# NEYRON TO‘RLARI YORDAMIDA VAQT BO‘YICHA BASHORATLASH MASALALARINI MATLAB MUHITIDA YECHISH

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**Annotatsiya.** *Ushbu maqolada vaqtga bog‘liq ma’lumotlar asosida bashoratlash masalalarini neyron to‘rlari yordamida yechish imkoniyatlari ko‘rib chiqilgan. Tadqiqotda MATLAB dasturiy muhiti asosiy vosita sifatida tanlanib, uning sun’iy neyron tarmoqlar bilan ishlashga oid kutubxonalari orqali vaqt seriyasi prognozlash modellari qurildi. Ayniqsa, LSTM va boshqa rekurrent neyron tarmoqlar asosida yaratilgan modellar yordamida vaqt bo‘yicha bashoratlarning aniqligi tahlil qilindi. Eksperimentlar shuni ko‘rsatadiki, MATLAB muhiti neyron tarmoq arxitekturalarini oson sozlash, o‘qitish va natijalarni vizual tahlil qilish imkoniyatlarini taqdim etadi. Maqolada amaliy misollar orqali bashorat sifatini baholash ko‘rsatkichlari va model samaradorligi keltirilgan.*

**Kalit so‘zlar:** *Vaqt seriyasi, neyron tarmoqlar, MATLAB, bashoratlash, LSTM, rekurrent neyron tarmoq, prognozlash aniqligi, sun’iy intellekt, algoritm samaradorligi, ma’lumotlar tahlili.*

**Annotation.** *This article explores the possibilities of solving forecasting problems based on time-dependent data using neural networks. In the study, the MATLAB software environment was selected as the primary tool, and models for time series forecasting were built using its neural network libraries. Particular attention is given to models based on LSTM and other recurrent neural networks to analyze the accuracy of time-based predictions. Experimental results show that the MATLAB environment provides convenient tools for configuring neural network architectures, training them, and visually analyzing the outcomes. The article also presents performance indicators and model efficiency assessments through practical examples.*

**Keywords:** *time series, neural networks, MATLAB, forecasting, LSTM, recurrent neural network, prediction accuracy, artificial intelligence, algorithm efficiency, data analysis.*

**Аннотация.** *В данной статье рассматриваются возможности решения задач прогнозирования на основе временных данных с использованием нейронных сетей. В качестве основной платформы в исследовании была выбрана программная среда MATLAB, в которой с применением встроенных библиотек для работы с искусственными нейронными сетями были построены модели прогнозирования временных рядов. Особое внимание уделено моделям, основанным на LSTM и других рекуррентных нейронных сетях, с целью анализа точности прогнозов.*

*Экспериментальные результаты показывают, что среда MATLAB предоставляет удобные инструменты для настройки архитектуры нейронных сетей, их обучения и визуального анализа полученных результатов. В статье также представлены показатели оценки качества прогнозов и эффективности моделей на практических примерах.*

**Ключевые слова:** *временные ряды, нейронные сети, MATLAB, прогнозирование, LSTM, рекуррентная нейронная сеть, точность прогноза, искусственный интеллект, эффективность алгоритма, анализ данных.*

**Kirish.** Neyron to‘rlari yordamida timsollarni tanib olish, ob'ektlarni sinflarga ajratish, muvofiqlashgan boshqaruv, approksimasiya masalalari, bashoratlash, ekspert tizimlarini yaratish, assosiativ xotirani tashkil etish kabi masalalar yechiladi. Neyron to‘rlari vaqt bo‘yicha bashoratlash masalalarini yechishda ham anchayin samarali xisoblanadi.

Vaqt bo‘yicha bashoratlash masalasini umumiy ko‘rinishi quydagicha: Bizga o‘tgan teng vaqtlar oralig‘ida obektdan olingan y natija vektori

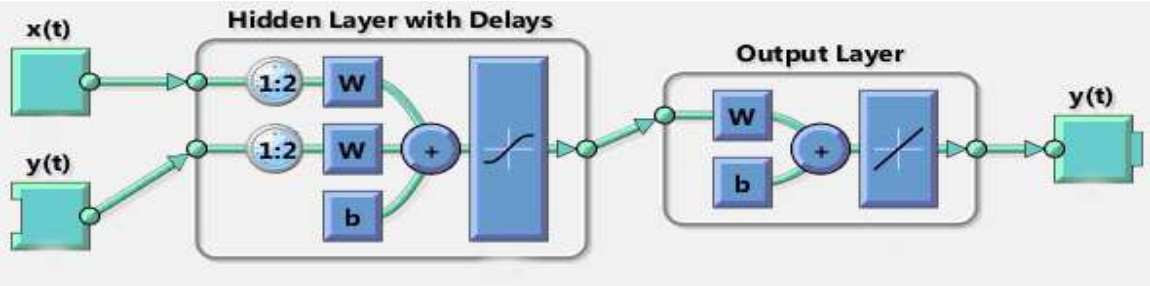
Vaqt bo‘yicha bashoratlash masalasini kirish ma'lumotlariga qarab quydagi turlarga ajratiladi va xar birini yechish uchun turlicha modeldagi neyron to‘ridan foydalaniladi.

1.Nonlinear autoregressive with external input (NARX Tashqi kirishlar bilan chiziqsiz avtoregressiv). Buning matematik ko‘rinishi quydagicha

$$y(t) = f(y(t-1), ..., y(t-d), x(t-1), ..., (t-d)) \quad (1)$$

bu yerda x(t) va y(t) oldindan vaqt bo‘yicha olingan tajriba ma'lumotlari.

Bunday vaqt bo‘yicha bashoratlash masalalari uchun ishlatiladigan neyron to‘ri modeli NARXnet deb xam yuritiladi, lekin u aslida ko‘p qatlamli to‘g‘ri taqsimlangan neyron to‘rining xususiy xoli xolos. Bu neyron to‘rining ko‘rinishi quydagicha:

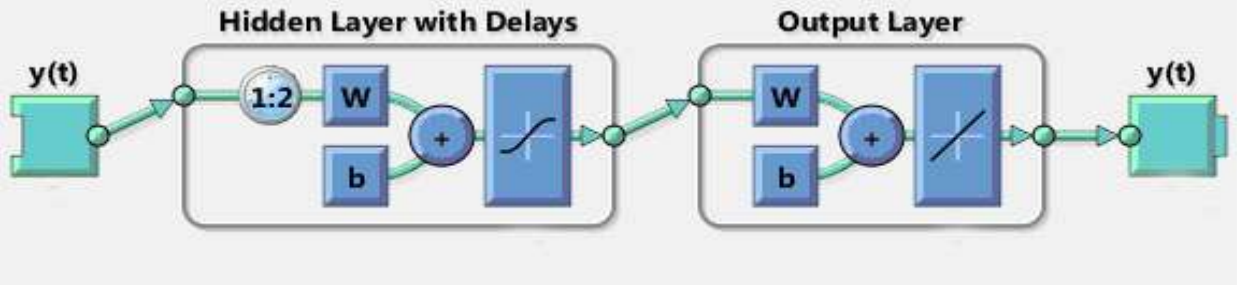



Bu modelning boshqa neyron to‘ri modellaridan farqli jixati shundaki, o‘qitish jarayonida natijaviy chiqish vektoridan yana o‘qitishda foydalanigidir.

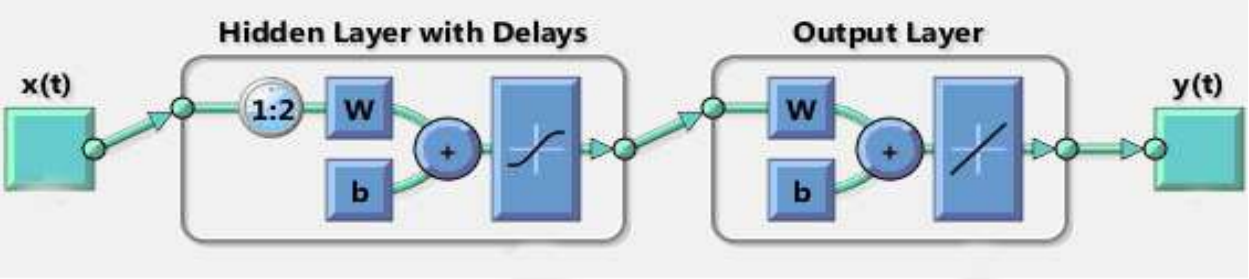
2. Nonlinear autoregressive(NAR Chiziqsiz avtoregressiv). Bunda faqatginga y(t) ko‘rinishidagi tajriba asosida olingan chiqish vektori beriladi va shu asosda bashoratlashni amalga oshirish talab etiladi. Buning matematik ko‘rinishi quydagicha

$y(t) = f(y(t-1), ..., y(t-d))$ , (2)

bu yerda y(t) natijalar vektori bo‘lib, oldingi tajribalar yordamida shakllantriladi va bunday vaziyat uchun quriladigan neyron to‘ri ko‘rinishi quylagicha.




1. Nonlinear Input-Output(NIO). Bunda tajriba asosida olingan x(t) kirish vektori va u(t) natijalar vektori berilgan bo‘ladi. Bu xuddi NARX ga o‘xshash lekin farqli tarafi olingan natijalardan o‘qitishda foydalanmaydi.

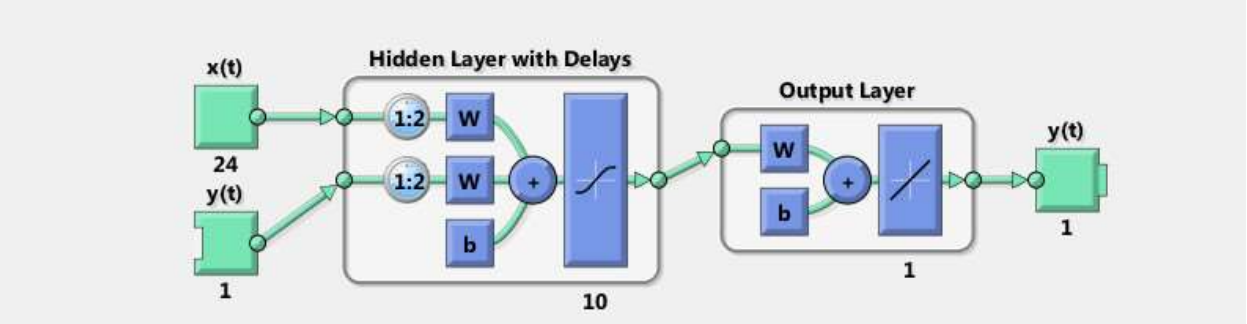



3. Tajriba ma'lumotlari.

Tajriba sifatida Venesiya shaxridagi Lagun daryosi suvi satxini ko‘tarilish va tushishini prognozlash masalasini yuqoridagi neyron to‘ri modellari yordamida yechishni qaraylik. Bizda daryo satxining balandliklari xaqidagi 1990-1995 yillardagi xar bir soatdagi daryo satxi xaqidagi ma'luot berilgan. Biz bu 43800 ta ma'lumotdan neyron to‘rini o‘qitishda xatoliklarni qayta taqsimlash metodining Levenberg –Marquardt o‘qitish algoritmidan foydalanamiz.

4. Xisoblash.

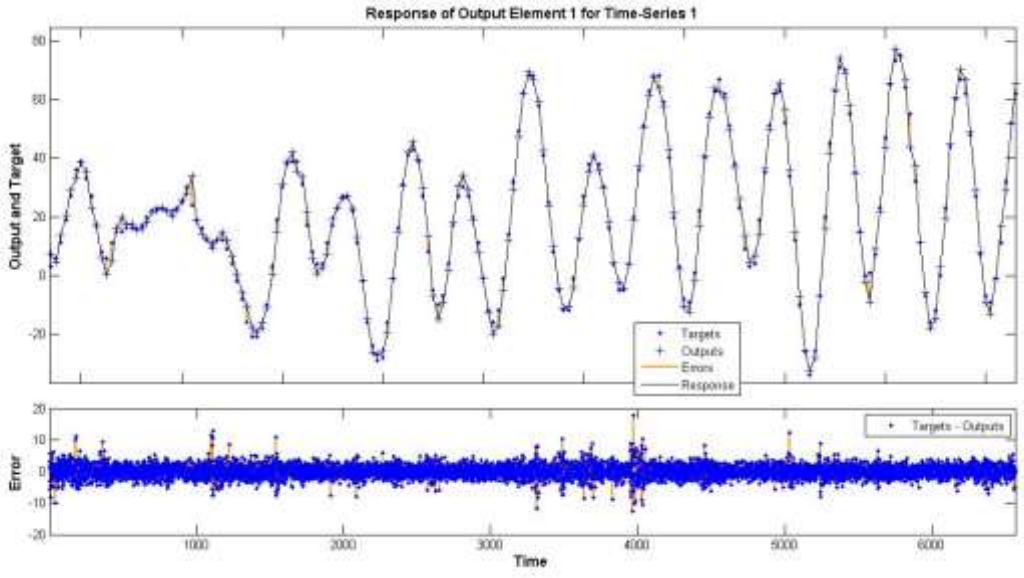
4.1 NARX net bilan bashrotlash natijalari.



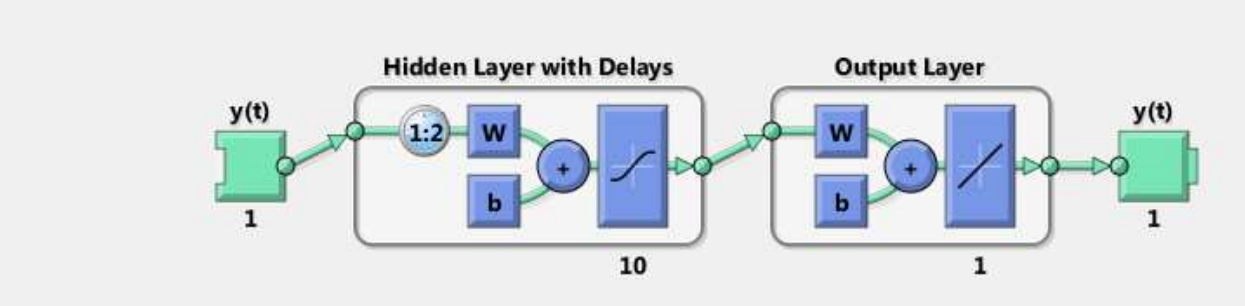

NARX tipidagi neyron to‘ri strukturasi

O‘qitishdagi o‘rtacha kvadratik xatolik


Testlash natijalari.

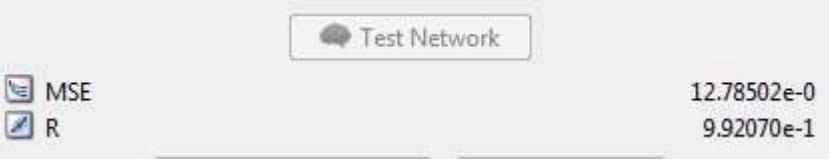



4.2NAR net bilan bashrotlash natijalari.

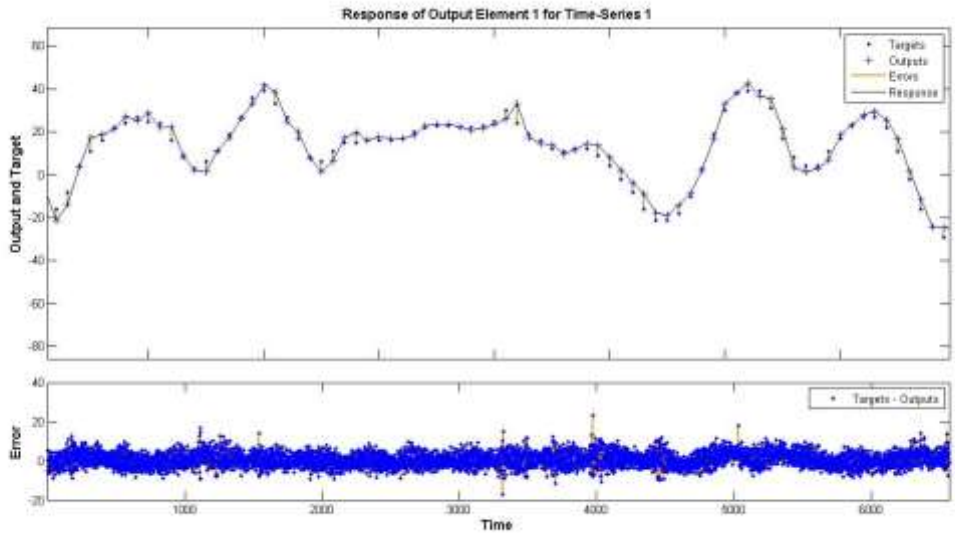



NAR tipidagi neyron to‘ri strukturasi

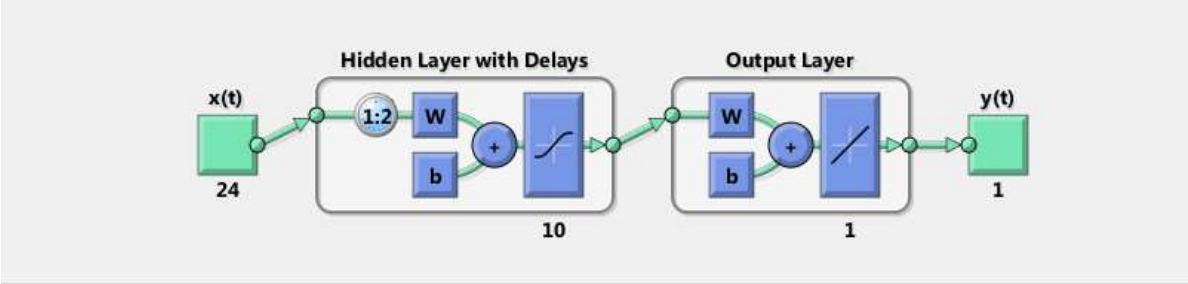
O‘qitishdagi o‘rtacha kvadratik xatolik.




Testlash natijalari.



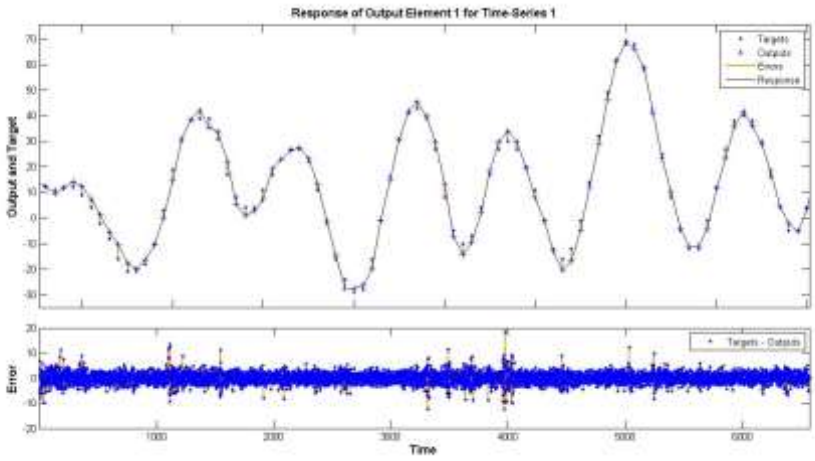

4.3 NIO net bilan bashrotlash natijalari.




NIO tipidagi neyron to‘ri strukturasi.

O‘qitishdagi o‘rtacha kvadratik xatolik.


Testlash natijalari.




**Xulosa**. Bu uchala neyron to‘ri modellarini o‘qitishda xatoliklarni teskari tarqatish algoritmidan foydalaniladi. Xulosa qilib aytganda yuqidagi neyron to‘ri modellaridan foydalanib birja kotirovkalari, valyuta kurslari, ishlab chiqarish jarayonlari, energetika soxasidagi talablar o‘zgarishi kabi masalalarni bashoratlash va samarali natijalar olish mumkin.

**Foydalanilgan adabiyotlar**

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