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Analysis of Stock Market Prediction by using PSO Algorithm Optimizing LS-SVM

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Abstract— Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on a financial exchange. The successful prediction of a stock's future price will maximize investor's gains. In this paper we analyze a machine learning model to predict stock market price, where existing algorithm integrates Particle swarm optimization (PSO) and least square support vector machine (LS-SVM) are identified in which, the PSO algorithm is employed to optimize LS-SVM to predict the daily stock prices. The proposed model is based on the study of stocks historical data and technical indicators. PSO algorithm selects best free parameters combination for LS-SVM to avoid over-fitting and local minima problems and improve prediction accuracy. The proposed model was also applied and evaluated using thirteen benchmark financials datasets and compared with artificial neural network with Levenberg-Marquardt (LM) algorithm. The obtained results showed that the proposed model has better prediction accuracy and the potential of PSO algorithm in optimizing LS-SVM.

Keywords—Least Square Support Vector Machine, Particle Swarm Optimization, Technical Indicators and Stock Price prediction.

I. INTRODUCTION

Stock price prediction has been at focus for years since it can yield significant profits. Predicting the stock is not a simple task, mainly as a consequence of the close to random walk behavior of a stock series. Fundamental and technical analyses were the first two methods used to forecast stock prices. Artificial neural network (ANNs) is the most commonly used [1]. In most cases ANNs suffer from over-fitting problem due to the large number of parameter to fix and the little prior user knowledge about the relevance of the inputs in the analyzed problem [2]. Also, support vector machines(SVMs) had been developed as an alternative that avoids such limitations .Their practical success can be attributed to solid theoretical foundations based on VC theory [3]. SVM compute globally optimal solutions, unlike those obtained with ANNs which tend to fall into local minima [4]. Least squares –support vector machines (LS-SVM) method was reformulated the traditional SVM algorithm LS-SVM uses a regularized least squares function with equality constraints, leading to a linear system which meets the karush-kuhn-tucker (KKT) conditions for obtaining an optimal solution [5]. Although LS-SVM simplifies the SVM procedure, the regularization parameter and the kernel parameter play an important role in the regression system. Therefore, it is necessary to establish a methodology for properly selecting the LS-SVM must be robust against the influence of the free parameter values in the problem studies [6]. The perceived advantages of evolutionary strategies as optimization methods motivated some researcher to consider such stochastic methods in the contested of optimizing SVM. A survey and overview of evolutionary algorithms (EAs) found in [7]. Particle swarm optimization (PSO) is one of the most used (EA). PSO is a recently proposed algorithm by James Kennedy in 1995, motivated by social behavior of organisms such as bird in flocking fish schooling [8]. The optimizer which is used in the particle swarm optimization algorithm, while making adjustment towards "local" and "global" best particles is conceptually similar to the crossover operation used by genetic algorithm [9]. Neural network and wavelet DE noising for stock trading and prediction was introduced [10].the aim of this paper is to develop a machine learning model that hybrids the PSO and LS-SVM model. The performance of LS-SVM is based on the on the selection of free parameter (cost penalty), (insensitive-loss function) and (kernel parameter). PSO will be used to find the best parameter combination for LS-SVM.

II. LEAST SQUARE SUPPORT VECTOR MACHINE

Least squares support vector machine (LS-SVM) are least squares versions of support vector machines(SVM), which are a set of related supervised learning methods that analyze data and recognize patterns, and which are used for classification and regression analysis. In this version one finds the solution by solving a set of linear equations instead of a convex quadric programming (QP) problem for classical SVMs. Least squares SVM classifiers, were proposed by suykens and vandewalle [11].

III. PARTICLE SWARM OPTIMIZATION ALGORITHM

PSO is a relatively recent heuristic search method which is derived from the behavior of social groups like birds flocks or fish swarms. PSO moves form a set of points to another sets of points in a single iteration with likely improvement using a combination of determistic and probabilistic rules. The PSO has been popular in academia and industry, mainly because of its intuitiveness, ease of implementation and the ability to effectiveness solve highly non-linear, mixed integer optimization problems that are typical of complex engineering system. Although the survival of the fittest principal is not used in PSO. It is usually considered as an evolutionary algorithm. optimization is a achieved by giving each individual in the search space a memory for its previous success , information about success of a social group and providing a way to incorporate this success of a social group and providing a way to incorporate this knowledge into the movement of the individual. The cycle of evaluation followed by updates and positions (and possible update of X_i^{pb} and x^{sb}) is then repeated until a satisfactory solution has been found.

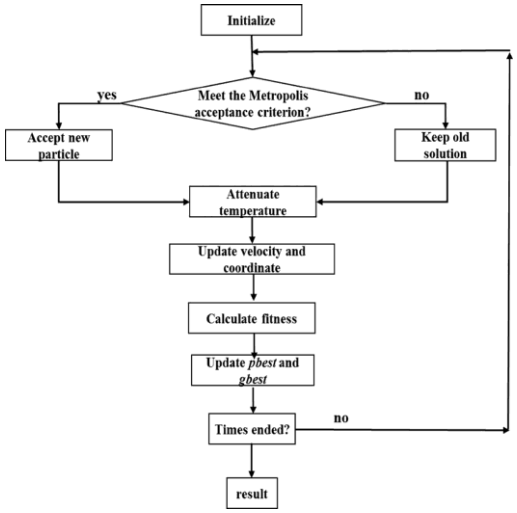

Figure.1. PSO Algorithm

The proposed model is based on the study of historical data, technical indicators and optimization LS-SVM with PSO algorithm to be used in the prediction of daily stock prices. Levenberg-marquaredt (LM) algorithm is used as a benchmark for comparison with LS-SVM and LS-SVM-PSO models. The proposed model architecture contains six inputs vectors represent the historical data and derived technical indicators and one output represent next price. The proposed algorithm was tested for many companies which cover all stock sectors in S&P 500 stock market, these sectors are information technology (Adobe, HP and oracle);financials (American Express and bank of New York); Health care (Life Technologies); Energy (Exxon-mobile and duck energy); communications(AT&T); Materials(FMC corporation); industrials (Honey Well). Five technical indicators are calculated from the raw datasets:

- **Relative strength index (RSI):** A technical momentum indicator that compares the magnitude of recent gains to recent loss in a attempt to determine overbought and oversold conditions od an asset. The formula for computing the relative strength index is as follows:

RSI = 100-[100/(1+RHS)]
Where,
RS = Avg. of x days up close. / Average of X day's down closes.

- **Money Flow index (MFI):** This one measures the strength of money in and out of a security. The formula for MFI is as follows:

Money Flows (MF) – typical price * volume
Money Ratio (MR) – (positive MF / negative MF)
MFI = 100 – (100/ (1+MR))

- **Exponential Moving Average (EMA):** This indicator returns the exponential moving average of a field over a given period of time.

- **Stochastic Oscillator (SO):** The stochastic oscillator defined as a measure of the difference between the current closing price of a security and its lowers low price , relative to its highest high price for a given period of time . The formula for this computation is as follows.

%K = [(close price – lowest price)/ (Highest Price – Lowest Price)]*100

- **Moving Average Convergence/Divergence (MACD):** This function calculates difference between a short and a long term moving average for a field. The formulas for calculating MACD and its signal as follows.

MACD = [0.075*EMA of closing prices]-[0.15*EMA of closing price]
Signal line = 0.2*EMA of MACD

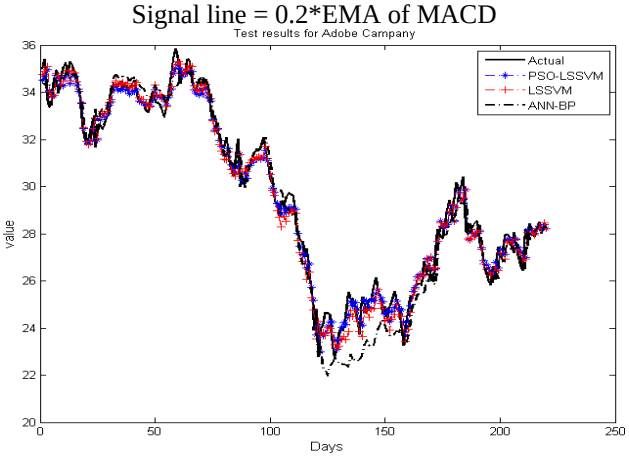

Figure.2. Results for Adobe Company

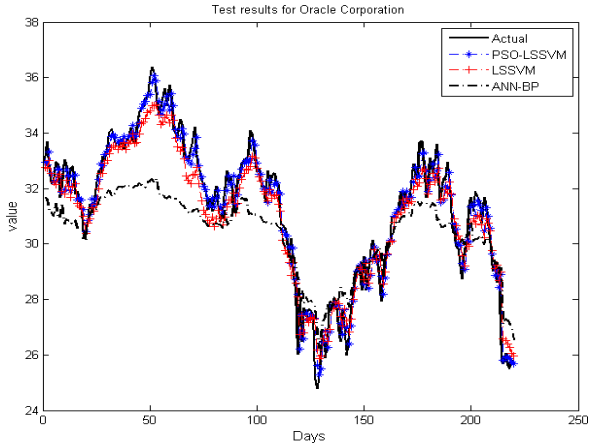

Figure.3. Results for Oracle Company

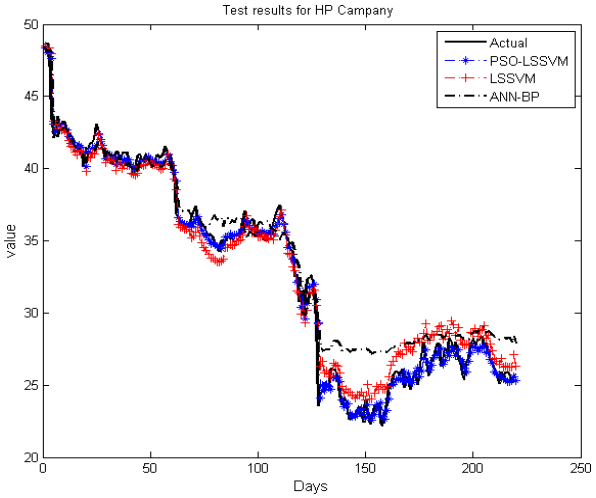

Figure.4. Results for HP Company

IV. RESULTS ANF DISCUSSION

LS-SVM-PSO, LS-SVM and ANN algorithm were trained and tested with data sets from Jan 2009 to Jan 2012. All data sets are available in [12]. All Datasets are divided into training part (70%) and testing part (30%). Fig. 3 to fig. 14 outline the application of proposed LS-SVM-PSO model compared with LS-SVM and ANN-BP algorithms at different data set with different sectors of the market. In fig. 2, fig. 3 and fig. 4, which present results of three companies in information technology sector (Adobe, oracle, HP), results show that LS-SVM optimized with PSO is the best one with lowest error value followed by LS-SVM algorithm. Fig. 5 and fig. 6 represent results of financial sector (American Express, and Bank of New York), we can remark that the predicted curve using the proposed LS-SVM-PSO algorithm is most close to the real curve which achieves best accuracy. Followed by LS-SVM, while Ann-BP is the worst one.

Fig. 7 represents results of using PSO-LS-SVM model in Honeywell Company which represents industrials stock sector, proposed model still achieves best performance. Fig. 8 and fig. 9 outline the results if testing proposed algorithm to Hospera and life technologies companies in health stock sector. From figures one can remark the enhancement in the error rate achieved by the proposed model. Fig. 10 and Fig.11 outline the results of testing proposed model on Exxon – model and duke energy companies which represent energy stock sector. PSO-LS-SVM also the best especially in fluctuation cases. Fig. 12 represents results for FMC Corporation in materials stock sector. The achievements of proposed model is very promising compared with SVM and ANN Fig. 13 outlines results for AT&T from communications stock sector. We can notice from figure the role of proposed model in reducing the error rate and overcoming local minima problems which found in ANN Results.

In all performance functions and in all trends and sectors. Proposed model performs better than other algorithm especially in cases with fluctuation in the time series function. Fig. 14 outlines comparison between PSO-LS SVM, algorithms according to MSE function [12].

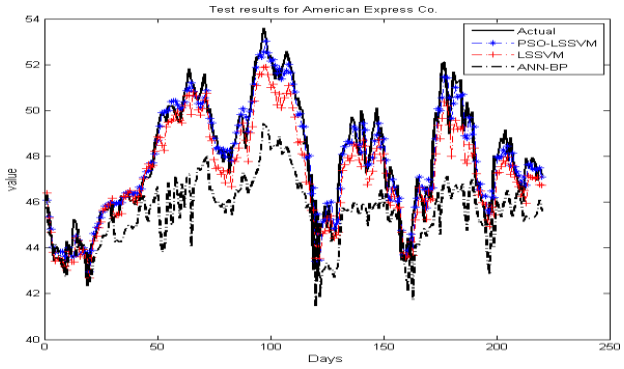

Figure.5. Results For American Express Company

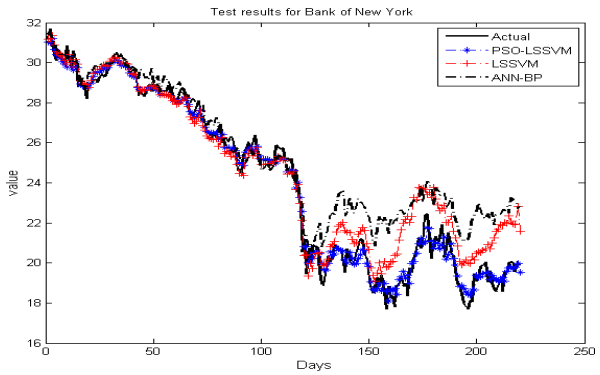

Figure.6. Results for bank of New York

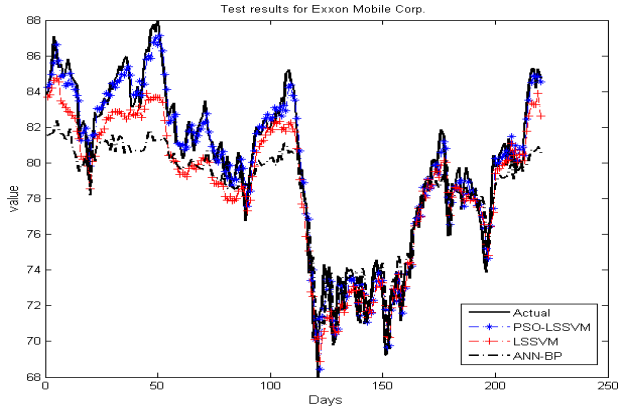

Figure.7. Results for Exxon Company

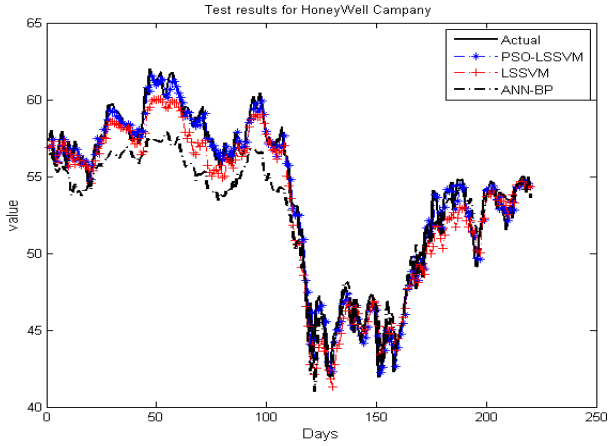

Figure.8. Results for Honeywell Company

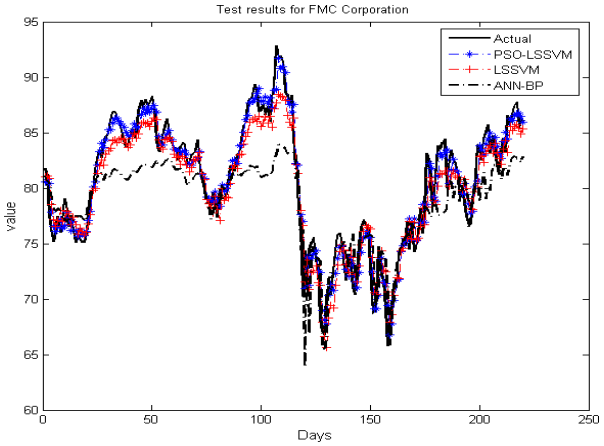

Figure.12.Results for FMC Corporation

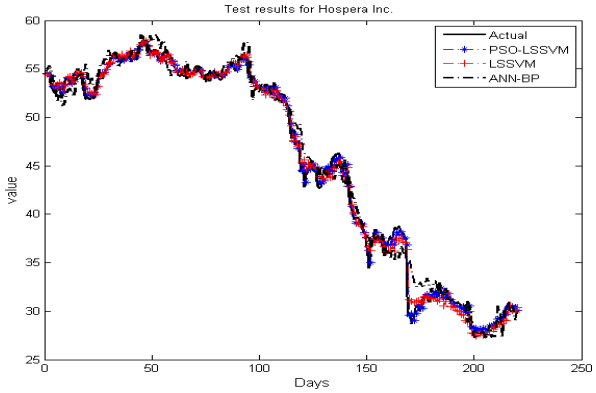

Figure.9. Results for Hospera Company

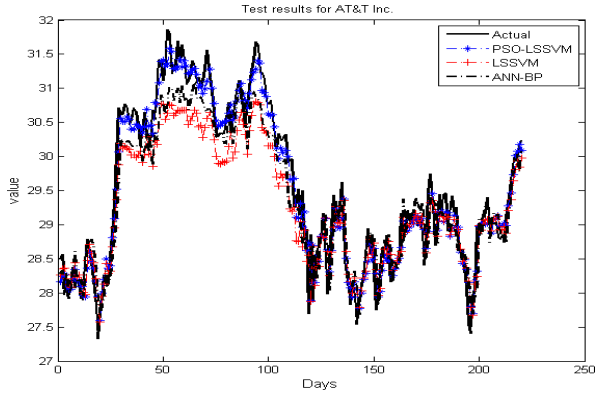

Figure.13. Results for AT&T Company

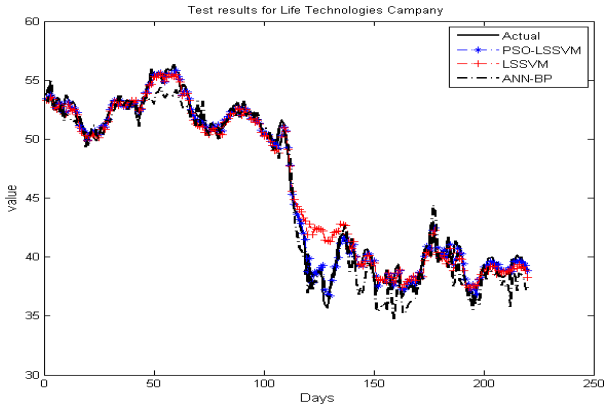

Figure.10. Results for life technologies' Company

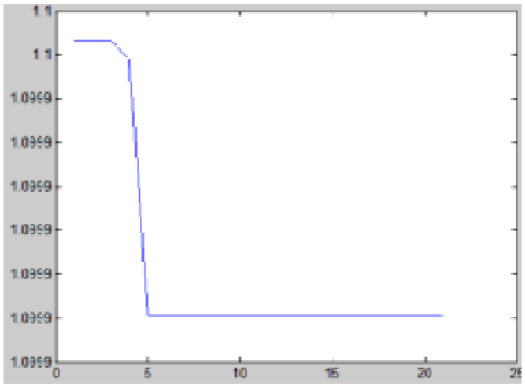

Figure.14. Convergence curve of PSO-LSSVM

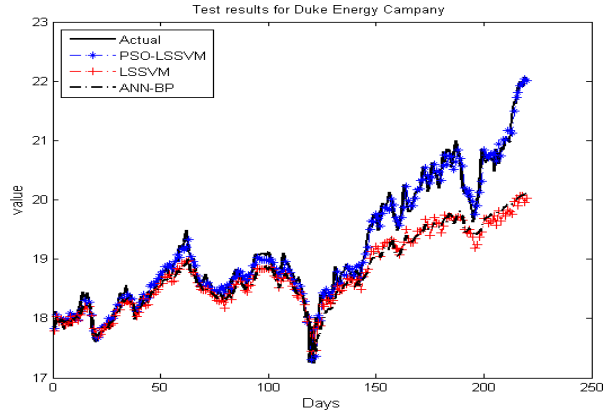

Figure.11. Results for Duke Energy Company

IV. CONCLUSION AND FUTURE SCOPE

This paper, proposed a machine learning model that integrates particle swarm optimization (PSO) algorithm and LS-SVM for stock price prediction using financial technical indicators. These indicators include relative strength index, money flow index, exponential moving average, stochastic oscillator and moving average convergence/ divergence the PSO is employed iteratively as global optimization algorithm to optimize LS-SVM for stock price prediction. Also, PSO algorithm used in selection of /LS-SVM free parameter C (cost penalty). The proposed LS-SVM-PSO model convergence to the global minimum. Also, it is capable to overcome the over-fitting

problem which found in ANN, especially in case of fluctuations in stock sector. PSO-LS-SVM algorithm parameters can be tuned easily. The performance of the proposed model is better than LS-SVM-PSO achieves the lowest error value followed LS-SVM-PSO achieves the lowest error value followed by single LS-SVM, while ANN-BP algorithm is the worst one.

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