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MATHEMATICAL BASIS OF ARTIFICIAL INTELLIGENCE SYSTEMS AND OPTIMIZATION PROCESS

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Abstract: This article analyzes the mathematical foundations of artificial intelligence (AI) systems and the optimization process. In creating AI models, the stages of data collection, normalization, formation of test and training sets, and optimization of parameters by minimizing the error function are consistently covered. The essence of the gradient method, standardization (Z-score) and the importance of the accuracy and regression coefficient (R^2) indicators are also shown.
According to the research results, the effective use of mathematical functions and optimization methods can increase the accuracy, reliability, and speed of SI systems.

Login

Nowadays, artificial intelligence (AI) systems are entering almost all areas of our lives. With the help of these systems, physical labor in society is gradually being replaced by mental labor and the possibility of facilitating complex working conditions is being created. As a result, development in various fields has accelerated significantly.
Artificial intelligence will help humans in solving future problems. Of this for and the system permanent in a way improvement and exists shortcomings elimination verb necessary .
In order to accomplish these tasks, it is important to create new, optimal algorithms. Such algorithms are based on mathematical functions and improve the communication between AI and humans. As a result, artificial intelligence will be able to accurately understand human commands and respond to them correctly.
of optimization techniques is important in creating a perfect artificial intelligence system . Through optimization methods, it is possible to improve the parameters of artificial intelligence models, reduce the error rate and increase the accuracy of the system.
Effective operation of these systems depends entirely on mathematical modeling and optimization techniques.
The SI system implements the processes of data collection, processing and making accurate decisions based on them.
Mathematical functions, statistical methods and optimization algorithms are essential to create a perfect SI model.
This process is explained in 6 steps below.

Stage 1. Data collection

Data is the basis of any SI system. They are often in the form of matrices or vectors . sums up :

$$X=\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix}$$

This X is the data on the ground . set , m is the number of samples , n is the number of features .
m is the number of **samples (sample size)-** this information in the collection objects or number of observations . That is , how many information our row existence shows .
n is the number **of features (number of features)-** this every one sample based on how many that there is information (measurement , signs). shows . That is , every one of the object descriptive number of characters .

Information various from sources gathers and next in phase processing to give for is being prepared .

Stage 2. Data editing and normalization

Information cleaned and statistically is normalized . Of this the goal is all parameters only to scale to bring and in calculation to stability to achieve .

Normalization formula :

$$x_i^{'}=\frac{x_i-x_{min}}{x_{max}-x_{min}}$$

Normalization is the information the same scale (range) or to measure to bring process . That is , different values mutual comparison or analysis to do for convenient will be .

Standardization (Z- score normalization):

$$z_i=\frac{x_i-\mu}{\sigma}$$

this on the ground

μ- average value,

σ-standard deviation.

Standardization is a measure in statistics that shows how many standard deviations (s) a value is from the mean.

These operations place the data between 0 and 1 or -1 and +1, which is important in calculating optimal functions.

Stage 3. Confirmation for questions creation

Information based on testing (validation) and training sets is separated :

$$D=D_t\cup D_t$$
$$D_t\cap D_t=\emptyset$$

Questions with the help of model's work ability will be checked . For example , forecasting in the model mistake as follows is determined by :

Error function (Loss function):

$$L(y,\hat{y})=\frac{1}{n}\sum_{i=1}^{n}(y_i-\hat{y}_i)^2$$

This function is the forecast values of the model $(\hat{y}_i)$ with real values (y_i) between the difference measures .

Step 4. Requests optimization

This in phase model's parameters optimal to the solution is brought . That is , an error function minimize through the most good result is found .

Gradient method (Gradient Descent):

$$\theta_{yangi}=\theta_{eski}-\alpha\frac{\partial L}{\partial\theta}$$

this on the ground :

θ- model parameter ,

α- learning rate ,

$\frac{\partial L}{\partial\theta}$ gradient.

This is a formula parameters iterative in a way will be updated and mistake decreasing goes :

$$L(\theta)\rightarrow min$$

This optimization algorithm is artificial intelligence and mechanical in learning the minimum value of the function finding for used

Step 5. Request execute (Compute and the result harvest to do)
Optimal parameters Once identified , the model exactly the task performs
For example , if this is a regression function if :

$$\hat{y}=f(X,\theta)$$

This on the ground
f– mathematical function,
X– entrance information ,
θ– model parameters .
If this is a classification task , softmax function is used:

$$P(y_i)=\frac{e^{z_i}}{\sum_{j=1}^{n} e^{z_j}}$$

Step 6. N atijani analysis to do and conclusion to release
Results analysis accuracy (in classification problems) or R² (in regression problems) indicators are used is considered .
For example :

$$R^2=1-\frac{\sum (y_i-\hat{y}_i)^2}{\sum (y_i-\bar{y})^2}$$

formulas with is calculated .
Here
y_i– actual values
$\hat{y}_i$– model prediction
$\bar{y}$– arithmetic mean of actual values
If $R^2=1$it means that the model is in ideal condition, $R^2=0$if it is, then the model is completely wrong.
If the accuracy enough if not , system reset is optimized and new parameters with trying This is seen . through the SI system itself improvement to the ability owner will be .

Conclusion
Artificial intelligence system mathematical functions in creation and optimization methods main in place stands Data from collecting by pulling result until analysis was every one stage — of data correct selection and again development Mathematical expert to be done depends .
This in processes normalization , gradient , mistake function and evaluate accuracy formulas plays an important role .
The result is the SI system not only clearly , but also in terms of resources both complete will be .

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