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ANN as a Construction tool to Solve Linear Programming Problem

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ABSTRACT: This paper shows the advantages of neural networks for solving diverse linear programming problems. Advantage of using neural networks to solve problems includes powerful computation and less time required. The presence of redundant data consumes great computational effort. Various redundant identification methods are used to reduce the computational effort but the accuracy of the system is not concerned. The developed hybrid neural network based structure which concern both accuracy and computational effort. The training and learning of the data are done here before apply the formal methodology.

KEYWORDS: Linear Programming, Back-propagation, Heuristic method, Artificial Neural Network, Redundant Constraints, Optimization.

I. INTRODUCTION

The most important techniques used in modeling and solving practical optimization problems that arise in industry, commerce, and management is Linear Programming. This is a mathematical models used to represent real life situations in the form of linear objective function and constraint. There are different methods are available to solve Linear Programming Problems. All methods are concentrates only on computational effort but the accuracy concern is very less. When formulating a Linear Programming (LP) model, researchers often include all possible constraints although some of them may not be binding at the optimal solution. These redundant constraints will not change the optimum solution but will increase the computational effort. Many researchers have proposed several algorithms (5,6,12) for identifying the redundant constraints in Linear Programming (LP) models. The widely used methodology for Linear Programming (LP) problems is Revised Simplex Method (3), a univariate search technique. This method suffers the drawback of slow convergence with the tendency of variable popping in and out of the basis matrix. These results more number of iterations and increase the computational effort and time. This results the development of a new algorithm, called Complex Algorithm. The bounded complex algorithm(2) is found to be more effective than revised simplex method on comparison based on the number of iterations, computational time and number of multiply/divide operations. This leads to achieve optimality in accuracy and also in computational effort, the new algorithm/method has been developed called Hybrid Algorithm. The developed hybrid algorithm/method trains the constraint and parameter with the help of ANN before applying the formal methodology.

II. MATERIALS AND METHOD

The typical neural network comprises of inputs of figure.(1) X_1, X_2 , corresponding to independent variables. A hidden layer as the first layer, and second layer is the output layer whose output unit is Y_1 corresponding to dependent variables. In between there is hidden layer H_1, H_2, \dots corresponding to intermediate variables.

These interact by means of weight variables i.e. $W(1), W(2)$. The activation function in neural network model is defined as

$$F(x) = P(x) + j+(x)$$

This paper presents the linear programming problem which will be solved by using neural network. The linear programming problem can be solved by various algorithms of neural network i.e. feedforward algorithm, hybrid

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algorithm, Hopfield neural network etc. But this paper presents the linear programming problem which will be solved by using back propagation algorithm. Use of backpropagation is rare in linear programming problem solution. It has its own advantages and disadvantages. Based on the detail literature survey and literature Gap following work is proposed. It contains defining linear programming problem and solution with neural network approach. Back propagation algorithm is used to train the network. Main Idea is to distribute the error function across the hidden layers, corresponding to their effect on the output. Process is divided into three modules

1. Implementation of neural network model.
2. Implementation of linear programming problem.
3. Solving linear programming problem by using neural network.

Step 1: Implementation of neural network model. The neural network model will be implemented by using backpropagation algorithm. Back propagation algorithm is used to train the network. In first phase neural network model will be established which will be checked for working of back propagation algorithm on any simple problem. The simulation technique is used to implement the network model.

Step 2: Implementation of linear programming problem. In this step the linear programming problem will be solved in MATLAB. Simple procedure will be used like Simplex Algorithm to solve the linear programming problem. It will be run for some problems to prepare test cases which will be used in training stage in final module.

Step 3: Solving linear programming problem by using neural network. The last module is designed to solve LPP by neural network. Working of the model is explained as follows.

Consider a LP problem in the following standard form:

Find x that

Maximizes: $b^T x$

Subject to the constraints: $A x \leq c, x \geq 0$ (1)

Where x and $b \in R^n, A \in R^m \times n$ and $c \in R^m$.

The dual problem of (1) is:

Find y that

Minimizes: $c^T y$

Subject to the constraints: $A^T y \geq b, y \geq 0$ (2)

Mathematically, the outputs of the above primal and dual neurons can be described by the following nonlinear dynamical system:

$$\frac{dx}{dt} = b - A^T (y + k \frac{dy}{dt}), x \geq 0 \quad (3)$$

$$\frac{dy}{dt} = -c + A (x + k \frac{dx}{dt}), y \geq 0 \quad (4)$$

It can be seen that (3) and (4) are equivalent to a system of second order differential equations. The Euler method is used to solve differential equations (3) and (4) which will be solved in neural network processing.

Algorithm:

Input:

1. Pair of Linear Programming Problems with solution
2. Minimum error value

Output:

Training Stage:

1. Initialize the weights in the network (often randomly)
2. Do

For each example data (e) in the training set

i. $O =$ neural-net-output (network, e);

ii. $T =$ output for e

iii. Calculate error ($T - O$) at the output units

iv. Compute Δw_i for all weights from Hidden layer to output layer;

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- v. Backward pass Compute δ_{wi} for all weights from input layer to hidden layer;
- vi. Backward pass continued
- vii. Update the weights in the network until dataset classified

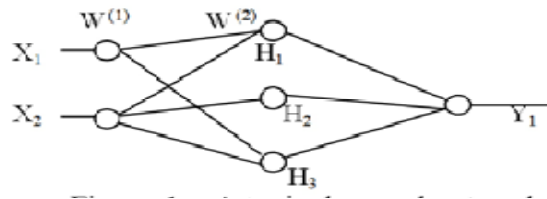


Figure.1 Shows a Neural Network

Load Forecasting Algorithm:

- Step1:** If the predicted day is belonging to a summer season, go to step 4. Otherwise, it is the day on spring, fall, or winter seasons.
- Step2:** Construct input information using the load data during three days (which are subject to Monday through Friday) before the predicted day.
- Step3:** Forecast the maximum load using the exponential smoothing method.
- Step4:** In case that the predicted day belongs to a summer season, the temperature sensitivities are computed using the variations of the load and temperature between the predicted day and its one previous day.
- Step5:** Forecast the maximum load with the temperature sensitivities calculated in step. After taking the above steps, the normalized value of the 24 hourly loads is calculated from the data obtained from the load during the previous three weeks of the predicted day. Thereafter, the 24 hourly loads of the day are forecasted from the normalized value.

Proposed Algorithm

- Step1:** If the predicted day / time are belonging to class-1 environment, go to step 4 otherwise, it is class-2 environment.
- Step2:** Construct input information using the input parameters and constraints using any formal or conventional methods like complex algorithm and or identifying redundant constraints before the predicted day or time.
- Step3:** Forecast the appropriate parameters.
- Step4:** In case that the predicted day or time belongs to a class-1 situation, the value of parameters may vary.
- Step5:** Forecast the appropriate parameters with the physical sensitivities calculated in step 4. After taking the above steps, the normalized value of parameters is calculated from the data obtained. Thereafter, the parameters for any class of situation are forecasted from the normalized value.

III. RESULT AND DISCUSSION

The Implementation of the hybrid model improves the accuracy of bounded variables in Linear Programming Problem model by suggesting the training and learning of parameters and constraints. The Training is possible in applications by applying Artificial Neural Network. The Hybrid Algorithm must be optimal in both computational effort and accuracy. All the above methodologies concentrated only on achieving best computational effort.

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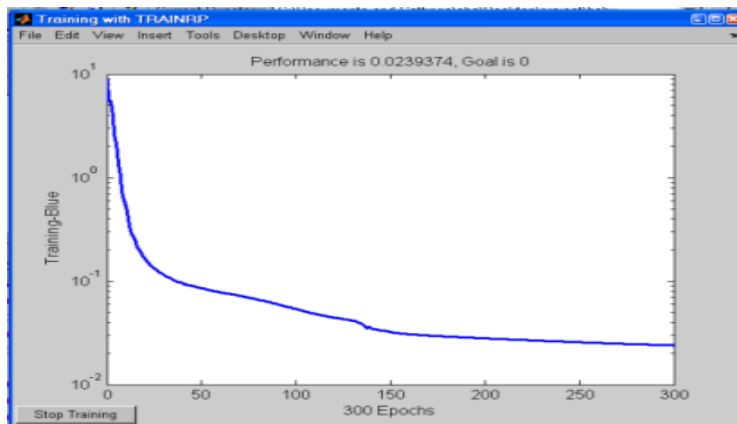


Figure: 2 Result of Performance Training

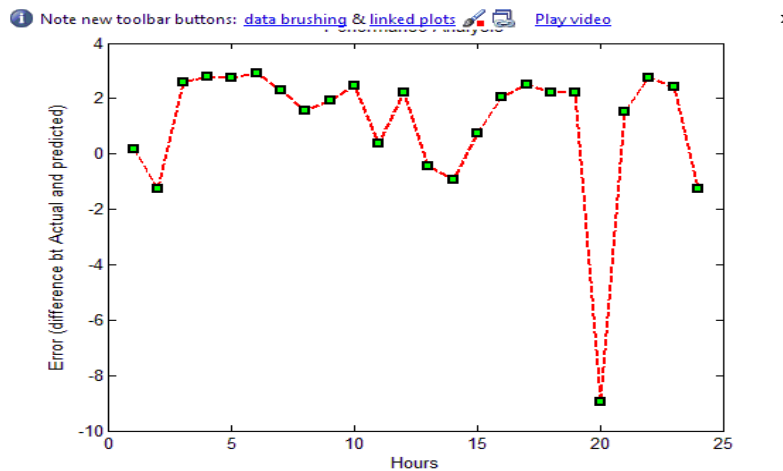


Figure: 3 Error between actual and predicted

IV. CONCLUSION

The implementation of neural network model gives the result of improving the accuracy of bounded variables in Linear Programming Problem model by suggesting the training and learning of parameters and constraints. The Training is possible in applications by applying Artificial Neural Network. I believe, the proposed algorithm shows increased performance in accuracy. The Hybrid method must be optimal in both computational effort and accuracy. All the above methodologies concentrated only on achieving best computational effort and reduce time whereas; accuracy of these systems may go down due to reducing number of constraints and number of iteration. To achieve optimality in computational effort and also in accuracy, I proposed a structure called Hybrid method with training model for optimization of parameters in a real time Linear Programming Problem.

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