INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATION & MANAGEMENT

IJRCM

A Monthly Double-Blind Peer Reviewed (Refereed/Juried) Open Access International e-Journal - Included in the International Serial Directories

Indexed & Listed at:

Ulrich's Periodicals Directory ©, ProQuest, U.S.A., EBSCO Publishing, U.S.A., Cabell's Directories of Publishing Opportunities, U.S.A., Open J-Gage, India [link of the same is duly available at Inflibnet of University Grants Commission (U.G.C.)], Index Copernicus Publishers Panel, Poland with IC Value of 5.09 & number of libraries all around the world.

Circulated all over the world & Google has verified that scholars of more than 2501 Cities in 159 countries/territories are visiting our journal on regular basis.

Ground Floor, Building No. 1041-C-1, Devi Bhawan Bazar, JAGADHRI – 135 003, Yamunanagar, Haryana, INDIA

http://ijrcm.org.in/

CONTENTS

CALL FOR MANUSCRIPTS

We invite unpublished novel, original, empirical and high quality research work pertaining to recent developments & practices in the areas of Computer Science & Applications; Commerce; Business; Finance; Marketing; Human Resource Management; General Management; Banking; Economics; Tourism Administration & Management; Education; Law; Library & Information Science; Defence & Strategic Studies; Electronic Science; Corporate Governance; Industrial Relations; and emerging paradigms in allied subjects like Accounting; Accounting Information Systems; Accounting Theory & Practice; Auditing; Behavioral Accounting; Behavioral Economics; Corporate Finance; Cost Accounting; Econometrics; Economic Development; Economic History; Financial Institutions & Markets; Financial Services; Fiscal Policy; Government & Non Profit Accounting; Industrial Organization; International Economics & Trade; International Finance; Macro Economics; Micro Economics; Rural Economics; Co-operation; Demography: Development Planning; Development Studies; Econometrics; Applied Economics; Development Economics; Business Economics; Monetary Policy; Public Policy Economics; Real Estate; Regional Economics; Political Science; Continuing Education; Labour Welfare; Philosophy; Psychology; Sociology; Tax Accounting; Advertising & Promotion Management; Management Information Systems (MIS); Business Law; Public Responsibility & Ethics; Communication; Direct Marketing; E-Commerce; Global Business; Health Care Administration; Labour Relations & Human Resource Management; Marketing Research; Marketing Theory & Applications; Non-Profit Organizations; Office Administration/Management; Operations Research/Statistics; Organizational Behavior & Theory; Organizational Development; Production/Operations; International Relations; Human Rights & Duties; Public Administration; Population Studies; Purchasing/Materials Management; Retailing; Sales/Selling; Services; Small Business Entrepreneurship; Strategic Management Policy; Technology/Innovation; Tourism & Hospitality; Transportation Distribution; Algorithms; Artificial Intelligence; Compilers & Translation; Computer Aided Design (CAD); Computer Aided Manufacturing; Computer Graphics; Computer Organization & Architecture; Database Structures & Systems; Discrete Structures; Internet; Management Information Systems; Modeling & Simulation; Neural Systems/Neural Networks; Numerical Analysis/Scientific Computing; Object Oriented Programming; Operating Systems; Programming Languages; Robotics; Symbolic & Formal Logic; Web Design and emerging paradigms in allied subjects.

Anybody can submit the **soft copy** of unpublished novel; original; empirical and high quality **research work/manuscript** ***anytime*** in ***M.S. Word format*** after preparing the same as per our **GUIDELINES FOR SUBMISSION**; at our email address i.e. infoijrcm@gmail.com or online by clicking the link **online submission** as given on our website (***FOR ONLINE SUBMISSION, CLICK HERE***).

GUIDELINES FOR SUBMISSION OF MANUSCRIPT

1. **COVERING LETTER FOR SUBMISSION:**

DATED: _____________

THE EDITOR
IJRCM

Subject: **SUBMISSION OF MANUSCRIPT IN THE AREA OF .**

(e.g. Finance/Marketing/HRM/General Management/Economics/Psychology/Law/Computer/IT/Engineering/Mathematics/other, please specify)

DEAR SIR/MADAM

Please find my submission of manuscript entitled '____' for possible publication in your journals.

I hereby affirm that the contents of this manuscript are original. Furthermore, it has neither been published elsewhere in any language fully or partly, nor is it under review for publication elsewhere.

I affirm that all the author (s) have seen and agreed to the submitted version of the manuscript and their inclusion of name (s) as co-author (s).

Also, if my/our manuscript is accepted, I/We agree to comply with the formalities as given on the website of the journal & you are free to publish our contribution in any of your journals.

NAME OF CORRESPONDING AUTHOR:
Designation:
Affiliation with full address, contact numbers & Pin Code:
Residential address with Pin Code:
Mobile Number (s):
Landline Number (s):
E-mail Address:
Alternate E-mail Address:

NOTES:
a) The whole manuscript is required to be in ***ONE MS WORD FILE*** only (pdf. version is liable to be rejected without any consideration), which will start from the covering letter, inside the manuscript.
b) The sender is required to mentionthe following in the **SUBJECT COLUMN** of the mail:
New Manuscript for Review in the area of (Finance/Marketing/HRM/General Management/Economics/Psychology/Law/Computer/IT/ Engineering/Mathematics/other, please specify)
c) There is no need to give any text in the body of mail, except the cases where the author wishes to give any specific message w.r.t. to the manuscript.
d) The total size of the file containing the manuscript is required to be below **500 KB**.
e) Abstract alone will not be considered for review, and the author is required to submit the complete manuscript in the first instance.
f) The journal gives acknowledgement w.r.t. the receipt of every email and in case of non-receipt of acknowledgment from the journal, w.r.t. the submission of manuscript, within two days of submission, the corresponding author is required to demand for the same by sending separate mail to the journal.

2. **MANUSCRIPT TITLE**: The title of the paper should be in a 12 point Calibri Font. It should be bold typed, centered and fully capitalised.

3. **AUTHOR NAME (S) & AFFILIATIONS**: The author (s) **full name**, **designation**, **affiliation** (s), **address**, **mobile/landline numbers**, and **email/alternate email address** should be in italic & 11-point Calibri Font. It must be centered underneath the title.

4. **ABSTRACT**: Abstract should be in fully italicized text, not exceeding 250 words. The abstract must be informative and explain the background, aims, methods, results & conclusion in a single para. Abbreviations must be mentioned in full.

5. **KEYWORDS**: Abstract must be followed by a list of keywords, subject to the maximum of five. These should be arranged in alphabetic order separated by commas and full stops at the end.

6. **MANUSCRIPT**: Manuscript must be in ***BRITISH ENGLISH*** prepared on a standard A4 size ***PORTRAIT SETTING PAPER***. It must be prepared on a single space and single column with 1" margin set for top, bottom, left and right. It should be typed in 8 point Calibri Font with page numbers at the bottom and centre of every page. It should be free from grammatical, spelling and punctuation errors and must be thoroughly edited.

7. **HEADINGS**: All the headings should be in a 10 point Calibri Font. These must be bold-faced, aligned left and fully capitalised. Leave a blank line before each heading.

8. **SUB-HEADINGS**: All the sub-headings should be in a 8 point Calibri Font. These must be bold-faced, aligned left and fully capitalised.

9. **MAIN TEXT**: The main text should follow the following sequence:

   INTRODUCTION

   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

   SCOPE FOR FURTHER RESEARCH

   ACKNOWLEDGMENTS

   REFERENCES

   APPENDIX/ANNEXURE

   It should be in a 8 point Calibri Font, single spaced and justified. The manuscript should preferably not exceed ***5000 WORDS***.

10. **FIGURES &TABLES**: These should be simple, crystal clear, centered, separately numbered &self explained, and **titles must be above the table/figure**. **Sources of data should be mentioned below the table/figure**. It should be ensured that the tables/figures are referred to from the main text.

11. **EQUATIONS**:These should be consecutively numbered in parentheses, horizontally centered with equation number placed at the right.

12. **REFERENCES**: The list of all references should be alphabetically arranged. The author (s) should mention only the actually utilised references in the preparation of manuscript and they are supposed to follow **Harvard Style of Referencing**. The author (s) are supposed to follow the references as per the following:

- All works cited in the text (including sources for tables and figures) should be listed alphabetically.
- Use (**ed.**) for one editor, and (**ed.s)** for multiple editors.
- When listing two or more works by one author, use --- (20xx), such as after Kohl (1997), use --- (2001), etc, in chronologically ascending order.
- Indicate (opening and closing) page numbers for articles in journals and for chapters in books.
- The title of books and journals should be in italics. Double quotation marks are used for titles of journal articles, book chapters, dissertations, reports, working papers, unpublished material, etc.
- For titles in a language other than English, provide an English translation in parentheses.
- The location of endnotes within the text should be indicated by superscript numbers.

PLEASE USE THE FOLLOWING FOR STYLE AND PUNCTUATION IN REFERENCES:

BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

UNPUBLISHED DISSERTATIONS AND THESES

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, KurukshetraUniversity, Kurukshetra.

ONLINE RESOURCES

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

WEBSITES

- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

FORECASTING OF ELECTRICITY DEMAND USING SARIMA AND FEED FORWARD NEURAL NETWORK MODELS

CHANDRABHUSHAN KESAVABHOTLA
RESEARCH SCHOLAR
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

DR. V. V. HARAGOPAL
PROFESSOR & HEAD
DEPARTMENT OF STATISTICS
OSMANIA UNIVERSITY
HYDERABAD

DR. A. VINAY BABU
PRINCIPAL
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
HYDERABAD

ABSTRACT
In this paper, Seasonal ARIMA and neural network models are compared for short term and long term forecasting. Electricity consumption of California data is used for modeling, which has a strong seasonal trend. Multiple SARIMA models are considered for forecasting and to compare the results with that of Neural network model. SARIMA model fits well the data and it resulted small RMSE values. Feed forward neural network model is also fitted the data but RMSE of fitted data is larger than that of SARIMA models. When 6 months forecast values are compared for SARIMA and Neural network models , the neural network model resulted lower RMSE than that for SARIMA models. Thus neural network model performed well for short term forecasting when seasonality is low whereas SARIMA model performed better for long term forecasting for the fitted model since seasonality effect is high.

KEYWORDS
ARIMA, Forecast, Electricity Demand, Feed Forward Neural Network, Forecast, SARIMA, Seasonal ARIMA.

INTRODUCTION
In practice, ARMA models on time series data are applied after removing any trend including seasonality trend as ARMA (Autoregressive Moving Averages) models do not allow skipping lags. But in the scenarios of monthly observations which depends on both the previous month and the month one year ago, SARIMA (Seasonal Autoregressive Integrated Moving Average) models can be applied as they allow skipping lags. In this paper , we compared SARIMA and Neural network models for forecasting electricity demand of California.

Hong-Choon Ong, and Shin-Yue Chan[1] have applied SARIMA and neural network models for forecasting water consumption, both the models performed well but double layered MLP (Multilayer Perceptron) neural network performed better than single layered MLP. Liu Hong, Cui Wenhua, and Zhang Qingling [2] have improved RBF(Radial Basis Function) neural network model with a nonlinear relationship mapping by combining single forecasting results with RBF input layer. Siddarameshwara et al [3], have applied Elman recurrent (feedback) neural network for short term load forecasting using MATLAB tool to allow loops and backward links in the network. Michael Nelson, Tim Hill, Bill , and Marcus [4] have compared neural network for seasonal and de-seasonal data, they observed that the neural network was more accurate for de-seasonal than that for seasonal data. Pei Liu et al [5] worked on cement supply chain for forecasting demand using SARIMA and neural network models, the results indicated that neural network has given more accurate forecast values than that of SARIMA for the quarterly data. Karin Kandananond[6] found that Neural Network model performed better than ARIMA in forecasting electricity demand of Thailand. Ramakrishna et al [7] have applied SARIMA and Neural networks to forecast monthly electricity demand of Andhra Pradesh and they have indicated that Neural Networks has performed better than SARIMA.

In this paper , SARIMA and neural network model are applied for forecasting electricity demand of California and for comparing the models. A data population of California residential electricity consumption for each month between 1973-2011 is considered for modeling and forecasting. California data is a monthly data extracted from public domain in internet. A sample data of 72 observations between 2006-2011 is considered where 66 observations are used for model fitting and 6 observations for comparing with predicted values. SPSS tool is used for neural network modeling and R programming for SARIMA modeling.

Time series plot of California residential electricity consumption in Figure 1 shows that there is an upward and downward trend in the time series and also some periodicity.

FIGURE 1 – TIME SERIES PLOT

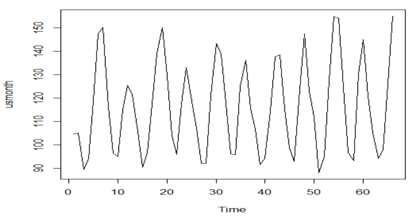


FIGURE 2 – ACF PLOT

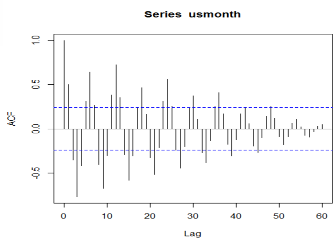
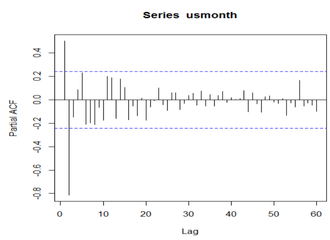


FIGURE 3 – PACF PLOT



ACF and PACF plots in Figure 2 and 3 respectively indicate that there are autocorrelations and a seasonal trend in the data.

SARIMA MODELING

Seasonal ARIMA is represented as ARIMA(p,d,q)x(P,D,Q)$_s$ where p is the number of autoregressive terms, d is the number of non-seasonal differences, q is the number lagged forecast errors in the prediction equation, P the number of seasonal autoregressive terms, D the number of seasonal differences, Q the number of seasonal moving average terms, and s is the periodicity , 12 in this case. R project is used to fit SARIMA model.

In ARIMA(p,d,q)x(P,D,Q)$_{12}$, the order of p, d, q and P,D, and Q are changed iteratively. For each iteration, AIC and RMSE (Root Mean Square Error) values are captured in the Table 1.

TABLE 1 – SARIMA MODEL IDENTIFICATION

ARIMA/SARIMA		AIC	RMSE	ARIMA/SARIMA		AIC	RMSE	ARIMA/SARIMA		AIC	RMSE
(1,0,1)		526.9	12.16	(1,1,1)	(0,1,1)$_{12}$	351.3	5.193	(1,0,1)	(1,1,1)$_{12}$	344.2	4.758
(2,0,2)		487.9	8.715	(1,1,1)	(1,1,1)$_{12}$	342.1	4.654	(1,1,2)	(1,1,2)$_{12}$	343.1	4.458
(2,1,2)		484.9	8.878	(1,1,1)	(1,1,0)$_{12}$	340.4	4.676	(2,1,0)	(1,1,0)$_{12}$	346.3	5.109
(2,0,0)		485.5	8.828	(0,1,1)	(0,1,1)$_{12}$	348.5	5.301	(1,1,2)	(0,1,1)$_{12}$	339.1	4.457
(2,1,0)		516.9	12.08	(1,1,0)	(0,1,1)$_{12}$	349.9	5.324	(2,0,2)	(0,2,2)$_{12}$	301.1	3.574
(1,1,0)		560.8	17.38	(1,1,0)	(1,1,1)$_{12}$	350.6	5.278	(2,0,2)	(0,1,1)$_{12}$	346	4.654
(2,0,1)		487	8.795	(1,1,0)	(1,1,0)$_{12}$	348.8	5.286	(2,0,2)	(0,2,1)$_{12}$	303.5	4.83
(1,1,1)		543.4	14.87	(2,1,0)	(0,1,1)$_{12}$	345.2	4.978	(3,0,2)	(0,2,2)$_{12}$	492.8	8.669
(0,1,1)		541.4	14.87	(2,1,1)	(1,1,1)$_{12}$	341.5	4.483	(3,0,1)	(0,2,2)$_{12}$	489.6	8.602
(1,0,1)	(0,1,0)$_{12}$	348.9	5.215	(2,1,0)	(1,1,0)$_{12}$	340.7	4.595	(3,0,3)	(1,2,2)$_{12}$	474.4	7.003
(1,0,1)	(0,1,1)$_{12}$	342	4.654	(2,1,0)	(0,1,1)$_{12}$	339.6	4.47	(3,0,3)		472.4	7.129
(1,0,1)	(0,2,1)$_{12}$	299.8	5.007	(1,1,1)	(1,2,1)$_{12}$	304.1	4.81	(3,0,3)	(0,1,0)$_{12}$	355.5	5.059
(1,0,1)	**(0,3,1)$_{12}$**	**247.7**	**6.521**	(0,0,1)	(0,1,1)$_{12}$	340.5	4.69	(3,0,3)	(0,2,1)$_{12}$	304.4	4.371
(1,0,1)	(0,3,2)$_{12}$	249	7.219	(0,0,2)	(0,1,1)$_{12}$	342	4.656	**(3,0,3)**	**(1,2,2)$_{12}$**	**306.9**	**3.294**
(1,0,1)	(0,3,3)$_{12}$	251	7.275	**(1,0,1)**	**(0,2,2)$_{12}$**	**297.3**	**3.569**	(3,0,3)	(0,3,1)$_{12}$	254.2	6.278

From the Table 1, it is observed that there are three models of SARIMA identified for comparison with unique characteristics : (1) SARIMA-1 model (1,0,1)x(0,3,1)$_{12}$ has the lowest AIC and RMSE of fitted data 6.52 (2) SARIMA-2 model (1,0,1)x(0,2,2)$_{12}$ has AIC 297.32 and RMSE 3.57 (3) SARIMA-3 model (3,0,3)x(1,2,2)$_{12}$ has AIC of 306.93 and lowest RMSE of 3.29. AIC and RMSE of SARIMA-2 fall between that of SARIMA-1 and SARIMA-3. These 3 models are considered for comparison of forecasted values with that of Neural Network model.

Ljung-box Test is carried on the residuals of 3 models identified and p-values are captured in the Table 2. The p-value of 3 models are > 0.05 level of significance indicate that the residuals are random.

TABLE 2 – LJUNG-BOX TEST

Model		p-value
SARIMA-1	(1,0,1)x(0,3,1)	0.629
SARIMA-2	(1,0,1)x(0,2,2)	0.901
SARIMA-3	(3,0,3)x(0,3,1)	0.935

FIGURE-4 ACF OF SARIMA-1

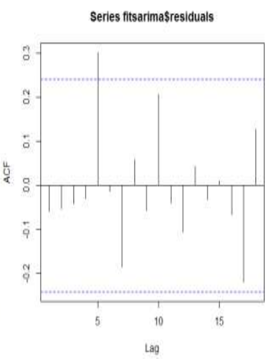


FIGURE-5 ACF OF SARIMA-2

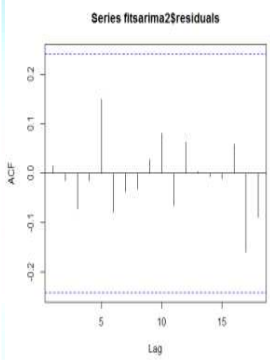
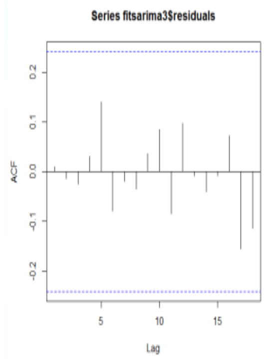


FIGURE-6 ACF OF SARIMA-3



ACF plot of residuals of 3 models are shown in Figure 4 , Figure 5 and Figure 6 respectively , indicates that there are no autocorrelations in the residuals except in one case in SARIMA-1. Thus, the identified models are adequate for fitting the data and for forecasting electricity demand.

The residuals are checked for any heteroskedasticity using McLeod Li Test. The p-values are plotted in Figure 7, Figure 8, and Figure 9 for the 3 models.

FIGURE 7 – MCLEOD-LI TEST OF SARIMA-1

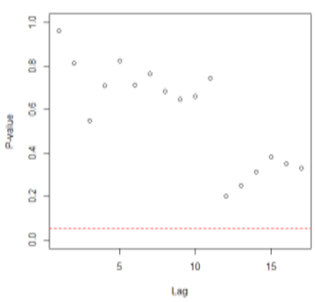


FIGURE 8 – MCLEOD-LI TEST OF SARIMA-2

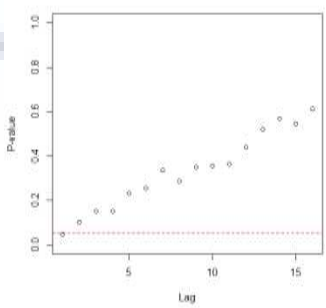
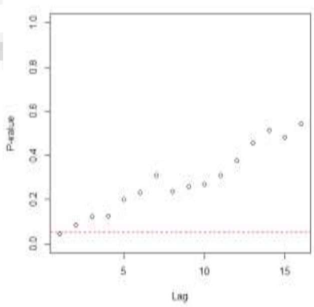


FIGURE 9 – MCLEOD-LI TEST OF SARIMA-3



All p-values are > 0.05 level of significance. Thus there is no heteroskedasticity in the residuals of all the 3 SARIMA models.

The estimated coefficients of 3 models and standard errors are shown in the Table 3

TABLE 3 - ESTIMATION OF COEFFICIENTS OF SARIMA MODELS

	SARIMA-1		SARIMA-2		SARIMA-3	
Coefficients	Estimation	Std error	Estimation	Std error	Estimation	Std error
ar1	-0.2979	0.1916	0.2574	0.289	0.0174	1.9557
ar2					0.3151	1.3834
ar3					-0.231	0.5226
ma1	1	0.3087	0.2903	0.2937	0.5381	1.9905
ma2					-0.1535	1.8611
ma3					0.056	0.5809
sar1			-1.7708	0.8146	-0.1486	0.3422
sma1	-0.999	0.8284	0.9987	0.8278	-1.8045	1.0562
sma2					0.9953	1.0592

From the table 3 , it is observed that the standard errors of SARIMA-3 are larger than that of SARIMA-1 and SARIMA-2

FORECASTING USING SARIMA MODEL

6 months forecasting is done using SARIMA estimated coefficients. The forecast values are captured in the Table 4 along with the actual values for error computation.

TABLE 4 – 6 MONTHS FORECAST VALUES OF 3 MODELS AND ACTUAL OBSERVED VALUES

Month	Observed	SARIMA-1	SARIMA-2	SARIMA-3
67	154.8885	180.3524	148.0356	147.219
68	153.6875	174.8095	143.3671	141.0729
69	122.8422	132.3018	120.4806	118.8866
70	94.57597	92.06967	96.89929	96.05149
71	93.12583	92.27572	92.35208	91.89427
72	116.0872	141.5576	132.4909	132.3498

The forecast accuracy is the difference between the actual value and the forecast value for the corresponding period.

$E_t = Y_t - F_t$ (1)

Where E is the forecast error at time period t, Y is the actual value at period t, and F is the forecast for period t.

The following measures are widely used in the industry to analyze the accuracy forecast values.

Mean Absolute Percentage Error $MAPE = \frac{\sum_{t=1}^{N} |\frac{E_t}{Y_t}|}{N}$ (2)

Mean Squared Error $MSE = \frac{\sum_{t=1}^{N} E_t^2}{N}$ (3)

Mean Absolute Error $MAE = \frac{\sum_{t=1}^{N} |E_t|}{N}$ (4)

Root Mean Squared Error $RMSE = \sqrt{\frac{\sum_{t=1}^{N} E_t^2}{N}}$ (5)

The above measures are computed for 6 month forecast values of 3 SARIMA models. The computed measures are captured in Table 5.

TABLE 5 – FORECAST ACCURACY - MEASURES OF AGGREGATE ERROR

	SARIMA-1	SARIMA-2	SARIMA-3
Sum of Squared Error (SSE)	1839.7777	434.1280	501.7612
Mean Absolute Error (MAE)	14.1454	6.5059	7.2015
Mean Squared Error(MSE)	306.6296	72.3547	83.6269
Root Mean Squared Error (RMSE)	17.5108	8.5062	9.1448
Mean Absolute Percentage Error (MAPE)	0.1056	0.0508	0.0555

One can notice from the Table 5 that RMSE of forecast values is lowest in the case of SARIMA-2, thus, SARIMA-2 is the best fit model from forecast accuracy perspective. The forecast values are plotted with the fitted data , shown in Figure 10, Figure 11, Figure 12 for SARIMA-1, SARIMA-2, and SARIMA-3 respectively. The forecast values are within 95% confidence boundaries for all models but the boundary range is larger in the case of SARIMA-1.

FIGURE 10 – SARIMA-1 WITH FORECAST VALUES

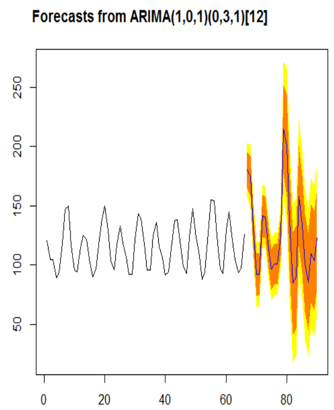


FIGURE 11 – SARIMA-2 WITH FORECAST VALUES

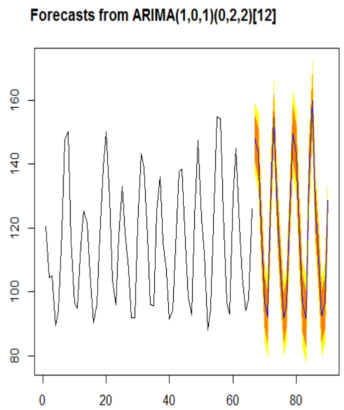
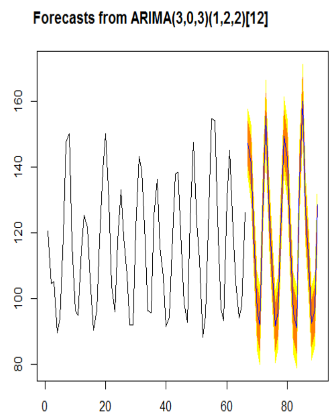


FIGURE 12 – SARIMA-3 WITH FORECAST VALUES



It is observed from Table 1 that RMSE of entire fitted data is lowest in the case of SARIMA-3 whereas RMSE of only Forecast values in the Table 5, is lowest in the case of SARIMA-2. And AIC is the lowest for SARIMA-1. The 3 SARIMA models were selected in the beginning to analyze the impact of AIC , significance of coefficients, and RMSE. Thus , a model needs to be chosen based on the data and it is important to analyze the forecast accuracy measures for fitted model and forecast values apart from AIC as the criteria for selection of a model. Since most of the statistical computations are automated in the tools, the iterative process is faster using any data mining tool and thus it is advised to look for lowest AIC as a guideline to select a model in the initial stages but subsequently it is useful to carry out an iterative method to look for accuracy measures such as RMSE to arrive at a suitable model for a given data.

From the above analysis it is observed that the relationships between inputs and outputs are playing important role to identify an appropriate model. Neural Networks are widely used modeling technique in the case of complex relationships between inputs and outputs and also to analyze complex patterns in data. If the underlying process of how the results are achieved , is not important then Neural Networks is a good modeling technique since it has inherent flexibility in dynamically interpreting the relationships between inputs and outputs to select linear regression or non-linear regression models but the synaptic weights of a neural network are not easily interpretable.

NEURAL NETWORKS MODELING

The most common neural network model[8] is the multilayer perceptron (MLP) which is a function of predictors/inputs/independent variables that minimize the error of outputs. MLP neural network model has been chosen to fit electricity consumption data of California and for forecasting monthly electricity demand. MLP consists of 3 layers – input, hidden, and output. MLP with Feed Forward Architecture is considered for forecasting California monthly electricity demand. IBM SPSS tool is used for neural network modeling and forecasting.

The scale-dependent variable is a time series data of monthly electricity consumption of California for 72 months. Two more inputs are considered ,one month lag and 12 month lag scale dependent variables, these two variables lag1 and lag12 are taken as covariates. The data is partitioned into training, testing and holdout. The training sample is used to train the neural network. The testing sample is used to track errors during training in order to prevent overtraining. The holdout sample is another independent group of records used to assess the final neural network. The covariate variables are rescaled using standardized method to improve network training. The training parameters are set in the tool as shown in Table 8. The architecture selection is automatic with 1 to 50 max units.

TABLE 8 – SPSS TOOL TRAINING PARAMETER SETTINGS

Parameter	Value
Training Criteria	Mini-Batch
Optimization Algorithm	Gradient descent
Initial learning rate	0.3
Lower Boundary of learning rate	0.001
Momentum	0.9
Learning rate reduction, in Epochs	10
Interval cetner	0
Internal Offset	0.5
Stopping rule-error steps	1
Max Training time	default

The partitioning of data is done by assigning relative number to training, testing and holdout sets. The relative numbers are changed iteratively to get best possible partition , for each iteration RMSE of testing is captured in Table 9. For the given data 70%-25%-5% partition has given lowest RMSE for testing records. The processed records summary is shown in Table 10 where 46 records considered for training, 10 for testing and 4 for holdout.

TABLE 9 – PARTITION AND RMSE OF TESTING

Partition	RMSE of Testing
70,20,10	0.185
70,25,5	0.118
80,15,5	0.273
85,10,5	0.230
60,30,10	0.252
65,30,5	0.204
75,20,5	0.287
55,40,5	0.243
50,45,5	0.170

TABLE 10 – SUMMARY OF DATA PROCESSED

Partition Summary		
		N
Sample	Training	46
	Testing	10
	Holdout	4
Valid		60
Excluded		12
Total		72

TABLE 11 – MODEL SUMMARY

Training	Sum of Squares Error	3.080
	Relative Error	.137
	Stopping Rule Used	1 consecutive step (s) with no decrease in error[a]
	Training Time	00:00:00.040
Testing	Sum of Squares Error	.140
	Relative Error	.023
Holdout	Relative Error	18.736

Dependent Variable: VAR00001

a. Error computations are based on the testing sample.

The feed forward neural network model summary is shown in Table 11, computed RMSE of testing is 0.118. The network information is shown in Table 12, it shows 2-3-1 architecture of one input layer with 2 neurons lag1 and lag12 , one hidden layer with 3 neurons, one output layer with one neuron of forecast values, the monthly load is the dependent variable. The network architecture is shown pictorially in Figure 13.

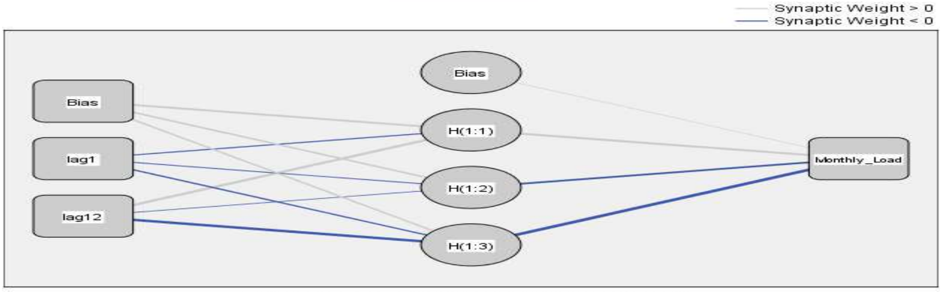
TABLE 12 – NETWORK INFORMATION

Network Information

Input Layer	Covariates	1	lag1
		2	lag12
	Number of Units[a]		2
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1[a]		3
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	Monthly_Load
	Number of Units		1
	Rescaling Method for Scale Dependents		Standardized
	Activation Function		Identity
	Error Function		Sum of Squares

a. Excluding the bias unit

FIGURE 13 – NEURAL NETWORK ARCHITECTURE WITH 70-25-5 PARTITION AND 2-3-1 UNITS (EXCLUDING BIAS)



Hidden layer activation function: Hyperbolic tangent

Output layer activation function: Identity

The estimates of coefficients of neural network model are shown in Table 13, indicate relationships among input layer units ,hidden layer units, and output layer units .

TABLE 13 – PARAMETER ESTIMATES OF NEURAL NETWORK MODEL

Predictor		Predicted: Hidden Layer 1 H(1:1)	Hidden Layer 1 H(1:2)	Hidden Layer 1 H(1:3)	Output Layer VAR00001
Input Layer	(Bias)	-.108	-.099	-.319	
	lag1	.133	.499	.187	
	lag12	-.537	.210	-.343	
Hidden Layer 1	(Bias)				-.138
	H(1:1)				-1.484
	H(1:2)				.718
	H(1:3)				-.277

FORECASTING USING FEED FORWARD NEURAL NETWORK MODEL

The selected Feed Forward Neural Network model is used to forecast the monthly electricity demand of California. The 6 months forecast of neural network model is compared with SARIMA-1, SARIMA-2, and SARIMA-3 forecast values in Table 14. RMSE computed for all the four models indicate the neural network model has lowest RMSE for the 6 months forecasts, though RMSE of fitted.

TABLE 14 – 6 MONTHS FORECAST OF SARIMA AND NEURAL NETWORK

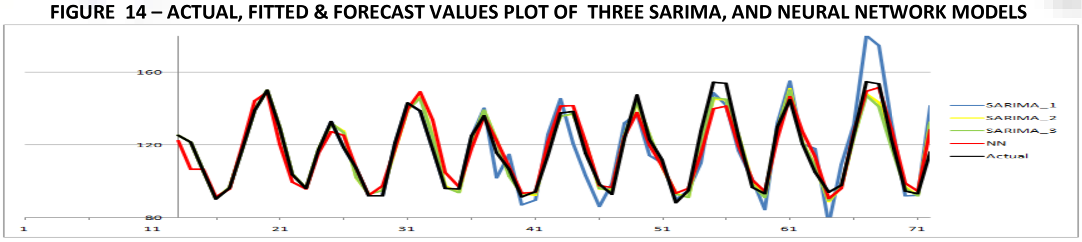
Actual	SARIMA-1	SARIMA-2	SARIMA-3	NN
154.888	180.352	148.036	147.219	149.664
153.688	174.809	143.367	141.072	151.561
122.842	132.302	120.481	118.887	128.793
94.576	92.069	96.899	96.051	98.850
93.126	92.275	92.352	91.894	94.634
116.087	141.558	132.491	132.35	128.578

RMSE values of SARIMA and neural network models of entire series and 6 months forecast values are shown in Table 15

TABLE 15 – RMSE OF ENTIRE SERIES AND 6 MONTHS FORECAST VALUES OF SARIMA AND NEURAL NETWORK

	SARIMA-1	SARIMA-2	SARIMA-3	NN
RMSE of Fitted Model	6.521	3.569	3.294	6.103
RMSE of 6 Months Forecast	17.511	8.506	9.145	6.374

FIGURE 14 – ACTUAL, FITTED & FORECAST VALUES PLOT OF THREE SARIMA, AND NEURAL NETWORK MODELS



From the table 15, one can notice that RMSE of fitted models is lowest for SARIMA-3 whereas RMSE of 6 months forecast values is lowest in the case of neural networks model and SARIMA-2 among SARIMA models . From fitted model perspective, SARIMA has shown lower error than that of Neural network, but from forecasting perspective neural network model has shown better results. Thus, SARIMA may be a good model for a long term forecasting as seasonality trend and has influence on the model fitment whereas for short term forecasting neural network model is a better option as it reduces errors with time due to learning progress from training process and also seasonality trend effect is low for short term. Fitted along with Forecast values vs. Actual values for all the models are shown in Figure 14, SARIMA-2 and SARIMA-3 fitted values are more closer to Actual than that of Neural network.

CONCLUSION

In this paper, SARIMA and Neural network models are compared with forecasting 6 months electricity demand of California. 3 models of SARIMA are considered for comparison purpose one with lowest AIC, one with lowest RMSE and another one in between model. And Neural network model is selected with a partition of data for training and testing based on the lowest RMSE. Forecast from 3 SARIMA and Neural network models are compared along with RMSE. SARIMA-2 has given the best Forecast among 3 SARIMA models based on RMSE of Forecast values while fitted model(i.e. entire series) of SARIMA-2 has AIC closer to SARIMA-1 and RMSE closer to SARIMA-3. It is observed that among SARIMA models and Neural network model, fitted data of SARIMA models have given better RMSE than that of neural network model. And in the case of 6 months forecast values, neural network has given lower RMSE compare to that of SARIMA models. Since error judgment is an important factor in forecasting though the model selection may be done on a different criteria such as AIC or significance level of coefficients and other factors. The model needs to be fine tuned objectively to reduce the errors hence, it is advisable to select multiple models with multiple criteria for comparing error level depending on the data. Thus, it is concluded that for forecasting California electricity demand , while neural network is a better model for short-term forecasting for the given data whereas seasonality trend impact is low, SARIMA is a better model for long term forecasting as seasonality trend is high for long term.

REFERENCES

1. Hong-Choon Ong, Shin-Yue Chan, Short-A Comparison on Neural Network Forecasting, 2011 International Conference on Circuits, System and Simulation, IPCSIT vol.7 (2011) © (2011) IACSIT Press, Singapore , pages 56-60.
2. IBM SPSS Neural Networks 19, User guide, 2010
3. Karin Kandananond, Forecasting Electricity Demand in Thailand with an Artificial Neural Network Approach, Energies 2011, 4, , Page(s): 1246-1257
4. Liu Hong; Cui Wenhua; Zhang Qingling, Nonlinear Combination Forecasting Model and Application Based on Radial Basis Function Neural Networks, IEEE Conference Publications, 2009 IITA International Conference on Control, Automation and Systems Engineering, Page(s): 387 – 390
5. Michael Nelson, Tim Hill, Bill Re, Marcus O'Connor, Can Neural Networks Applied to Time Series Forecasting Learn Seasonal Patterns: an Empirical Investigation, System Sciences, 1994. Proceedings of the Twenty-Seventh Hawaii International Conference, Digital Object Identifier: 10.1109/HICSS.1994.323316 , Page(s): 649 – 655
6. Pei Liu, Shih-Huang Chen, Hui-Hua Yang, Ching-Tsung Hung, Mei-Rong Tsai, Application of Artificial Neural Network and SARIMA in Portland Cement Supply Chain to Forecast Demand, IEEE Conference Publications , Fourth International Conference on Natural Computation, Page(s): 97 - 101.
7. R Ramakrishna, Naveen Kumar Boiroju and M Krishna Reddy, Neural Networks Forecasting Model for Monthly Electricity Load in Andhra Pradesh, International Journal of Engineering Research and Applications , Vol. 2, Issue 1, Jan-Feb 2012, pp.1108-1115
8. Siddarameshwara N, Anup Yelamali, Kshitiz Byahatti Electricity Short term Load Forecasting using Elman Recurrent Neural Network, IEEE Conference Publications , 2010 International Conference on Advances in Recent Technologies in Communication and Computing, Page(s): 351 - 354.

REQUEST FOR FEEDBACK

Dear Readers

At the very outset, International Journal of Research in Computer Application and Management (IJRCM) acknowledges & appreciates your efforts in showing interest in our present issue under your kind perusal.

I would like to request you tosupply your critical comments and suggestions about the material published in this issue as well as on the journal as a whole, on our E-mail**infoijrcm@gmail.com** for further improvements in the interest of research.

If youhave any queries please feel free to contact us on our E-mail **infoijrcm@gmail.com**.

I am sure that your feedback and deliberations would make future issues better – a result of our joint effort.

Looking forward an appropriate consideration.

With sincere regards

Thanking you profoundly

Academically yours

Sd/-

Co-ordinator

ABOUT THE JOURNAL

In this age of Commerce, Economics, Computer, I.T. & Management and cut throat competition, a group of intellectuals felt the need to have some platform, where young and budding managers and academicians could express their views and discuss the problems among their peers. This journal was conceived with this noble intention in view. This journal has been introduced to give an opportunity for expressing refined and innovative ideas in this field. It is our humble endeavour to provide a springboard to the upcoming specialists and give a chance to know about the latest in the sphere of research and knowledge. We have taken a small step and we hope that with the active co-operation of like-minded scholars, we shall be able to serve the society with our humble efforts.

Our Other Journals