

Application of Soft Computing Approach in Seven-segment Display Hardware as Applied to Business Strategies

Ajay Abrol

GCET: Government College of Engineering and Technology

Abid Sarwar (✉ sarwar.aabid@gmail.com)

Jammu University: University of Jammu

Research Article

Keywords: Seven-Segment Display, Soft Computing, ANN, Business Strategies

DOI: <https://doi.org/10.21203/rs.3.rs-242029/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

In this work, an attempt has been made to apply MBP, ANN approach to the hardware comprising twenty-four-seven segments to recognize composed data and apply the network for displaying current/ updated contents for various business strategies or display activities. Randomization has been applied for composing messages using binary bits for numbers or alphabets. Digits and numerals presented for designs are: 1, 2, 3, 4, 5, 6, 7, 8, 9, A, b, C, d, E, F, H, I, J, L, n, o, P, r S, U, y, Z. A total of 500 messages have been composed in this work. 66 % of the messages have been used in training, 30% in testing, and 4% for validation. The mean value of RMSE obtained at a learning rate of 0.3 and different values of momentum for training, testing and validation are 0.04672, 0.26201, and 0.212219 respectively with 211992 epochs. The mean value of RMSE obtained at different learning rates and 0.7 as the value of momentum for training, testing and validation are 0.11473, 0.27439, and 0.260156 respectively with 119802 epochs. Error with 0.3 learning rate and different values of momentum has been lesser compared with when 0.7 value of momentum and different learning rates. The further author recommends recognizing the unseen patterns using the validation in the adopted approach. A trained network can be applied to directly display composed/updated messages as per strategy.

Introduction

Displaying a message is useful application for any business, office, locations at public places whether they are indoor or outdoor application and universal fit for all events. These displays are the face of the man run activities. These applications are popular because of cost effectiveness to spread messages to the people concerned without talking to them. LEDs are solid state light sources with several colors and display characteristics. Digital displays have the advantage over static signs because they can display multimedia content such as images, animations, video and audio. Audio with musical effects make the environment more comfortable for the customer's attraction and satisfaction. [1] Digital displays change contents on the displays within milliseconds. As per scheduled messages can be placed on displays or changed as per pre planning or displaying needs identified [2]. Seven segment and sixteen segment displays are widely used for displaying messages and advertisements at public places. There is a shift from broadcasting messages using public address system to rich platform with public displays needed for communication among a group or groups and may be for interaction in some cases [3]. Web based multiscreen displays are designed for display of multimedia contents on multiscreen connected by the network. Web based technologies are used for displaying same messages and video content and moving messages on the screen [4]. Most digital displays are put at the point of sale. Intent is to uplift the sale, expand the business and to earn profit keeping in view the branding of the product for achieving long term relationship with the customers. These are placed in places that help customers to help and make buying decisions. Point of transit, where passengers are passing by for short time. Intent is brand identity. Point of wait where customers have sufficient time to look at displays. Designers use tactics to engage customers [5]. Machine learning has been used in the work for scheduling in Digital Storage: Information flow and loops adopted from [6]. Purpose of digital displays is displaying news, tourist information. Digital signage is term used in context of advertising [7]. Technologies sensing the environment are advanced. What are the contents that are to be sensed to adapt to consumers context are unanswered to a large extent [8]. Networks are applied in developments of digital signage (DS) Systems. A central system is employed for determining messages on any one out of whole displays installed for displays

in an organization or public place. There might be same contents on all displays. Transition time of a customer may be a criterion for display but sensors in the are used to track the customer in retailing premises and may be used to observe each one's sense at a particular display. Data processing is done in real way. This forms basis for implementing experimental retailing strategies [9]. Digital signage is an emerging channel that reaches out to consumers irrespective of time and space. Product identification is an important stage keeping in view the demand of the product in the market and for the customer once it is launched for design and sent for IPR (design approval). Once manufacturing is launched, the whole chain from manufacture to buyer becomes a chain of stake holders. Technologies are being tried keeping in view the interest of all the stake holders into considerations to achieve business objective and meet expected benefits. Objectives might differ with different customers and might overlap in some cases [10]. There has been a discrepancy between the experts from industry and academia on the application of displays. Outdoor advertising, steel and retail furniture, transit media etc. out of home have been discussed in the work [11]. While public static signages are being replaced with digital displays. This creates opportunities for application and induction of interactive display systems. Digital displays find usage in collaborative workspaces, social gaming platform and in the field of advertising. Attraction, interaction among concerned and conation have been used in analysis for ascertaining the effectiveness of displays in advertisements. Integration of smart mobile phones should be included as a component for enhancing the effectiveness of displays as tools in advertisements [12]. Mobile Phones interact with environment. Capabilities of smart phones are on the rise in the use as input device for situated displays and home appliances. Mobile phones usage interface for ubiquitous computing applications [13]. A new ubicomp infrastructure is emerging to be set up at public places. Hinderance in the adoption of application is the cost factor. Public displays space may not be apt unless there is source for funding. Advertisements using displays are the business models nowadays [14]. Selling applications, smart phone applications that are downloaded, sport results etc. are the few applications. Display function is further enhanced to benefit the society [15]. Operators of display architecture provides a scheduling procedure and there is an application for displaying contents. Contents are created by the expert in designing advertisements. Advertiser tries to cover contents to a larger extent so that success can be measured. On the other side user is interested in the contents of interest. Therefore, it becomes essential to schedule various activities [16]. Chon Bio-inspired information and communication technologies, BICT acnes of status recorded manually are high. The work proposes a display that is real and has automatic seven segment display tracking system. The system is applied to the actual machine that are used in manufacturing [17]. In manufacturing industry, the manufacturing status can be shown via seven segment display. During operation the operator records the status of the machine periodically

As a main contribution of this paper messages comprising 168 binary digits are used as inputs to the network. 350 such input patterns are used for training models. There are 150 test patterns and 20 validation patterns. Multiple back propagation, MBP is proposed with configurations as presented in Table 3 and Table 4. The data received at the input nodes is passed to various layers comprised of neurons. The learning rate has been kept fixed and momentum varies from 0.2 to 0.9 for various networks. Similarly, Momentum has been kept fixed to 0.7 and learning rate is varied from 0.1 to 0.9 for various network configurations. Processing helps to recognize messages that can be displayed with a potential to be used in advertisements. It is hoped to support the digital designs and make use of digital displays with application of ANN.

Seven segments display comprise of three horizontal and four elongated vertical segments that are made to switch on and off to display digits in with figure of eight as shown in Figure 1. and characterized with letters a,b,c,d,e,f, g and dp. As and when particular segments are turned on or off, certain alphabetical digits or letters are created. [18]

By selecting and timing such segments on or off, segments can display each of the ten decimal digits or numeral's. Pins 7,6,4,2,1,9 & 10 are connected respectively to segments a, b, c, d, e, f, g pins respectively. Pins 8 and 3 of the seven segments are common and pin 5 is connected to decimal point, dp. Displays are less expensive and are easier to operate. The work is focused on medical devices that employ seven segment displays [19]. A number of offers are there in the market for selling different products in the market. Designing and delivering offers need to be understood. It is recognized by the manufacturer that customer paying attention is essential to ensure merchandise stand out in the market from competition. Key areas in retailing are technology and tool that help the customer to make decision. visual displays that help customer in decision, consumption of product and customer's engagement, collection of big data, application of analysis & probability.

The usage of digital displays at market and public places attract the public attention and engage them in developing interest in the product. Design approaches focus on improving existing designs or develop new products. Integrate combination of new products and services in order to promote new business models [20]. Public signages used earlier were static. Nowadays, digital displays create opportunities with the deployment of interactive displays systems that are used in places like social gaming platform and advertising. Communication concepts are used and applied considering consumer behavior. The communication includes attraction, interaction and involve conation. These three factors analyze the effectiveness of interactive displays [21]. Placing of displays has a concern with zone of influence due to which social, behavioral and interactional properties get influenced at places distant from displays. Road signage and its rotation to the development of transport technologies are interlinked. In transportation, signs approaching automobile are much faster [22]. Digital displays take a wider variety of types that are different from general purpose computer monitor. Displays with different shapes can be displayed on unexpected surfaces and unexpected places. New sensing technologies can be incorporated that help new types of interaction [23]. The dilemma of digital displays portraying advertisements can not be displayed as per demand of actual audience. It is difficult to discriminate an audience that has seen that ad, audience that has missed out advertisements., audience having interest and opting detailed information, an audience for which advertisement is not required [24]. Advertising media is expanding and reaches mobile audience. Audience may work, play or perform other activities like driving or shopping. There are four types of main platforms advertising at the outdoor, transit media advertising, retail furniture and digital OOH media [25].

Methodology

Display on segments is broadly divided into two broad categories: Common cathode and common anode type. In the case of displaying a message on 24-seven segments, it is required to use twenty-four NPN transistors for activation of all segments in a particular sequence. Also, 8 PNP transistors control the binary data that is to be displayed in a sequence. All the transistors are connected to particular bits of a microcontroller on certain ports of the microcontroller used.

But in the current approach, only seven bits are used in the formulation of the message that is to be displayed on respective segments and the eighth bit for decimal display has been ignored that can be incorporated in future work. Moreover, the eighth bit is ignored as only those bits have been considered that can create a digit or numerals on the seven segments. The proposed networks only recognize the correctness of processed data that can be sent for display on segments using various strategies like sending a message as a stream of data in particular segment sizes, received at the output, and then displayed on the seven segments.

The adopted approach takes care of training 330 patterns where each pattern comprises 168 bits. All the 168 bits or lesser bits are supposed to be displayed simultaneously on segments applied in the hardware. 150 patterns are used for testing and 20 patterns are used for validation. Data of 168 bits can also be considered as a sequence of data that can be transmitted to the destination through wireless media and then displayed on displays.

The approach adopted is as: Firstly, the codes of digits were labeled as per the logic to display digits and numerals. Take a seven-segment display. Digital display 0-9 or alphanumeric characters can be formed using individual segments in displays. a, b, c, d, e, f, and g are the individual segments as shown in Table 1.

By making on and off such elements different messages can be composed. By displaying such message on a combination of 8-seven segment displays, messages can be formed as shown in Figure 2

In the presented work the digits 1-8 are randomized and their binary equivalents are used to compose the messages. Randomization is achieved in order to accommodate different messages as presented in Table 2

Similarly, characters are randomized and respective messages are formed. Now messages comprising of 24, 7-segment displays with each digit comprising 8- binary bits form messages. Therefore, patterns with 168, 500 binary bits are formed. 66 % of the data is used for training, 30% of the data is used for testing 4% of the tested patterns are used for validation. The networks have been found to classify all the 20 validation patterns not seen earlier by the network.

Scheduling procedure is applied to display content as per strategy and as per the strategic policy of the advertiser to display or partially display the contents. Production processes involve strategies that add capacity to the main assembly line. There are situations when workers supporting workstations experience high production time. Assembly line can be stopped to finish a product. Stopping at some stage decreases the efficiency of the assembly line. Production time handling needs a variety of strategies. This needs an understanding of specific situations in the individual work stations. A detailed study and analysis of the production line for a mixed-model assembly line are required for considering various perspectives. Displaying and monitors in upcoming production sequence help workers and supervisors of mixed line assembly by way of handling various production times. Moreover, visualization of the curves helps to detect bottlenecks and to prevent upcoming problems and production time variables [26]. IT systems support decision making in handling complex behavior of production systems. Re-scheduling of the job is related to the availability of requisite information. Planning is considered periodically. Demand is event-driven. IT systems put in communication efforts in informal communication [27]. In manufacturing processing rate of a job is linked and dependent on the number of resources allocated to a particular job at a line. The problem arises when is to be determined the sequence of job and resource allocation that minimizes the makespan [28]. Scheduling

depends upon resource utilization. The bottlenecks in the process need to be identified. Bottlenecks, throughput decide the impact of every item in the product mix. Modification to production scheduling is required in the process of manufacturing.

The work offers a reliable and flexible approach for evaluating the validity of scheduling [29].

Different approaches are used to improve cross-domain collaborations during the manufacturing process of special-purpose machinery. Tools involving simulations need information on systems. In the early phase, specific tools exchange data as per requirement but do not improve the communication and collaboration among various domains. Quality of system and transferring of data are the parameters used in the design process of manufacturing. The cross-domain optimum of the solution is not supported if the collaboration between domains in the design stage is not there [30]. Steps for displaying contents in the current study are as presented in Figure 3. Displays are installed at the various display places. Sensors are installed along with display units that are used to take reaction from the audience. Other methodologies can be adopted for getting the feedback based on the past history and background of the different segments of the customers including customers from niche segments. By making strategies keeping in view the latest market trends, the messages can be updated. The sole aim is only to attract the attention of the customer and interact with the external world without making lengthy discussions and spending a lot of time. The time can be spent to entertain the customer who has shown interest and has some queries about at least some of the products. Once the customer is satisfied and has shown interest, he can be put on the list and can be in touch by sending emails or What's App messages.

Results

Multiple back propagations have been employed for training, testing, and validation of the network. The learning rate is fixed to 0.3 and momentum is varied from 0.2 to 0.9 in steps as represented in Table 3. Momentum is fixed to 0.7 and learning rate is varied from 0.1 to 0.9 in steps as represented in Table 4

From the Table 3 it has been observed that there is least number of epochs and minimum error for validation for the network 168-100-100-168, a network with 168 inputs, 100 and 100 neurons in the first and second hidden layers, 168 output nodes. The numbers of epochs with 92722 epochs. Average validation error has been found to be lower compared with testing error but it is more than testing error in RMSE.

Average validation error in RMSE has been found to be lesser than testing RMSE and more than training RMSE. Validation error has been found to be lowest with learning rate of 0.3 and momentum of 0.7, training error is 0.0767309401, testing error is 0.2614249381 and validation error is 0.1985972644. The testing and validation errors are minimum with least number of epochs. The network topology of the network 1 is presented in Figure 4 and learning curve of the network 1 is presented in Figure 5. The topology of the network 2 is presented in Figure 6 and learning curve of the network 2 is presented in Figure 7. The topology of the network 2 is presented in Figure 8 and learning curve of the network 2 is presented in Figure 9. Training error for three networks has been found decreasing with increasing number of epochs. Testing error is also lowest for largest number of epochs.

Conclusion

The network shown in Figure 5 has a learning rate of 0.3 and momentum of 0.2. The network shown in Figure 7 has a learning rate of 0.3 and momentum of 0.3. Network 7 shows lesser values for training, testing, validation errors, and several epochs compared to respective values in network 1 of Figure 5. It is concluded that the mean value of training error, testing error, and validation error in Table 4 are lesser than the respective values in Table 3. In Table 4 μ is kept constant and the learning rate is varied for different networks whereas in Table 3 learning rate is fixed and momentum is varied for different network designs. Composed seven segment display data trained, tested, and validated networks can be applied for product advertisement, attracting the attention of customers or travelers at public places. Thereafter the messages can be updated, processed with the trained MBP [31]. Validation results of 100% support the claim of reliably displaying the message on the output devices.

Declarations

Due to technical limitations, Declaration section is not available for this version.

References

1. Gowrishankar Kasilingam*, Mritha Ramalingam and Chandra Sekar, "A Survey of Light Emitting Diode (LED) Display Board", Indian Journal of Science and Technology, Vol 7(2), 185–188, February 2014.
2. Bauer, C. and Spiekermann, S., 2011. Conceptualizing context for pervasive advertising. In *Pervasive Advertising* (pp. 159-183) Springer, London.
3. Davies, N., Clinch, S. and Alt, F., 2014. Pervasive displays: understanding the future of digital signage. *Synthesis Lectures on Mobile and Pervasive Computing*, 8(1), pp.1-128.
4. Ahn, S., Song, S., Yang, J., Oh, H. and Choi, J.K., 2014, October. Web-based multi-screen digital signage. In *2014 IEEE 3rd Global Conference on Consumer Electronics (GCCE)* (pp. 244-245). IEEE.
5. Main PAPER, BAUER c, Kryvinska, N, Strauss C(2016), " The Buisness with Digital Signage for Advertising In:F. Ricciardi, A.Harfouchs (eds): Information and Communication Technologies in Organizations and Society- Past, present and Future Issues, Chapter 15, Lecture Notes in Information Systems and Organization (LNISO), Springer, Berlin, 2016, vol 15, pp. 285-302
6. Muller, J., Exeler, J., Buzeck, M., Kruger, A: Reflective signs: Digital signs That: Adapt to Audience Attention. In 7th International Conference Pervasive Computing(Pervasive 2009), 11-14 May 2009, Nara, Japan , pp. 17-24, Springer (2009)
7. Bauer, C; Dohmen, P; Strauss, C: A Conceptual framework for backend servers of contextual digital Signage. *Journal of Service Science Research*, 4(2) pp.271-297 (2012)
8. Bauer, C. and Spiekermann, S., 2011. Conceptualizing context for pervasive advertising. In *Pervasive Advertising* (pp. 159-183). Springer, London
9. Bauer, C., Garaus, M., Strauss, C. and Wagner, U., 2018. Research directions for digital signage systems in retail. *Procedia Computer Science*, 141, pp.503-506

10. Bauer, C., Dohmen, P. and Strauss, C., 2012. A conceptual framework for backend services of contextual digital signage. *Journal of Service Science Research*, 4(2), pp.271-297
11. A.T.Roux, DLR Van der Walddt, "Out of Home advertising media: theoretical and industry perspective
12. James She, Jon Crowcraft, Hao Fu, Flora Li, Convergence of interactive displays with smart mobile devices for effective advertising: A survey
13. Ballagas R, Bierchers j, Robs Mand Sherbu, J.G, 2006, The smart phones a ubiquitous input device IEEE pervasive computing 5(1), pp. 70-77
14. Florian Alt, Stefan Schneegas, "A Conceptual Architecture for Pervasive advertising on public displays Networks, PPD 2012, Capri Italy
15. Alt. F, Mullerj & Schmidt, A Pervasive advertising on public display Networks, IEEE Computer (to appear 2012)
16. Florian Alt, Stefain Schnegass, "A Conceptual Architecture for Pervasive advertising on public displays Networks, PPD 2012, Capri Italy
17. Real time seven segment display detection and recognition online systems using CNN, Autanan Wannachai Wanarut Boonyung, Paskorn Cham prasert. International Conference ON Bio Inspired Information and Communication Technologies, BICT, 2020, pp. 52-67.
18. Akanle¹, Victoria Oguntosin ² , "A digital indicator system with 7-segment display" 3rd International Conference on Science and Sustainable Matthew Development (ICSSD 2019) IOP Conf. Series: Journal of Physics: Conf. Series 1299 (2019) 012139.
19. Finnegan, M.Villarrod, C Velardo & Tarassenko , "Aautomated method for detecting and reading seven segment digit images of blood glucose meters and blood pressure monitors" Journal of Medical Engineering & Technology vol 43 (6), 2019, pp. 341-355
20. Ceschin, F. and Gaziulusoy, I., 2016. Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design studies*, 47, pp.118-163
21. She, J., Crowcroft, J., Fu, H. and Li, F., 2014. Convergence of interactive displays with smart mobile devices for effective advertising: A survey. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)*, 10(2), pp.1-16
22. O'Hara, K., Perry, M., Churchill, E. and Russell, D. eds., 2003. *Public and situated displays: Social and interactional aspects of shared display technologies* (Vol. 2). Springer Science & Business Media.
23. Agamanolis, S., 2003. Designing displays for human connectedness. In *Public and Situated Displays* (pp. 309-334). Springer, Dordrecht.
24. Beyer, G., Mayer, C., Kroiss, C. and Schroeder, A., 2009. Person aware advrtising displays: Emotional, cognitive, physical adaptation capabilities for contact exploitation. In *1st Workshop on Pervasive Advertising at Pervasive* (Vol. 2009)
25. Roux, T., van der Walddt, D.L.R. and Ehlers, L., 2013. A classification framework for out-of-home advertising media in South Africa. *Communication*, 39(3), pp.383-40
26. Keckl, S., Kern, W., Abou-Haydar, A. and Westkämper, E., 2016. An analytical framework for handling production time variety at workstations of mixed-model assembly lines. *Procedia CIRP*, 41, pp.201-206

27. Heinicke, M., 2016. Influence of shifts in production programs on the resilience of production systems. *Procedia CIRP*, 41, pp.117-122
28. Józefowska, J., Mika, M., Różycki, R., Waligóra, G. and Węglarz, J., 2002. A heuristic approach to allocating the continuous resource in discrete–continuous scheduling problems to minimize the makespan. *Journal of Scheduling*, 5(6), pp.487-499
29. Kaylani, H. and Atieh, A.M., 2016. Simulation approach to enhance production scheduling procedures at a pharmaceutical company with large product mix. *Procedia Cirp*, 41, pp.411-416.
30. Helbig, T., Erler, S., Westkämper, E. and Hoos, J., 2016. Modelling dependencies to improve the cross-domain collaboration in the engineering process of special purpose machinery. *Procedia CIRP*, 41, pp.393-398.
31. Lopes; N. and Ribeiro; B. (2010). A strategy for Dealing With Missing Values BY Using Selective Activation Neurons IN a Multi-Topology Framework. IEEE World Congress on Computational intelligence WCCI 2010.

Tables

Table 1 Binary Data For Displaying Digits and Numerals on Seven Segment Display

CASE	SEGMENT						
	SEGMENT a	SEGMENT b	SEGMENT c	SEGMENT d	SEGMENT e	SEGMENT f	SEGMENT g
0	ON	ON	ON	ON	ON	ON	OFF
1	OFF	ON	ON	OFF	OFF	OFF	OFF
2	ON	ON	OFF	ON	ON	OFF	ON
3	ON	ON	ON	ON	OFF	OFF	ON
4	OFF	ON	ON	OFF	OFF	ON	ON
5	ON	OFF	ON	ON	OFF	ON	ON
6	ON	OFF	ON	ON	ON	ON	ON
7	ON	ON	ON	OFF	OFF	OFF	OFF
8	ON	ON	ON	ON	ON	ON	ON
9	ON	ON	ON	OFF	OFF	ON	ON
A	ON	ON	ON	OFF	ON	ON	ON
b	OFF	OFF	ON	ON	ON	ON	ON
C	ON	OFF	OFF	ON	ON	ON	OFF
d	OFF	ON	ON	ON	ON	OFF	ON
E	ON	OFF	OFF	ON	ON	ON	ON
F	ON	OFF	OFF	OFF	ON	ON	ON
H	OFF	ON	ON	OFF	ON	ON	ON
I	OFF	OFF	OFF	OFF	ON	ON	OFF
J	OFF	ON	ON	ON	OFF	OFF	OFF
L	OFF	OFF	OFF	ON	ON	ON	OFF
n	OFF	OFF	ON	OFF	ON	OFF	ON
O	OFF	OFF	ON	ON	ON	OFF	ON
P	ON	ON	OFF	OFF	ON	ON	ON
r	OFF	OFF	OFF	OFF	ON	OFF	ON
S	ON	OFF	ON	ON	OFF	ON	ON
U	OFF	ON	ON	ON	ON	ON	OFF
y	OFF	ON	ON	ON	OFF	ON	ON
Z	ON	ON	OFF	ON	ON	OFF	ON

Table 2 Few Samples of Randomized Data for Display on Seven Segments

7	4	6	3	5	1	8	2
6	4	2	1	3	5	7	8
8	5	1	3	6	2	4	7
8	4	6	3	5	1	8	2
7	4	2	1	3	5	7	8
2	3	8	7	1	4	5	6
5	2	6	1	7	4	8	3
2	1	8	7	3	5	4	6
1	3	7	6	4	5	8	2
1	3	2	6	8	4	5	7
3	8	2	1	4	6	5	7
5	6	7	2	8	4	3	1
7	5	1	2	6	3	4	8
1	5	6	2	8	4	7	3
8	4	6	3	5	1	8	2
S	O	r	n	p	J	u	L
r	O	L	J	n	p	S	u
u	p	j	n	r	L	O	S
L	n	u	S	J	O	u	n
n	u	L	J	O	r	p	S
s	p	J	L	r	n	O	u

Table 3 Results with fixed Learning rate and variable momentum

Net No.	Configuration of network	Lr	Mu	Training Error (RMSE)	Testing Error (RMSE)	Validation Error (RMSE)	Epochs
1	168-100-100-168	0.3	0.2	0.0617009011	0.2724602365	0.2911355316	131447
2	168-100-100-168	0.3	0.3	0.0643478588	0.2586364434	0.1436560046	92722
3	168-100-100-168	0.3	0.4	0.05583121908	0.2673212190	0.2561449993	90675
4	168-100-100-168	0.3	0.5	0.0544318965	0.2534433304	0.2739053005	97711
5	168-100-100-168	0.3	0.6	0.0416356554	0.2721783049	0.2749644876	387938
6	168-100-100-168	0.3	0.7	0.0535593511	0.2548947566	0.2744005597	124206
7	168-100-100-168	0.3	0.8	0.0448388377	0.2662605935	0.2623023954	395053
8	168-100-100-168	0.3	0.9	0.0591899107	0.2560682428	0.2123819182	376189
Mean				0.0467293413	0.262015513	0.212219458	211992.626

Table 4 Results with fixed Momentum and variable learning rate

Net No.	Configuration of network	Lr	Mu	Training Error (RMSE)	Testing Error (RMSE)	Validation Error (RMSE)	Epochs
1	168-100-100-168	0.1	0.7	0.552095080	0.284260342	0.2604066990	119234
2	168-100-100-168	0.2	0.7	0.0684780930	0.2715223885	0.3068216970	136253
3	168-100-100-168	0.3	0.7	0.0767309401	0.2614249381	0.1985972644	95600
4	168-100-100-168	0.4	0.7	0.0712463652	0.2646845935	0.2690239232	147053
5	168-100-100-168	0.5	0.7	0.0423888784	0.2796980940	0.2733196050	119562
6	168-100-100-168	0.6	0.7	0.0580560766	0.2804924187	0.2041374133	140544
7	168-100-100-168	0.7	0.7	0.0529636238	0.2853336994	0.3399035590	162025
8	168-100-100-168	0.8	0.7	0.0564594761	0.269381641	0.2589544869	11082
9	168-100-100-168	0.9	0.7	0.0541543944	0.2727428129	0.2302456969	146870
Mean				0.114730326	0.274393436	0.260156706	119802.556

Figures

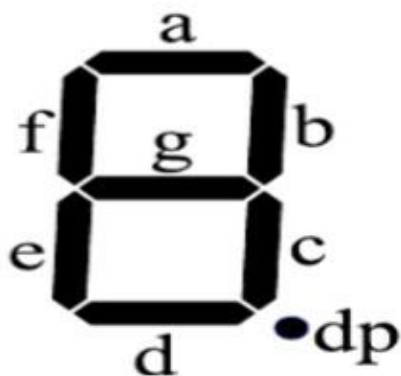


Figure 1

Seven segment display [17]

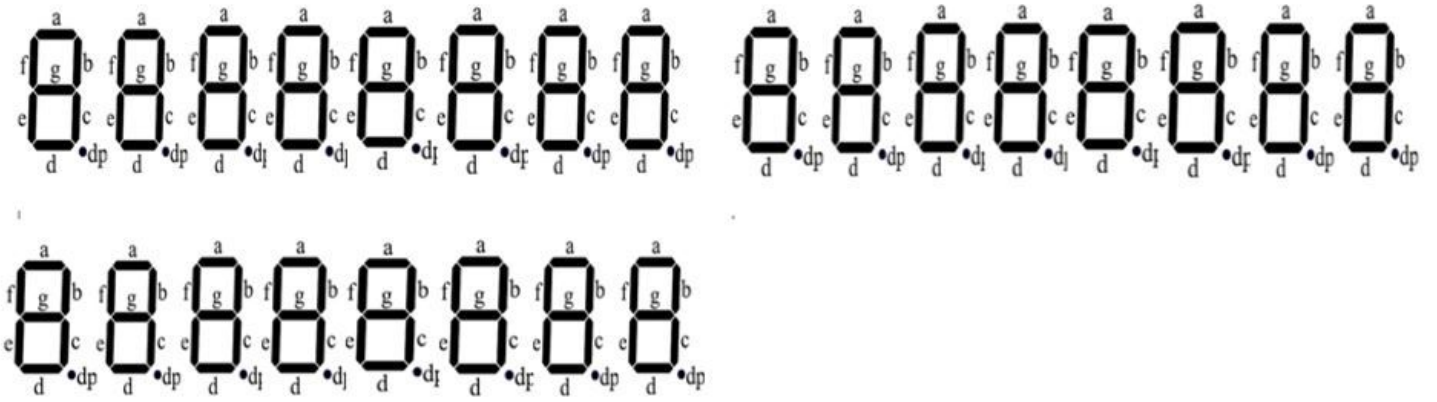


Figure 2

24-Segments Shown on which Data can be Displayed [17]

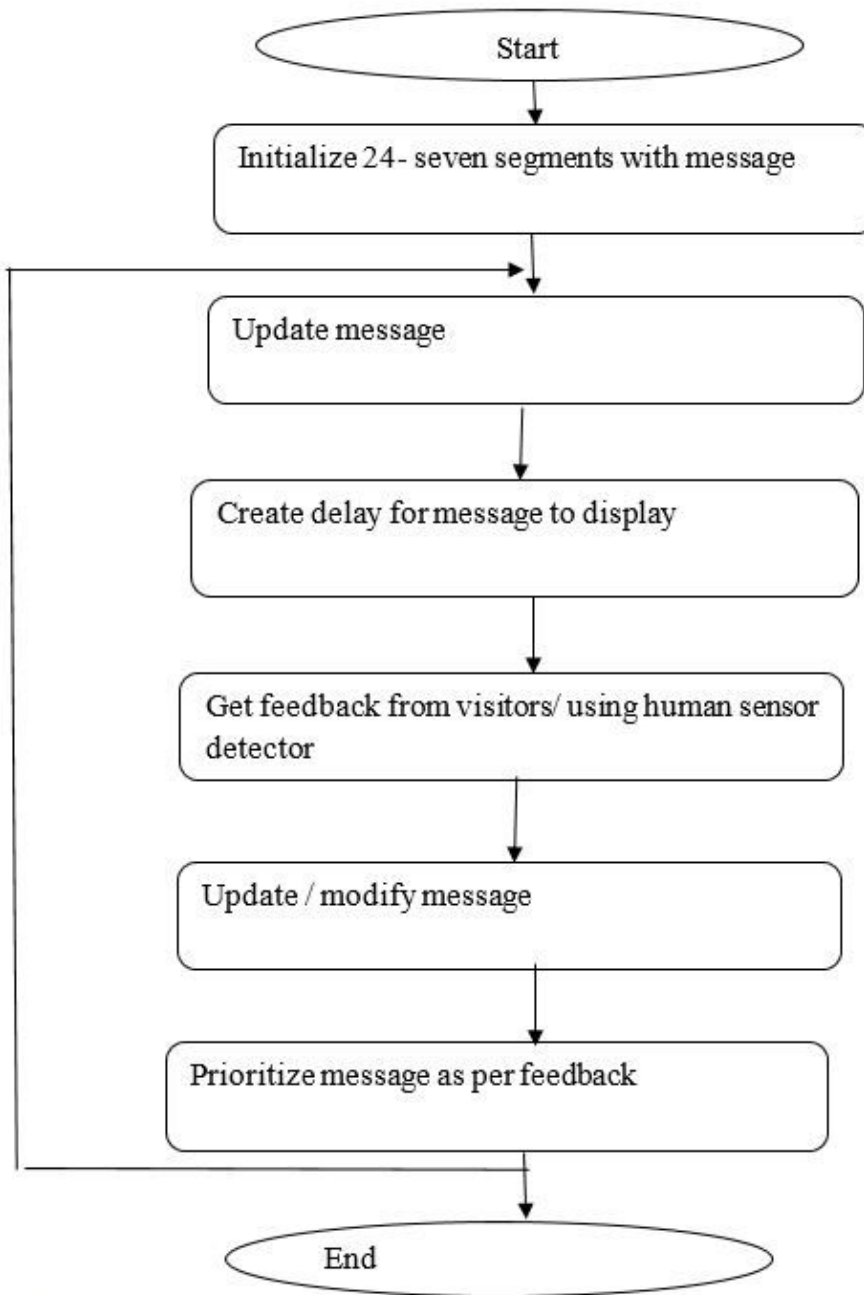


Figure 3

Flow Chart for Designing Display strategies

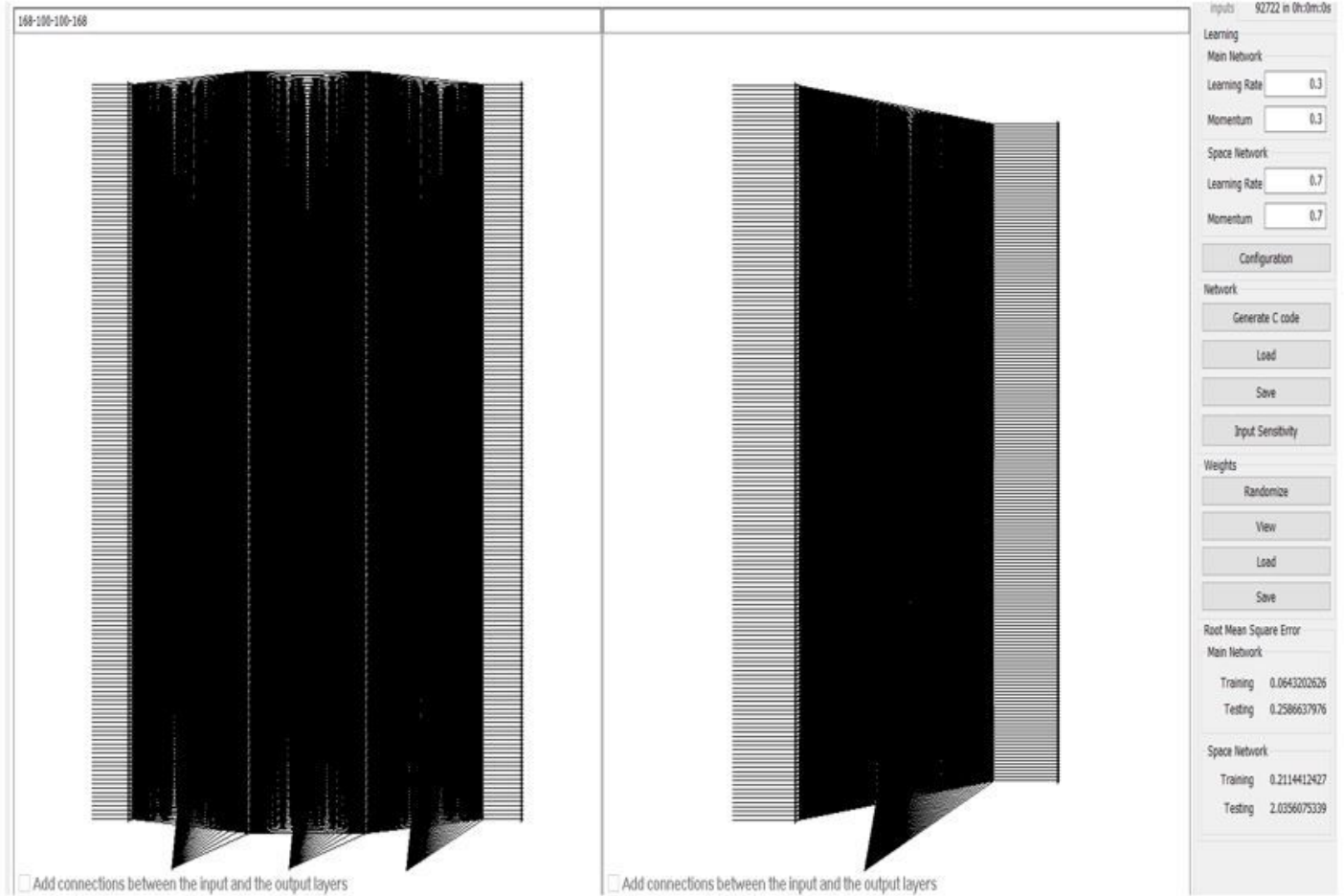


Figure 4

Topology for the network1 (Table 3)

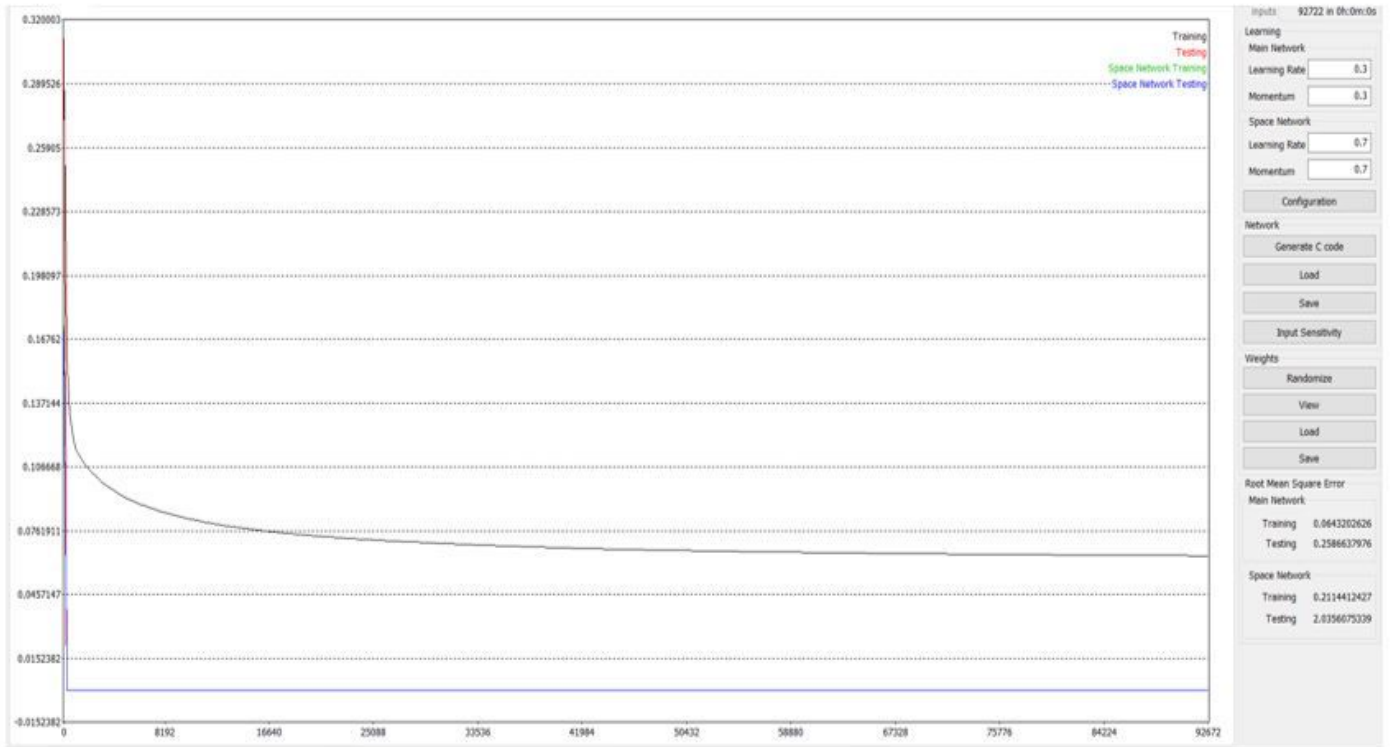


Figure 5

RMSE error curve for the network1

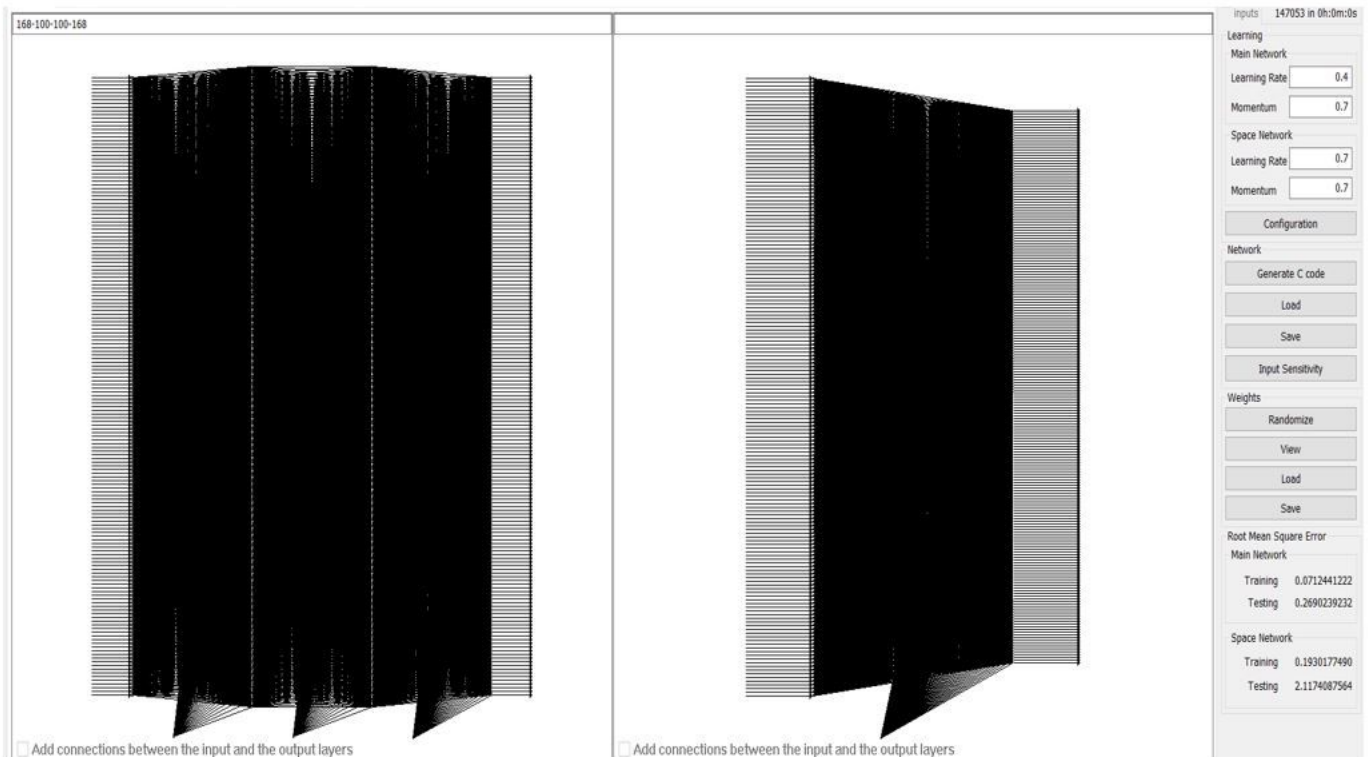


Figure 6

Topology for the network2

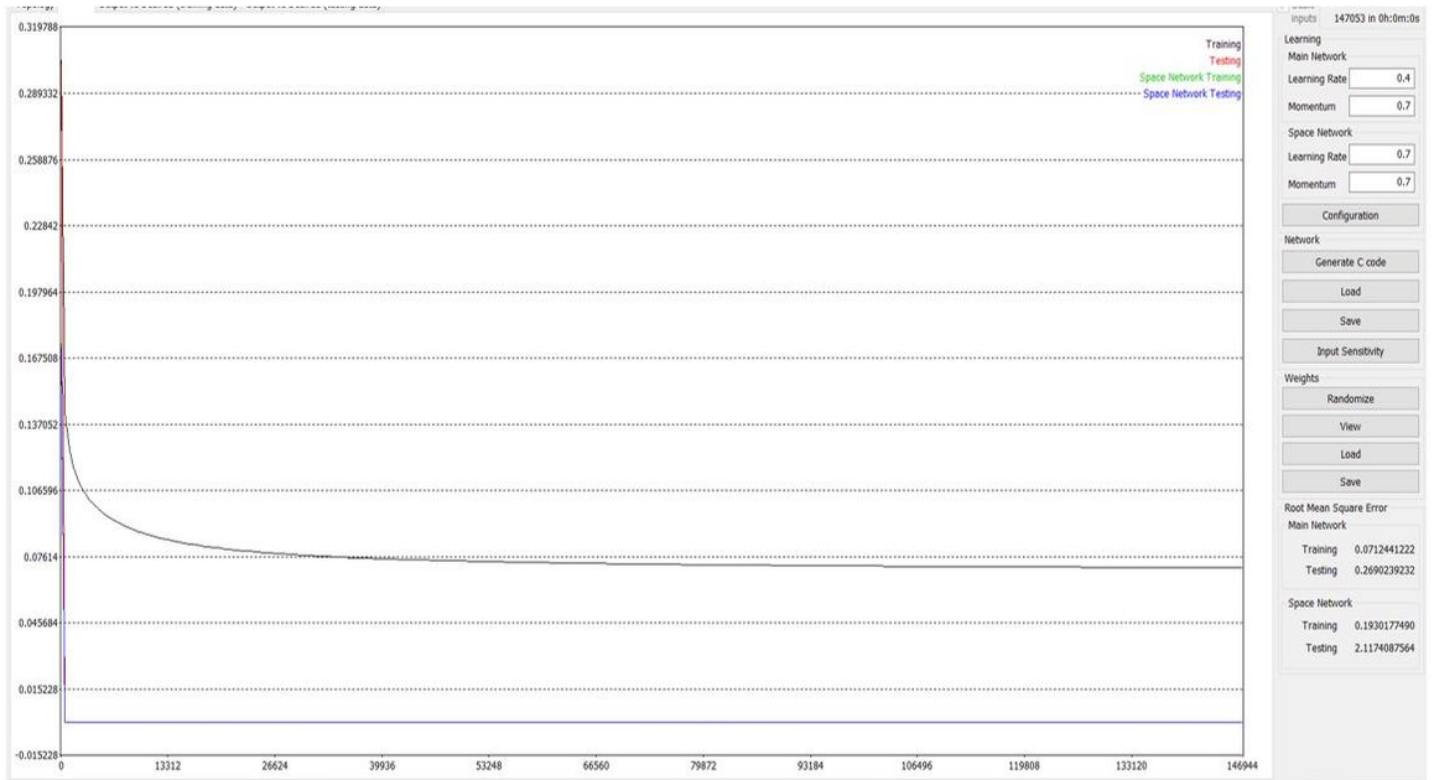


Figure 7

RMSE error curve for the network2 (Table 3)