MATHEMATICAL MODELING OF MACHINE LEARNING ALGORITHMS

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Abstract: The article provides an overview of the main mathematical models in machine learning methods, such as linear regression, logistic regression, decision trees, support vector machine (SVM) and neural networks. The study highlights the importance of mathematical modeling for the development and application of machine learning algorithms and offers new perspectives in the field.

Keywords: machine learning, linear regression, logistic regression, decision trees, support vector machine (SVM), neural networks.

Machine learning algorithms play an important role in the development of artificial intelligence and are widely used in many fields. In this article we will look at the main methods of machine learning and the application of machine learning models in new areas [Abdurakhmonova, N.2021,2022].

Linear regression is one of the basic machine learning methods for regression analysis when you want to predict a continuous dependent variable based on one or more independent variables. The mathematical model of linear regression is a linear equation that determines the relationship between independent and dependent variables. In general, the linear regression equation can be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_r x_r + \varepsilon \qquad (1)$$

where y is the dependent variable, x_1, x_2, ..., x_r are independent variables, β_0, β_1, β_2, . .., β_r - model coefficients, ε - random error. The purpose of linear regression is to find the optimal coefficients β_0, β_1, β_2, . .., β_r, which minimize the sum of squared errors (the sum of squared differences between the predicted and actual values). To find coefficients, the least squares method (OLS) or its variations are often used.

Logistic regression is a classification algorithm used to solve binary classification problems (where data needs to be divided into two classes). It can also be generalized to a multi-class classification. The logistic regression mathematical model uses the logistic function (also known as the sigmoid) to predict the probability of membership in a particular class. For binary classification, the logistic regression equation can be written as:

$$P(y = 1|x) = 1/(1 + \exp(-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_r x_r))) \quad (2)$$

where P(y=1|x) is the probability of belonging to class 1 for given values of the independent variables, exp is the exponential function. The goal of logistic regression is to find the optimal coefficients $\beta_0, \beta_1, \beta_2, \ldots, \beta_r$, which maximize the likelihood of the data or minimize a loss function, such as a logarithmic loss function.

Support Vector Machines (SVM) Support Vector Machines (SVM) is a powerful machine learning algorithm used for classification and regression problems. It is based on finding an optimal hyperplane that maximally separates data from different classes in the feature space [Abdurakhmonova, N.2021,2022]. The SVM mathematical model defines a separating hyperplane as a linear combination of support vectors. For linearly separable data, the SVM mathematical model can be written as:

$$y(x) = w * x + b \quad (3)$$

where y(x) is the predicted class, w is the vector of weights, x is the vector of features, b is the bias (free term). In the case of nonlinear data, SVM can use kernel functions to project the data into higher dimensions where it becomes linearly separable.

Development of new methods - mathematical modeling stimulates the development of new methods and approaches in the field of machine learning. It allows us to explore new mathematical concepts, develop more efficient algorithms, and explore the principles behind deep learning, recurrent neural networks, generative models, and other advanced techniques. In general, mathematical modeling plays a central role in the development and application of machine learning algorithms. It allows us to understand, optimize, generalize and manage the complexity of algorithms, and stimulates the development of new methods. Thanks to mathematical models, we can extend the power of machine learning and apply it to various fields, from data science to medicine, finance, robotics and many more.

References:

1. Mathematical analysis: textbook / compiled by E. P. Yartseva. - Stavropol: NCFU, 2017. - 256 p. — Text: electronic // Lan: electronic library system. — URL: https://e.lanbook.com/book/155295 (access date: 06/30/2023). — Access mode: for authorization. users.
2. Abdullayeva, Z. S., & Shihnazarova , G. A. (2023, April). INTELLEKTUAL TAHLIL ASOSIDA CHET TILI BILIMINI TEKSHIRISHNI MODELLASHTIRISH. In INTERNATIONAL SCIENTIFIC CONFERENCES WITH HIGHER EDUCATIONAL INSTITUTIONS (Vol. 1, No. 14.04, pp. 150-152).
3. Shixnazarova , G. A., & Gulyamova , D. R. (2016). Modeling of the process of examination data mining techniques in the study of English language. Computer science: problems, methodology, technologies, 900.
4. Abdullayeva, Z. S., & Shikhnazarova , G. A. (2023). Priority factors of the nutritional model that influence the prenatal development of the fetus. In E3S Web of Conferences (Vol. 420, p. 05011). EDP Sciences.
5. Абдурахмонова, Н., & Абдувахобов, Г. (2021). О ‘QUV LUG ‘ATINI TUZISHNING NAZARIY METODOLOGIK ASOSLARI. МЕЖДУНАРОДНЫЙ ЖУРНАЛ ИСКУССТВО СЛОВА, 4(6).

6. Abdurakhmonova, N., Shakirovich, I. A., & O‘G‘Li, K. N. S. (2022). Morphological analyzer (morfoAnalyse) Python package for Turkic language. Science and Education, 3(9), 146-156.
7. Ismailov, A. S., Shamsiyeva, G., & Abdurakhmonova, N. (2021). Statistical machine translation proposal for Uzbek to English. Science and Education, 2(12), 212-219.
8. Абдурахмонова, Н., & Бойсариева, С. (2023). TABIIY TILNI QAYTA ISHLASHDA (NLP) OKKAZIONALIZMLARNING MORFEM TAHLILI. МЕЖДУНАРОДНЫЙ ЖУРНАЛ ИСКУССТВО СЛОВА, 6(3).
9. Abdurakhmonova, N., Tuliyev, U., Ismailov, A., & Abduvahobo, G. (2022). UZBEK ELECTRONIC CORPUS AS A TOOL FOR LINGUISTIC ANALYSIS. In Компьютерная обработка тюркских языков. TURKLANG 2022 (pp. 231-240).
10. Shamshaddinovna, A.Z., Alisherovna, S.G., Karimullaevna, K.G., & Baxtiyorovich, A.S. (2023). RATIONAL NUTRITION OF PREGNANT WOMEN IN THE PERIOD OF PRENATAL DEVELOPMENT OF THE FETUS. Web of Medicine: Journal of Medicine, Practice and Nursing, 1(3), 1-6.
11. Abdufattokhov, S., Ibragimova, K., & Gulyamova, D. (2021, November). The applicability of machine learning algorithms in predictive modeling for sustainable energy management. In International Conference on Forthcoming Networks and Sustainability in the IoT Era (pp. 379-391). Cham: Springer International Publishing.
12. Gulyamova, D. (2022, April). The Applicability of Machine Learning Algorithms in Predictive Modeling for Sustainable Energy Management. In Forthcoming Networks and Sustainability in the IoT Era: Second International Conference, FoNeS-IoT 2021, Volume 1 (Vol. 129, p. 379). Springer Nature.