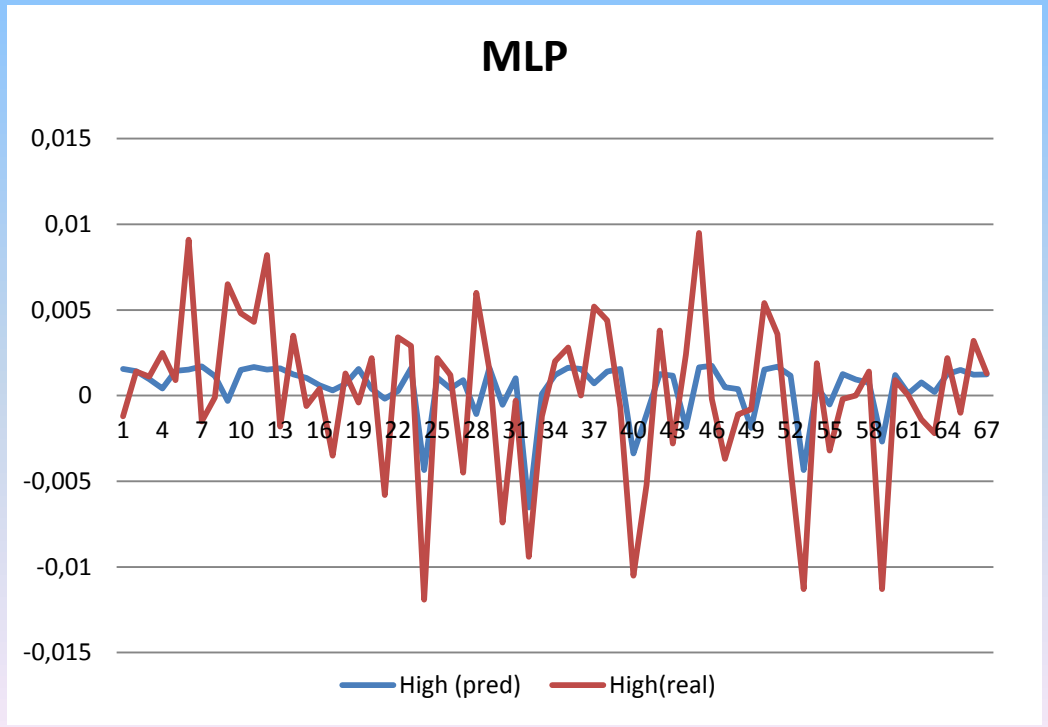
$$H_{High} = \{S(\Delta High_{i+1}) = F(S(\Delta High_{i-2}), S(\Delta Low_{i-2}), S(\Delta Close_{i-2}), S(\Delta High_{i-1}), S(\Delta Low_{i-1}), S(\Delta Close_{i-1}), S(\Delta High_{i-1}), S(\Delta Low_{i}), S(\Delta Close_{i}))\}$$

$$H_{Low} = \{S(\Delta Low_{i+1}) = G(S(\Delta High_{i-2}), S(\Delta Low_{i-2}), S(\Delta Close_{i-2}), S(\Delta High_{i-1}), S(\Delta Low_{i-1}), S(\Delta Close_{i-1}), S(\Delta High_{i-1}), S(\Delta Low_{i}), S(\Delta Close_{i}))\}$$

$$MSE = \sqrt{\frac{\sum_{i=1}^{n}(S(\Delta High_i) - S(\widetilde{\Delta High_i}))^2}{n-1}}.$$

MLP. NeuroHigh

- Neural network with 8 hidden layers;
- Genetic algorithm and BP-algorithm were used in the capacity of training algorithm;
- Testing data: 06 – 11.2012



$$MSE = \sqrt{\frac{\sum_{i=1}^{n}(S(\Delta High_i) - S(\widetilde{\Delta High_i}))^2}{n-1}} = 0{,}03938$$

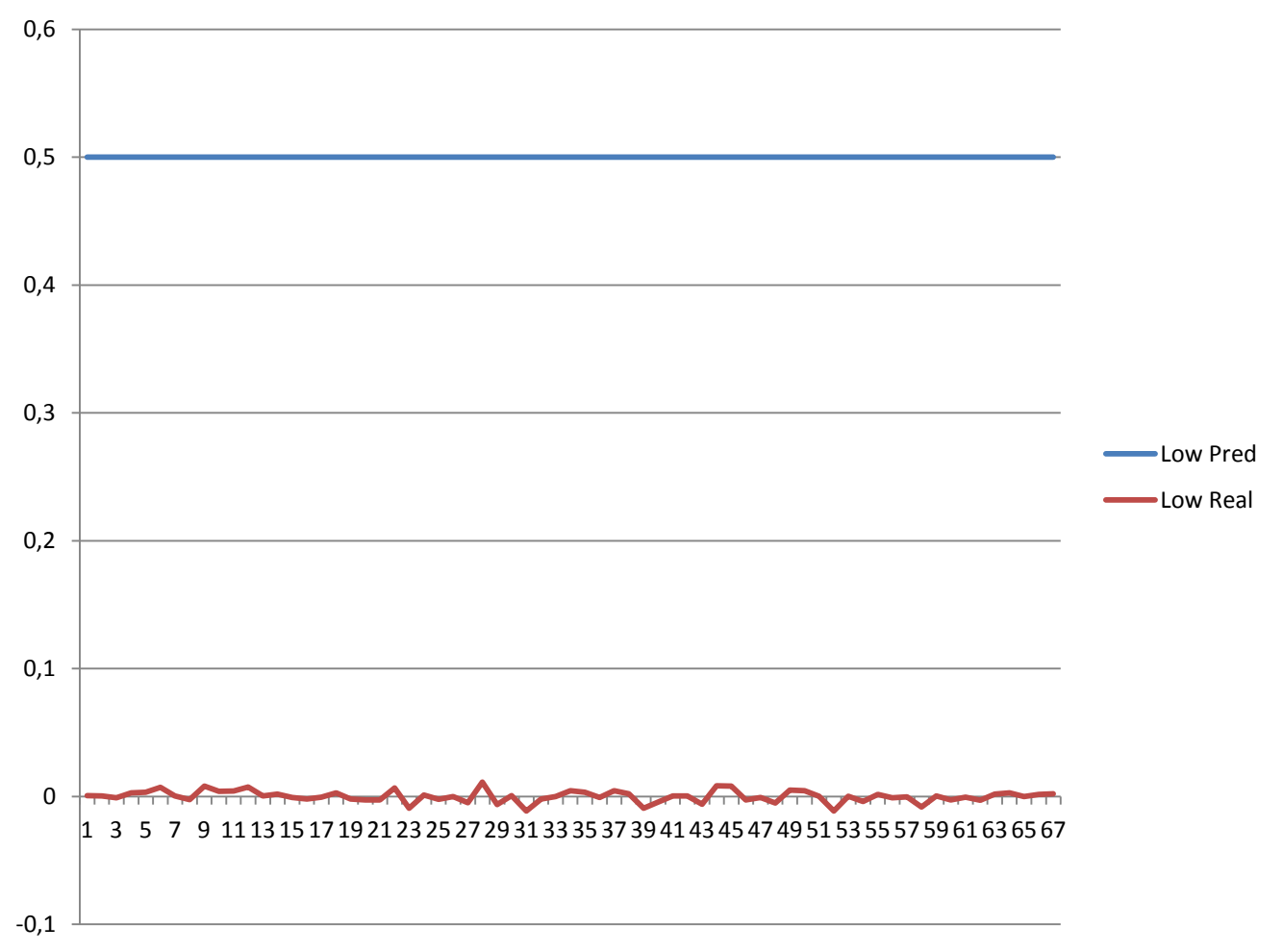
$$NMSE = \frac{MSE}{maxS(\Delta High_i) - minS(\Delta High_i)} = 0{,}6836$$

$$MAE = \frac{1}{n}\sum_{i=1}^{n} S(\Delta High_i) - S(\widetilde{\Delta High_i}) = 0{,}166$$

$$\min MAE = \min\left(S(\Delta High_i) - S(\widetilde{\Delta High_i})\right) = 0{,}0022$$

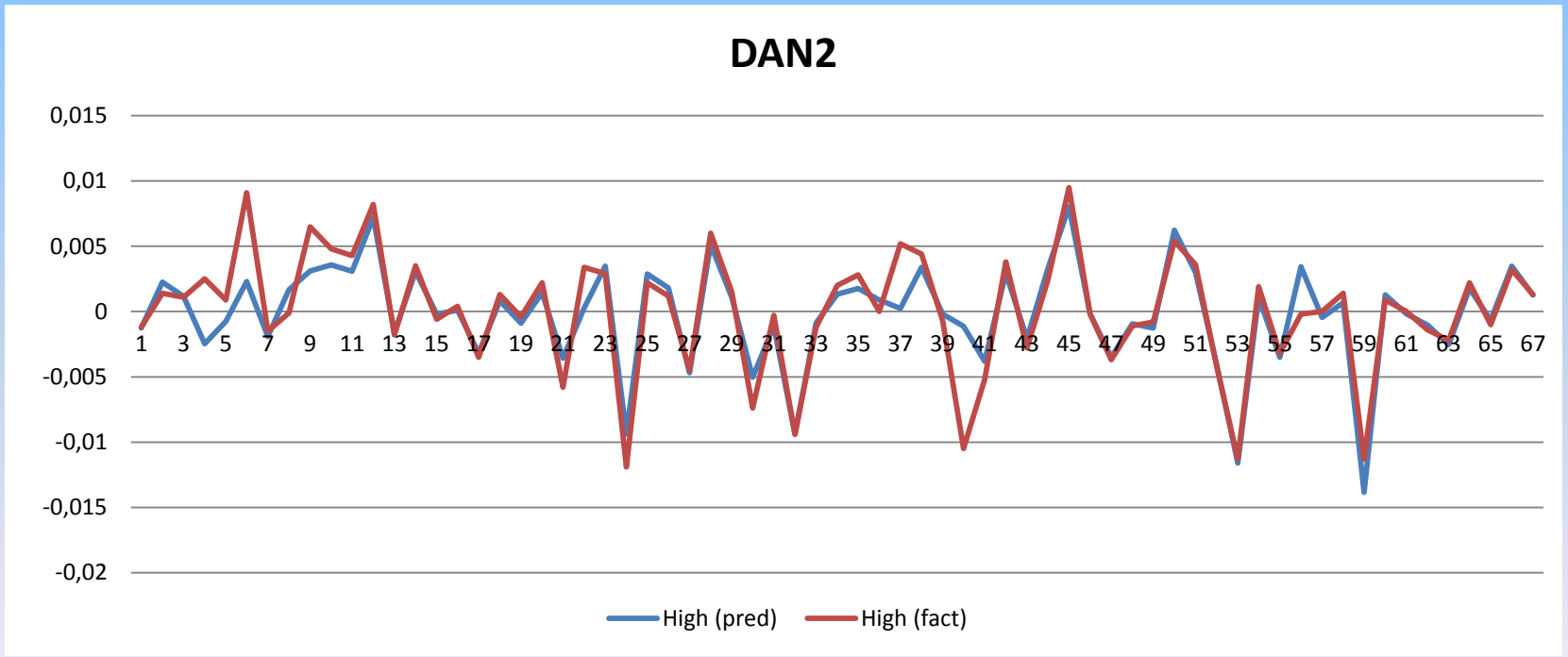
$$max\ MAE = \max\left(S(\Delta High_i) - S(\widetilde{\Delta High_i})\right) = 0{,}4375$$

MLP. NeuroLow

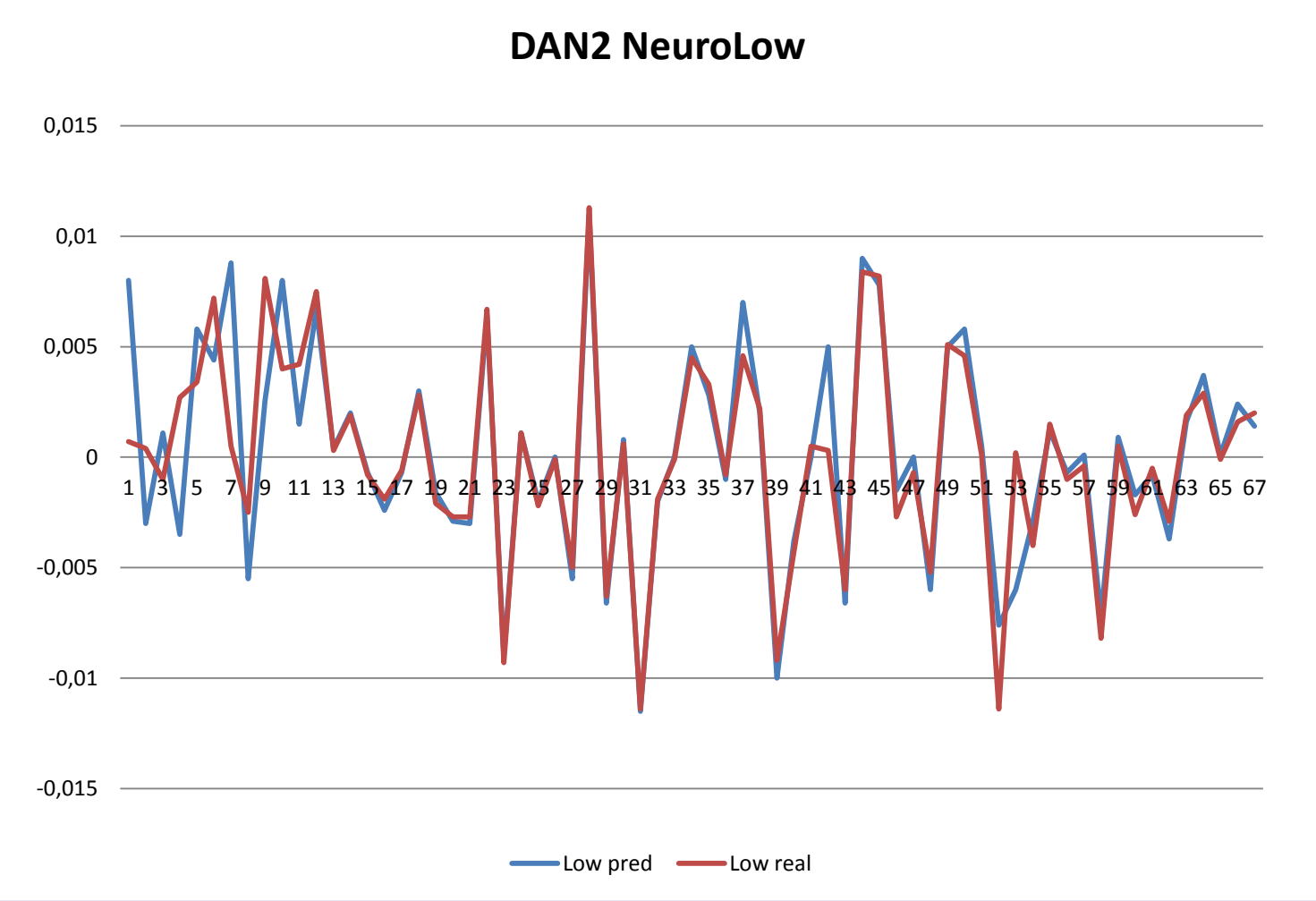


DAN2. NeuroHigh

- Neural network with 10 layers;
- During network's training process algorithm of conjugate gradient and OLS-assesments of linear regression's coefficients were used;
- Testing data: 06 – 11.2012



DAN2. NeuroLow



The main achievements

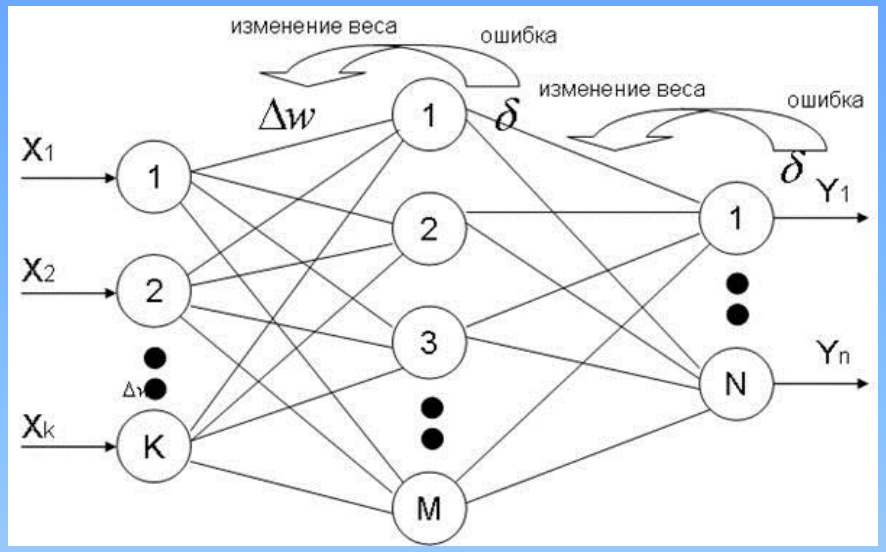
- the analysis of methodology of neural networks is carried out, the financial market Forex is studied
- 2 models for forecasting of extreme rates are constructed

Conclusions

•Neural networks show good results in approximation of noisy data;
•Neural networks are capable to solve problems with unknown in advance mathematical algorithm, the algorithm is created in network training process;
•Genetic algorithms are capable to overcome a problem of the local minimum;
•Neural networks can be trained to make both the analysis of the exchange markets and forecasting of currency rates;
•The constructed models promote an idea of a profitable strategy that can be used on a trading floor.

Thank you for your attention

Training of network (back-propagation algorithm)



$$E = \frac{1}{2}(z-y)^2,$$

$$V_k^j(t+1) = V_k^j(t) + h * \frac{\partial E}{\partial v_k^j}, \quad \frac{\partial E}{\partial v_k^j} = \delta_k * y_k * (1-y_k) * y_j$$

$$W_k^j(t+1) = W_k^j(t) + h * \frac{\partial E}{\partial w_k^j}, \quad \frac{\partial E}{\partial w_k^j} = \left[\sum_i \delta_i * y_i * (1-y_i) * V_i^k\right] * [y_k * (1-y_k) * X_i],$$