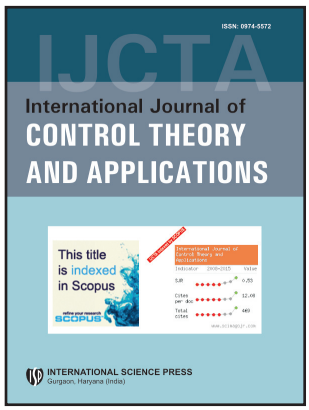

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An Optimization of Power Purchase Considering Renewable Integration

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Abstract: The organization Load Dispatch centre (LDC) is the main centre for the operation, planning, monitoring, and control of the power system. Electricity cannot be reserved and has to be produced at the time of need. So that it is essential that the system is planned and operated optimally and economically. The main functionalities of Load Dispatch Centre are: generation, distribution and transmission of electric supply to the consumers, it also provides reliable and continuous power supply. In the present scenario these operations are done manually by the organization LDC. It is a time consuming and slow work process. Optimization of power purchasing is a solution for this. The proposed system optimizes the prediction of the power plant and cost while purchasing electricity according to consumer needs. The optimization is mainly depends up on the historical data and the power plant real time data. Here, choosing the two type of electricity purchasing i.e., interstate and intrastate purchasing. There are mainly three types of forecasting methods: STLF, LTLF and MTLF. The proposed system concerned with short term load forecasting only. The short term load forecasting has become important because of increasing energy demand. Particle swarm optimization technique is used for the optimization. The proposed method also considers renewable energy resources such as wind, tidal and geothermal heat. One of the advantages with the use of renewable energy is that as it is renewable. It is therefore continual and so will never run out.

Keywords: LDC-Load Dispatch Centre; PSO-Particle Swarm Optimization; Small Hydro Project; Short Term Load Forecasting; Medium Term Load Forecasting; Long Term Load Forecasting; Genetic Search Algorithm.

1. INTRODUCTION

Power purchase optimization is of vital importance for Load Dispatch Centre. The function of Load Dispatch Centre is to purchase electricity from different power plants. Traditional methods required more manual observation with all kind of power plant information, which consumes more time and manpower. With the development of optimization model, fast and accurately detecting the power plant in a good manner. Two kinds of data are widely used in our proposed work: Historical Data and Power Plant real time data. The real time data's are type of electricity, rate, availability, distance, voltage, losses, standardization, voltage level, quantum power of requested. According to consumers' needs the system calculate each power plant percentage of losses, rate and the total value and finally it will select plant id with lowest cost.[1] STLF is concerned with the predicting

the load over an interval which ranges from one hour to one week. The consumers declare the demand for the electricity purchase and consider the transmission losses. [2] Establishment of standardized market trading platform and rules will help with the building of electricity market. It can both reflect the wishes of buyers and sellers, but also be able to accommodate the large number of subjects to transaction so as to enhance the efficiency of market transaction. The main advantage is that the market parties compete in a market in the same platform.

Along with the plant optimization we should consider the Renewable energy sources and we are considering 7% out of total power needs. [3] Kerala has good potential for promotion and development of renewable and non-conventional energy, particularly Solar, Wind, and Small Hydro Projects (SHP).

The proposed method can discover the appropriate power plant for electricity purchasing. Major challenges associated with the process the data for feature selection. The main features that affect the electricity purchasing is that the type of electricity, rate, availability, distance, voltage, losses, standardization, voltage level, quantum power of requested. According to these data our system calculates the total rate for each power plant and selects the optimal power plant for electricity purchasing.

There are four modules to process the data. Mainly three type of searching can be done here i.e. power plant real time data based optimization, history based optimization, and quality based optimization. Above the three methods uses the Particle Swarm Optimization technique. After completing the three searches we can get the three results. In some time the three results will be different in this case we can select a good one form the power plant data because only power plant data provide the real time data. The proposed system uses the Particle swarm Optimization technique for better accuracy when compared to other methods. The advantages of PSO over other methods are that it is easy to implement and there are few parameters to adjust.

2. RELATED WORK

Some of the solutions currently exists that uses hybrid algorithm for short term load forecasting. [1] The particle swarm optimization algorithm where used at the training phase of artificial neural network and it can be combined with the gravitational search algorithm. There is a need to predict the load with accuracy and mainly used method is linear regression and time series, which predict the future load only. The next method is combining PSO and Genetic search algorithm to form a single algorithm that will be used to get the result for load forecast. Different load forecast method has different degree of success. Here the particle swarm optimization done only at the training phase there for the accuracy is low.

Another existing system is that the parties to declare the purchase electricity sales curve and also considering the transmission losses. [2] The important element for the power system is direct purchasing. The user in the system has the capacity to choose the market for purchasing. It is an important one to increase the efficiency of market allocation of resources. Different trading method can be used for purchasing electricity i.e. bilateral purchasing, centralized match transaction and centralized auction trading.

The next existing method is that which solve the problem related with thermal power plants. The economic dispatch problem can deals by a smooth differentiable objective function. [4] Economic dispatch problem is a constrained optimization problem where the objective is to minimize the fuel cost increased in the generator system. Electrical operation, planning and control of electrical power system have always been a vital concern in the electric power industry. A crucial truth that increases the importance of the optimal economic operation is that the electrical energy is that the electrical energy cannot be stored in large amount. In power system naturally inspired algorithm are going better results than the conventional methods. [5] The existing method use these conventional methods i.e. lambda iteration method and gradient method. These methods are mainly optimizing the multi-area, multiple fuel options, generator with prohibited operating zones.

Feature selection and optimization techniques are different types. [6] The feature selection methods are filter approach and wrapper approach. Feature selection is commonly used to reduce the dimensionality of data.

In existing method use the wrapper approach for feature selection. One of the disadvantages of using wrapper approach is that it causes high computational cost when compared with the other methods.

The proposed method can analyze the real time data from the power plant and historical data from Load Dispatch Centre. Human expert can be avoided at the time of processing and locating the power plant. It will use both renewable and non-renewable energy. The advantage of using renewable energy is continual and so will never run out. [7] The accuracy of the proposed system can be evaluated by using precision and recall.

3. PROPOSED WORK

The amount of data has rapidly increased in every year. It contains plenty amounts of data. These data are also potentially included interesting patterns and relationship, which can be discovered using knowledge discovery and data mining techniques. Data mining techniques mainly applied for analysing the hidden patterns in the data sets. Data pre-processing is an essential step before feature selection. This process, when applied at the early stage of mining, can substantially improve the overall quality of the mined patterns and the time required for the actual mining.

The proposed system uses history data from Load Dispatch Centre and the real time data from the power plants. Here the main task is to optimize the power plant according to the consumer needs and cost. The proposed system automatically predicts the power plant id. For the prediction, classify the data sets into different classes. In each class different feature can be selected. In proposed system select at least ten features (rate, availability, quantum of power requested, Percentage of losses, intra or interstate purchase, unit price, distance, Type of power etc). Features selection methods are used to increases the overall efficiency of optimization model. There are two feature selection approaches: the Filter approach and the Wrapper approach. The Filter approach includes 3 methods, including Information Gain, mutual information and Chi-square. The Wrapper approach used search method consisting of Genetic Search, Best First search. Wrapper approach cause high computational cost makes the wrapper approach impractical. Before moving to the feature selection method there is data pre-processing task. In pre-processing step, it will discard those terms that occur in less than two classes and maintain a stop list for the discarded features. [6] The next step is optimization model here, the algorithm PSO is used for optimization. The accuracy measures are precision and recall.

The proposed system uses three types of searches. First type is predicting the power plant from history data sets; second one is prediction from real time data and the last one according to the standardization of power plants. After the three searches getting the result is different at some time in this case proposed system choosing the search related to real time data and standardization because these data are real and current data.

A. Architecture

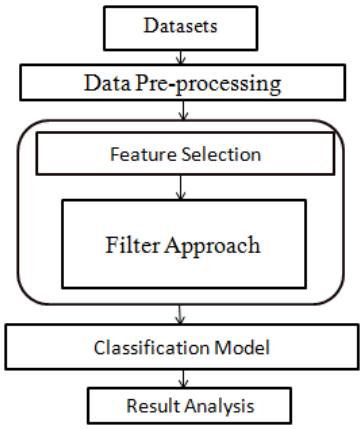

Figure 1: Steps for Optimization Model

B. Datasets

Data set is a collection of related sets of information that is composed of separate elements but can be manipulated as a unit by a computer.

Plant Id	Plant Name	Type	Distance	Unit Cost
pl01	Chhabra Thermal Power Plant	Thermal	316.0	4.0
pl02	Ennore Thermal Power Plant	Thermal	316.0	7.0
pl03	Tuticorin Thermal Power Plant	Thermal	332.0	7.0
pl07	Tarapur Atomic Power Station	Atomic	1480.0	10.0
pl09	Giral Lignite Power Plant	Thermal	2304.0	3.0
pl10	Chhabra Thermal Power Plant	Thermal	1982.0	3.0
pl11	Obra Thermal Power Station	Thermal	2372.0	3.0
pl12	Anpara Thermal Power Station	Thermal	2324.0	3.0
pl13	Parichha Thermal Power Station	Thermal	2257.0	3.0

Figure 2: Data set of current power plant

C. Data Pre-processing

In pre-processing state, discard those terms that occur in less than 2 documents. Maintain a stop list for saving the discarded terms.

D. Feature Selection

Feature selection is the process that chooses a subset of relevant features for building the model. Feature selection is one of the most important and frequently used techniques in data pre-processing for data mining. It is also useful in term of the data analysis process, as it shows which the input variables or features are important for predicting, and how those features are related. The goal of feature selection for classification task is to maximize classification accuracy. [6] Feature selection can be divided in filter methods and wrapper methods. Filter methods is defined as using some actual property of the data in order to select feature using the classification algorithm. Entropy measure has been used as filter method for feature selection for classification. Feature selection methods provide three main benefits when building predictive models as following:

1. The model improving is obviously interpretation
2. They can make shorter training times
3. Enhanced generalization by reducing over fitting.

Several feature selection methods have been introduced in the data mining domain. The main aim of these techniques is to remove irrelevant or redundant features from the dataset. Feature selection methods have two categories: wrapper and filter. The wrapper evaluates and selects attributes based on accuracy estimates by the target learning algorithm. Using a certain learning algorithm, wrapper basically searches the feature space by omitting some features and testing the impact of feature omission on the prediction metrics. The feature that make significant difference in learning process implies it does matter and should be considered as a high quality feature. On the other hand, filter uses the general characteristics of data itself and work separately from the learning algorithm. Precisely, filter uses the statistical correlation between a set of features and the target feature. The amount of correlation between features and the target variable determine the importance of target variable. Filter based approaches are not dependent on classifiers and usually faster and more scalable than wrapper based methods. In addition, they have low computational complexity.

E. Filter Approach

The filter method precedes the actual feature selection methods. The filter approach is input variables of the learning induction algorithm, computationally simple and rapidly scalable. Using filter method, feature selection is done once later can be provided as input to different classifiers. Various feature selection techniques and feature ranking have been offered such as Mutual Information, Chi-Squared, and Information gain etc. Filter based approaches are not dependent on classifiers and usually faster and more scalable than wrapper based methods. In addition, they have low computational complexity.

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Popular filter based feature selection methods

- Mutual Information
- Information Gain
- Chi-squared

Mutual Information: It measure the mutual dependency between the binary feature and each predefined class label as the feature score

$$\mathrm{MI}(x_k, c_i) = \log \frac{p(x_k, c_i)}{p(x_k)p(c_i)} \tag{1}$$

Information Gain: It is a measure of the difference between two probability distributions

$$\mathrm{IG}(x_k, c_i) = p(x_k, c_i) \log \frac{p(x_k, c_i)}{p(x_k)p(c_i)} + p(\bar{x}_k, c_i) \log \frac{p(\bar{x}_k, c_i)}{p(\bar{x}_k)p(c_i)} \tag{2}$$

Chi-squared: It evaluates each feature input variables with respect to the class labels.

$$\mathrm{Chi}(x_k, c_i) = \frac{[p(x_k, c_i)p(\bar{x}_k, \bar{c}_i) - p(x_k, \bar{c}_i)p(\bar{x}_k, c_i)]^2}{p(x_k, c_i)p(x_k, \bar{c}_i)p(\bar{x}_k, c_i)p(\bar{x}_k, \bar{c}_i)} \tag{3}$$

F. Optimization Model

Particle swarm optimization was first introduced by Kennedy and Eberhart in the year 1995. It is an exciting new methodology in evolutionary computation and a population-based optimization tool like GA. PSO is motivated from the simulation of the behavior of social systems such as fish schooling and birds flocking.

The PSO algorithm requires less memory because of its inherent simplicity. [5] PSO is similar to the other evolutionary algorithms in that the system is initialized with a population of random solutions, call particle (swarm), flies in the d-dimension problem space with a velocity, which is dynamically adjusted according to the flying experiences of its own and colleagues. Swarms collect information from each other through an array constructed by their positions using the velocity of particles. Position and velocity are both updated by using guidance from particles' own experience and experience of neighbors.

The position and velocity vectors of the ith particle of a d-dimensional search space can be represented as Xi = (xi1,xi2,…..xid) and Vi = (vi1,vi2,…….vid), respectively. On the basis of the value of the evaluation function, the best previous position of a particle is recorded and represented as pbesti= (pi1,pi2,…….pid).If the gth particle is the best among all particles in the group so far, it is represented as Pbestg = G-best= (pg1,pg2,……. pgd).The particle tries to modify its position using the current velocity and the distance from pbest and gbest. The modified velocity and position of each particle for fitness evaluation in the next, that is, (k +1)th iteration, are calculated using following equations:

$$v_{id}^{(k+1)} = [W * v_{id}^{k} + c_1 * Rand_1() * (P_{bestid} - x_{id}^{k}) + c_2 * Rand_2() * (G_{best\ gd} - x_{id}^{k})] \quad (4)$$

$$x_{id}^{(k+1)} = x_{id}^{k} + v_{id}^{k+1} \quad (5)$$

Here W is the inertia weight parameter which controls the global and local exploration capabilities of the particle. c1and c2 are cognitive and social coefficients, respectively, and Rand 1(),Rand 2() are random numbers between 0 and 1. C1 pulls the particles towards local best position and c2 pulls towards the global best position. Usually these parameters are selected in the range of 0 to 4. In the procedure of the particle swarm paradigm, the value of maximum allowed particle velocity Vmax determines the resolution, or fitness, with which regions are to be searched between the present position and the target position. If Vmax is too high, particles may fly past good solutions. If Vmax is too small, particles may not explore sufficiently beyond local solutions. Thus, the system parameter Vmax has the beneficial effect of preventing explosion and scales the exploration of the particle search.

1. Initialize a population of particles as Pi = (Pi1, Pi2, Pi3…….... Pi N) ' N' is number of generating units. Population is initialized with random values and velocities within the d-dimensional search space. Initialize the maximum allowable velocity magnitude of any particle Vmax. Evaluate the fitness of each particle and assign the particle's position to P-best position and fitness to P-best fitness. Identify the best among the P-best as G-best and store the fitness value of G-best.
2. Change the velocity and position of the particle according to equations (4) and (5), respectively.
3. For each particle, evaluate the fitness, if all decisions variable are within the search ranges.
4. Compare the particle's fitness evaluation with its previous P-best. If the current value is better than the previous P-best, then set the P-best value equal to the current value and the P-best location equal to the current location in the d-dimensional search space.

5. Compare the best current fitness evaluation with the population G-best. If the current value is better than the population G-best, then reset the G-best to the current best position and the fitness value to current fitness value.
6. Repeat steps 2-5 until a stopping criterion, such as sufficiently good G-best fitness or a maximum number of iterations/function evaluations is met.

Figure 3: Flow chart for PSO

4. EXPERIMENT RESULTS

Results for every stages of the proposed method database are presented below (figure 4) describe the home page for the proposed system. Here there is a button for the administrator to login as an admin, KSEB for submitting the quantum of power requested and the power plant login for updating the power real time data this can update by the power plant admin. After login to the admin by providing the user id and password the next session will be the Figure 5.

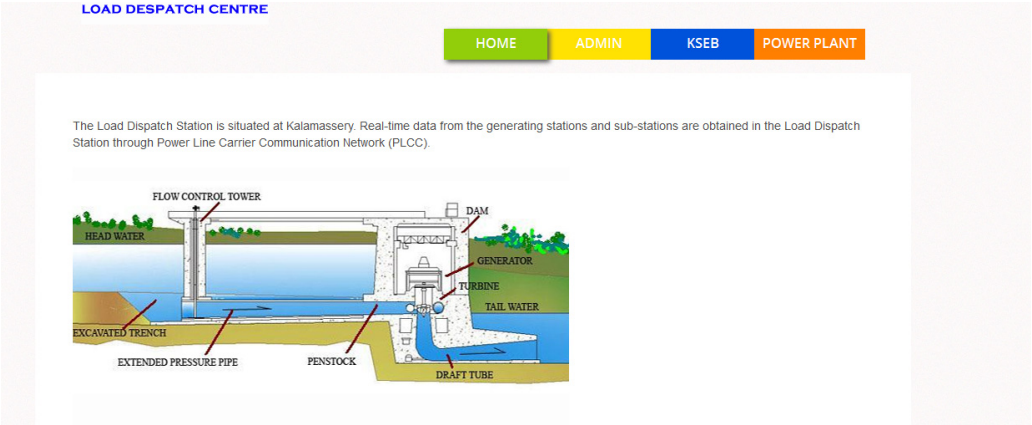

Figure 4: Home Page

Figure 5 include all the 3 types of searches: Optimized search, from history and optimized plant after searching the proposed system shows the good plant for electricity purchasing. Figure 6 shows the final result.

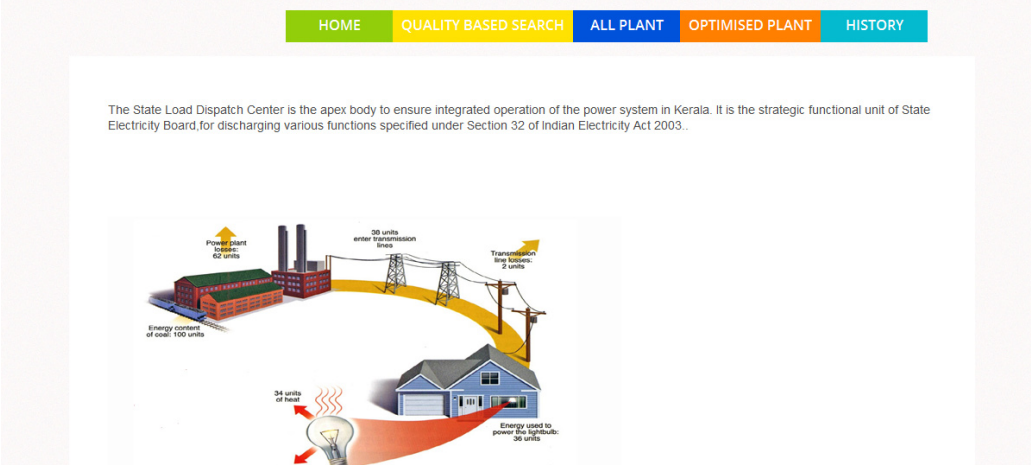

Figure 5: Searching

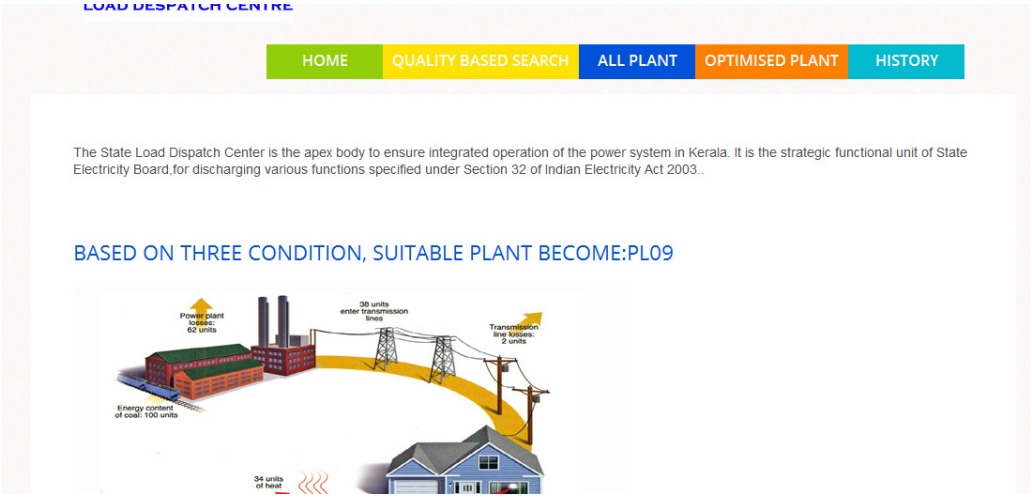

Figure 6: Results

The accuracy can be measured by Precision and Recall. [7] Some performance measures were used for the evaluation of the classification results, where TP/TN is the number of True Positives/Negatives instances, FP/FN are the number of False Positives/Negatives instances.

Precision is a proportion of predicted positives which are actual positive:

$$\text{Precision} = \frac{TP}{TP + FP}$$

Recall is a proportion of actual positives which are predicted positive:

$$\text{Recall} = \frac{TP}{TP + FN}$$

5. CONCLUSION

Conventional methods cannot handle massive unlabelled high-dimensional heterogeneous data in real time. Feature selection methods select the most important features for each class. Then apply the class specific features in to optimization model. Performance of optimization model evaluated. In existing system it can be done by manually. Generate a optimization model for electricity purchasing. Feature selection advantages: Improve the performance of the learning algorithm, Data understanding, gaining knowledge about the process and perhaps helping to visualize it, increasing the comprehensibility of mining results.

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