

Optimal Floor Plan for Residential Houses leveraging Vaastu Shastra: A neural approach

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Abstract

Net Zero Sustainable Buildings are needed to protect the environment as .Architects and building owners are trying to focus on utilizing sustainable and energy efficient methods to design the spaces of the future which in turn would contribute to the global net zero effort.

To achieve the above objective, the western thinking can be facilitated with the ancient eastern architectural perspectives such as Vaastu-Sastra to build sustainable and eco-friendly habitat is the prime focus of this paper. The deals with neural approach to predict the optimal layout for a particular design of a residential house based upon a compatibility score for the same leveraging Fuzzy Inference System to decide on the compliance of the new design.

1. Introduction

Smart Buildings and Smart Cities are concepts that are being talked about every day and the West is forging ahead towards developing the same. The East (specifically India) is also investing a lot in this effort gradually. But there are a lot of disadvantages with implementation of such types of environments by constructing high-rise residential. Also, in a developing country the investment factor stands in the way which results in construction/development of environments with lower costs hampering the quality. Human civilization as of today is facing towards the western world and adopting methodologies and techniques which are in vogue there, across the globe. However, the Eastern world has a rich traditional history and well-defined culture which spans from nuances of day-to-day activities to scientific thinking.

2. Problem Statement

To adopt to rapid urbanization, compact residential spaces are developed across the major cities of the globe with a very unsustainable approach causing long term health hazards for the common man. The root cause for the same can be traced down to the design of the houses/apartments with respect to the cardinal directions, where we can observe that some places have almost no sustainable space for a healthy habitat.

3. Literature Review

A detailed literature review has been carried out in lieu of Vaastu Shastra and its technological aspects. Below are the notable points that need to be mentioned.

- Reena Thakur Patra [1] has discussed about Vaastu in Perspectives of Technology where she has specifically pointed out how modern-day philosophers and their thoughts regarding design and technology is like that of the ancient eastern knowledge of Vaastu. Specific mentions have been done for Mitcham, Borgmann, Ihde and Polanyi.
- Rayjada& Chauhan [2] has discussed about how different principles of Vaastu Shastra is realized in modern day engineering practice and has tried to specify how different aspects such as site

planning, construction, strength, and earthquake safety are relevant to the rules of Vaastu Shastra.

- Chandra, Nandaplaet. [3] has carried out a detailed review regarding adoption of Vaastu techniques for people from different walks in the construction industry. They have also put up a few use cases to justify how the traditional beliefs in house construction can be observed from a modern engineering perspective.
- Mishra & Rout [4] has discussed how environmental protection can be achieved by following the principles of Vaastu Shastra regarding Geopolymer Technology. He has explained the use of geopolymers in case of road construction and its related protectional aspects and how this sort of material is important in lieu of Vaastu Shastra.
- Dash & Joshi [5] has carried out a comparative analysis between Vaastu and other design methodologies and has given a critical estimate regarding its applicability. A detailed comparison has been done between Vaastu and seismic designs where they have analyzed and pointed out how the rules of Vaastu are competent with the modern design principles. This is a 12-point classification.
- Bandyopadhyay&Chaturvedi [6] has discussed about the different harmful aspects of smart buildings and how these aspects are creating health hazards of the common man.

4. Eastern Perspectives Of Design

As per the Eastern concepts of Vaastu Shastra, a perfectly balanced and sustainable habitable place can be achieved ensuring enhanced health, wealth and happiness if the house is designed as per the VaastuPurusha Mandala. This is a scientific approach comprising of different principles as per the Eastern concepts of five basic elements (panchabuttas), daily & annual position and movement of the Sun, Earth's magnetic & energy fields and the eight cardinal directions. The positioning of rooms as per this system ensures proper ventilation, sunlight & privacy across the designed house which in turn creates an atmosphere beneficial to the owner. Since there is an inherent importance and need of sunlight to humans, Vaastu Shastra aims towards bringing in the useful sunrays inside the house to all the occupants considering their activities during different times of the day. The diurnal movement of the sun from sunrise to sunset is tracked and accordingly the rooms are positioned in different parts of the design ensuring that light is obtained when that specific room is in operation or use. The 24 hours of 1 solar day is divided into eight parts which in-turn is associated with the eight cardinal directions, with one direction being positioned for one certain period. The most likely room is tagged with the activity as per the direction of the sun.

5. Development Of Intelligent System

An intelligent system has been developed which leverages Artificial Neural Network to predict the direction of the respective rooms and its corresponding area based on the size and face of the plot with respect to the geographical north. Moreover, the Vaastu compliance of such a design has been calculated

using Fuzzy Inference Techniques. The development has been carried out in 5 distinct operational steps as the following.

5.1. Cardinal Direction Assignment

The floor plan layout has been decomposed in the form of a matrix to achieve the input and outputs of the network. The 8 cardinal directions have been considered in a circular format with the center being the 9th direction. The directions have been numbered accordingly starting from the center in a clockwise manner.

For example, if a room is in the Eastern direction, its Matrix Equivalence would be 4. Similarly, for South, the equivalent would be 6.

5.2. Floor Plan Decomposition

It is evident through observation of the layout that the plan has a North Facing doorway. This is one of the most compliant designs as per Vaastu, since the setting of the rooms are in a circular manner with a central position left open for dwelling.

This is a North Facing Plot and following is the data extracted from the layout.

Table 1
Data from Floor Plan

Type	Direction	Matrix equivalent	Sq Ft	Conversion to Sq m
Bedroom 1	SW	7	168.75	15.68
Toilet 1	W	8	40.00	3.72
Toilet 2	W	8	43.13	4.01
Open Area	W	8	63.00	5.85
Bedroom 2	NW	9	159.38	14.81
Store	S	6	47.44	4.41
Kitchen	SE	5	112.50	10.45
Stair	NE	3	152.00	14.12
Living	C	1	302.25	28.08
Puja	NE	3	12.69	1.18
Dining	0	NULL	0.00	0.00
Face of Plot	N	2	-	-
Total (Calculated)			1268.50	117.85
Total (Actual)			1101.13	102.30

Similarly, the data from all the collected floor plans have been decomposed in this format. In total, 50 designs have been used for the same, with plots ranging from 50 sq m to 300 sq m

5.3. Artificial Neural Network

Floor Plan layouts have been gathered post consultation with Vaastu expert. These floor plans have been decomposed into matrix format which has served as an input and output for the neural network.

Inputs

- Area of the Plot
- Direction of Face of the Plot
- Room Type Availability

Outputs

- Area of the Room
- Direction or location of the Room in the Plot

Data Division: Random

Training: Levenberg-Marquardt

Performance: Mean Squared Error

Calculations: MEX

The output from the network was used to generate Vaastu compliant floor plans with optimal layout.

5.4. Knowledge Base Development

The knowledge base has been developed by consulting with experts from the domain through questionnaire, consultation, and experience.

3 variables have been used to construct this knowledge base.

- Room Type (28)
- Direction (9)
- Priority (Low, Medium, High)

Example of Knowledge Base

- Room Type: Study Room
- Knowledge Acquired
 - Recommended Location – The recommended locations for the study room are in the Northeast, North and West directions.
 - Avoid – Avoid placing the study room in the Southwest and Northwest directions.
 - Door – The door to the study room can be in the Northeast or North
- Rule Base Formed
 - IF RoomType is 'Study Room' THEN Direction is Northeast AND Priority is High
 - IF RoomType is 'Study Room' THEN Direction is North AND Priority is High
 - IF RoomType is 'Study Room' THEN Direction is West AND Priority is High
 - IF RoomType is 'Study Room' THEN Direction is Southwest AND Priority is Low
 - IF RoomType is 'Study Room' THEN Direction is Northwest AND Priority is Low
 - IF RoomType is 'Study Room' THEN Direction !(Northeast, North, West, Southwest, Northwest) AND Priority is Medium

In a similar way 280 rules were generated for all the different room types altogether.

5.5. Compliance Score

The compliance score has been calculated based on the rules developed and using Fuzzy Inference System. The Fuzzy Inference System was developed using the Mamdani Model comprising of 2 inputs and followed by the compliance score as the output. The compliance score is a value ranging between 0 and 1 which defines how close the design is to the defined Vaastu rules.

6. Results & Discussion

Designs were generated for 3 different type of plots ranging from 80 sqm to 150 sqm. In all the cases, compliance to the generated designs were more than 80%.

Table 2
Results - Compliance Score

Input Area (sq m)	Face of Plot	Compliance Score
80	North	88%
100	East	84%
150	East	85%

The model has efficiently provided the correct area and direction as per the combination of rooms provided when the size of the plot was varied.

7. Conclusion

This work has resulted in predicting Vaastu compliant designs for any size of plot. It can be leveraged to design sustainable designs for habitats of the future which in turn would contribute to the global sustainability goals the world community is trying to achieve within the next decade.

Energy optimization, net zero building designs, sustainability index measurement, smart healthcare habitat designs can be the key research areas that shall be facilitated by this work.

Declarations

The authors have no conflict of interest in their research.

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Figures

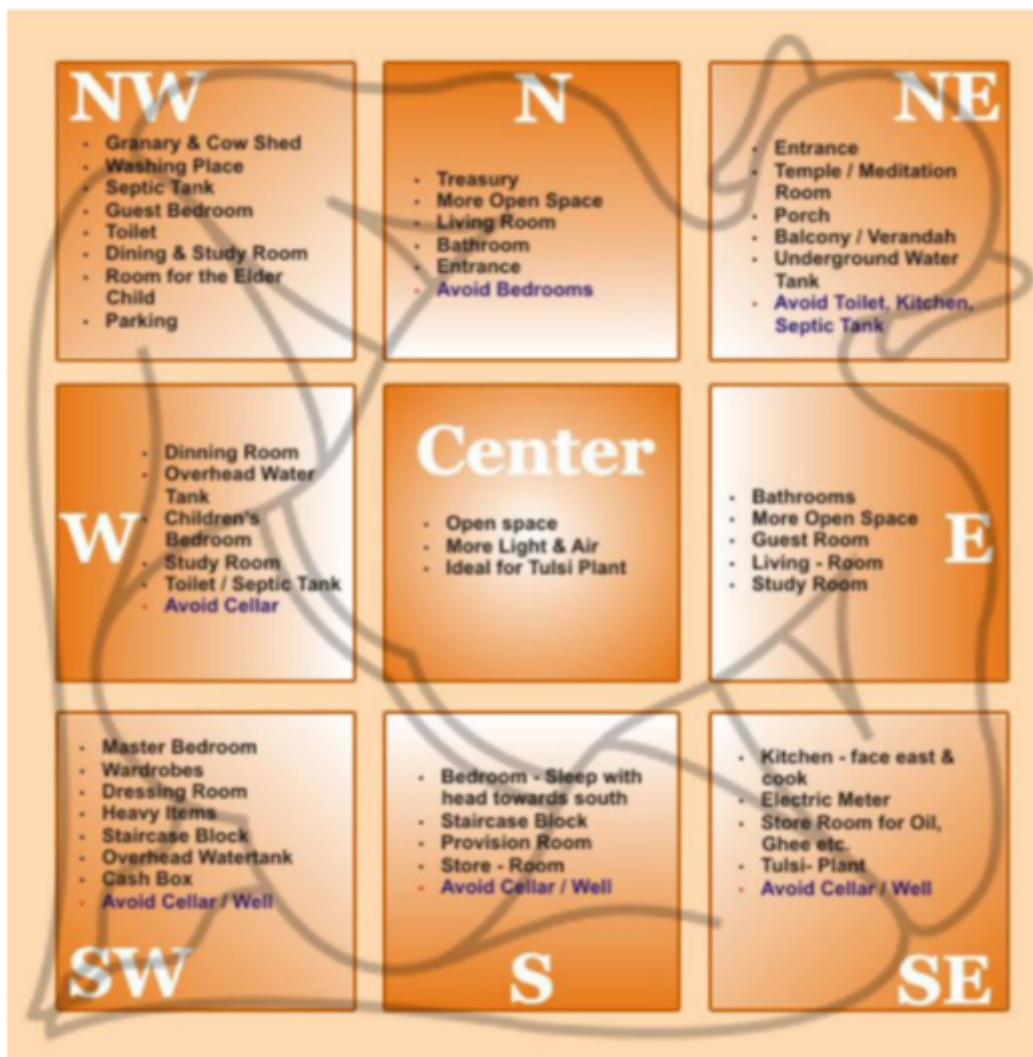


Figure 1

Different Rooms positions based upon Vaastu Shastra [9]

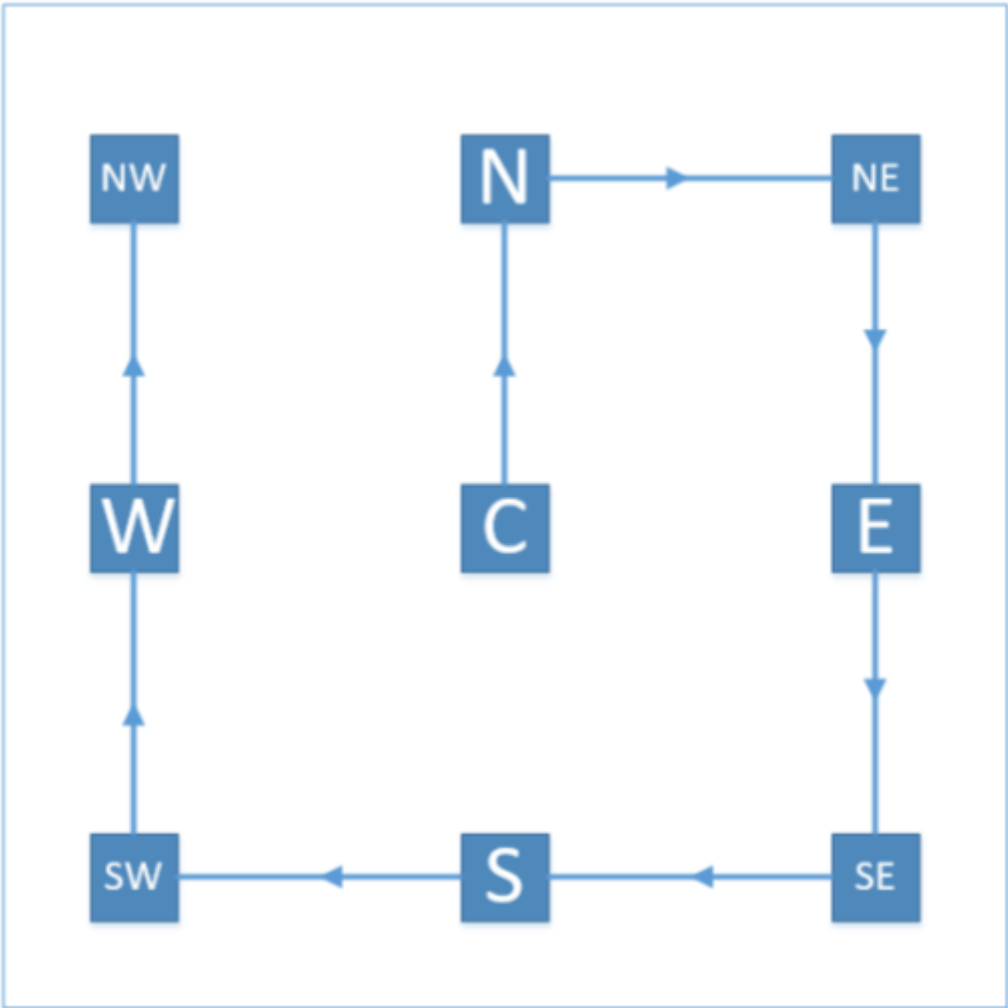


Figure 2

Cardinal Direction positions

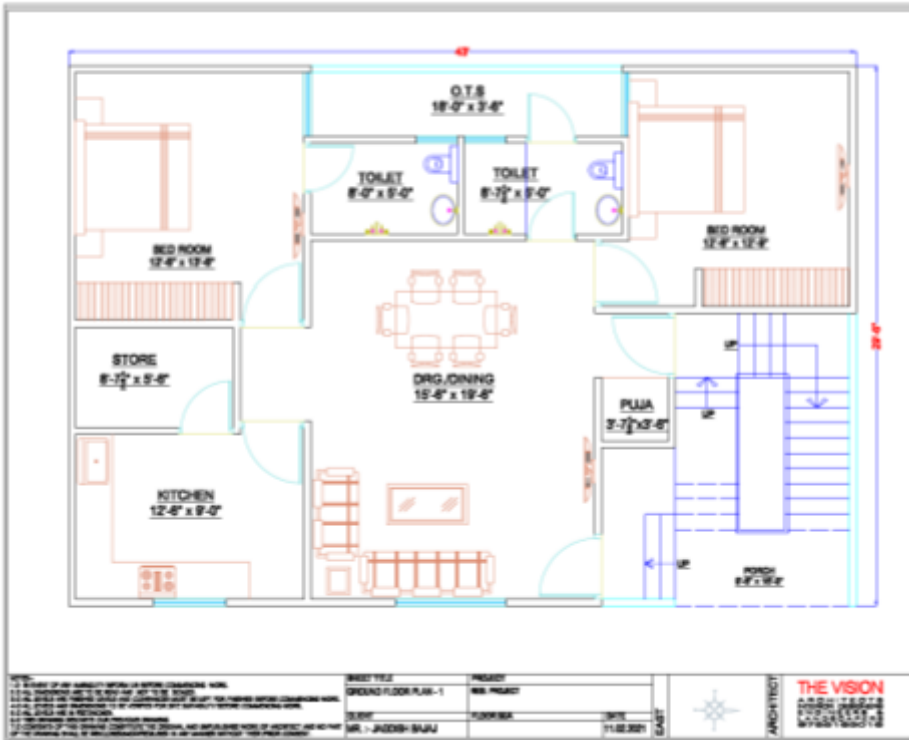


Figure 3

Floor Plan Layout

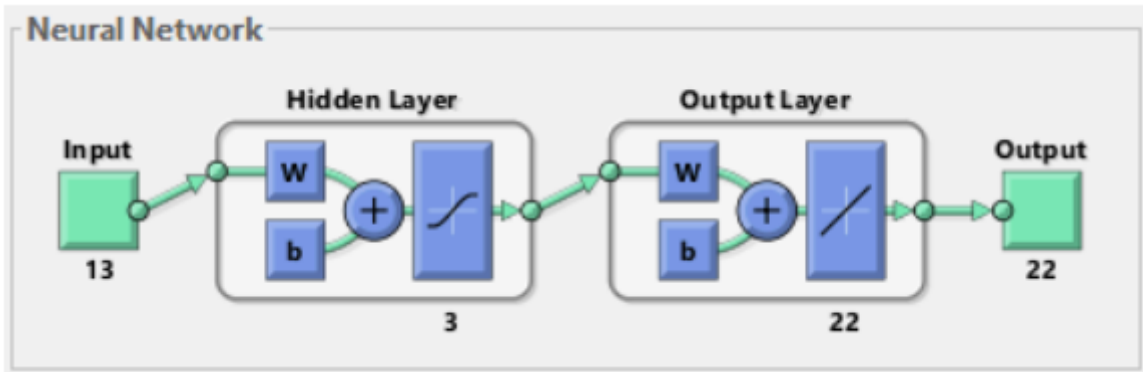


Figure 4

Network Architecture

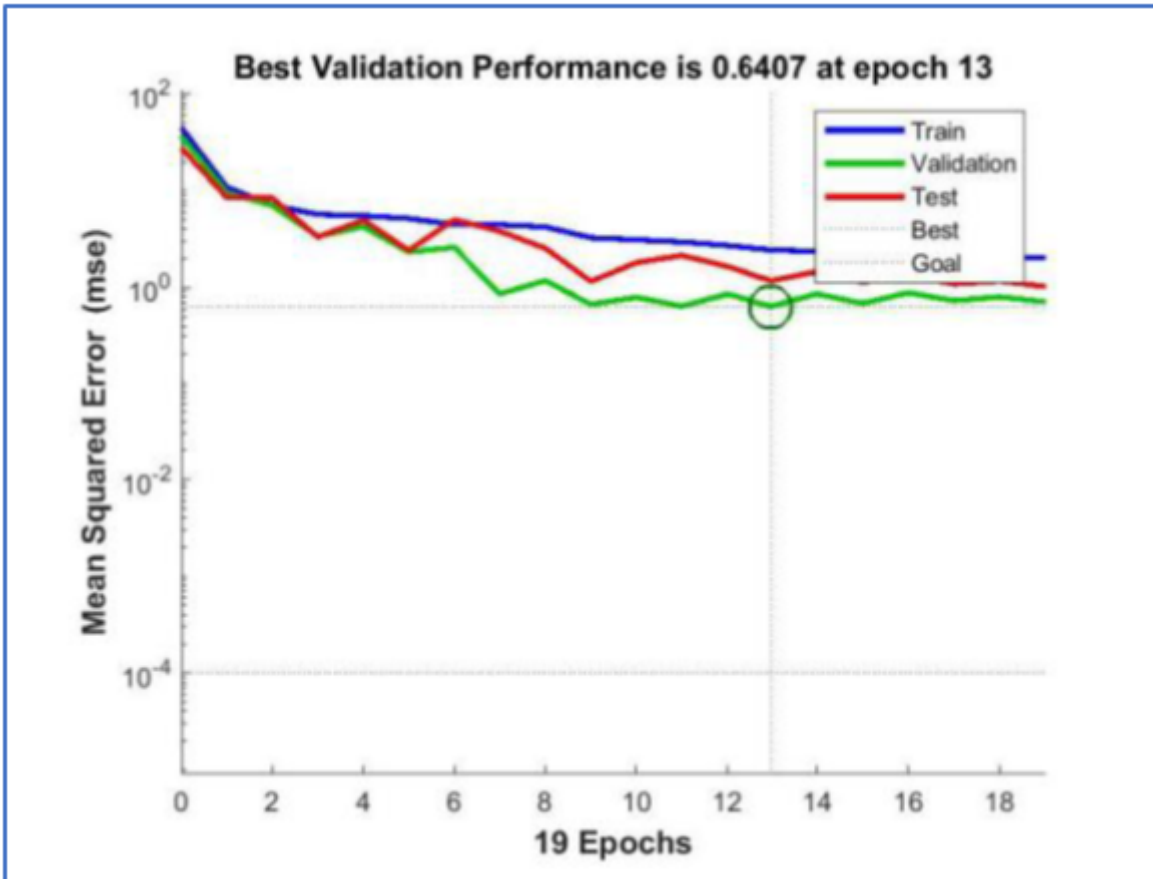


Figure 5

Performance Plot

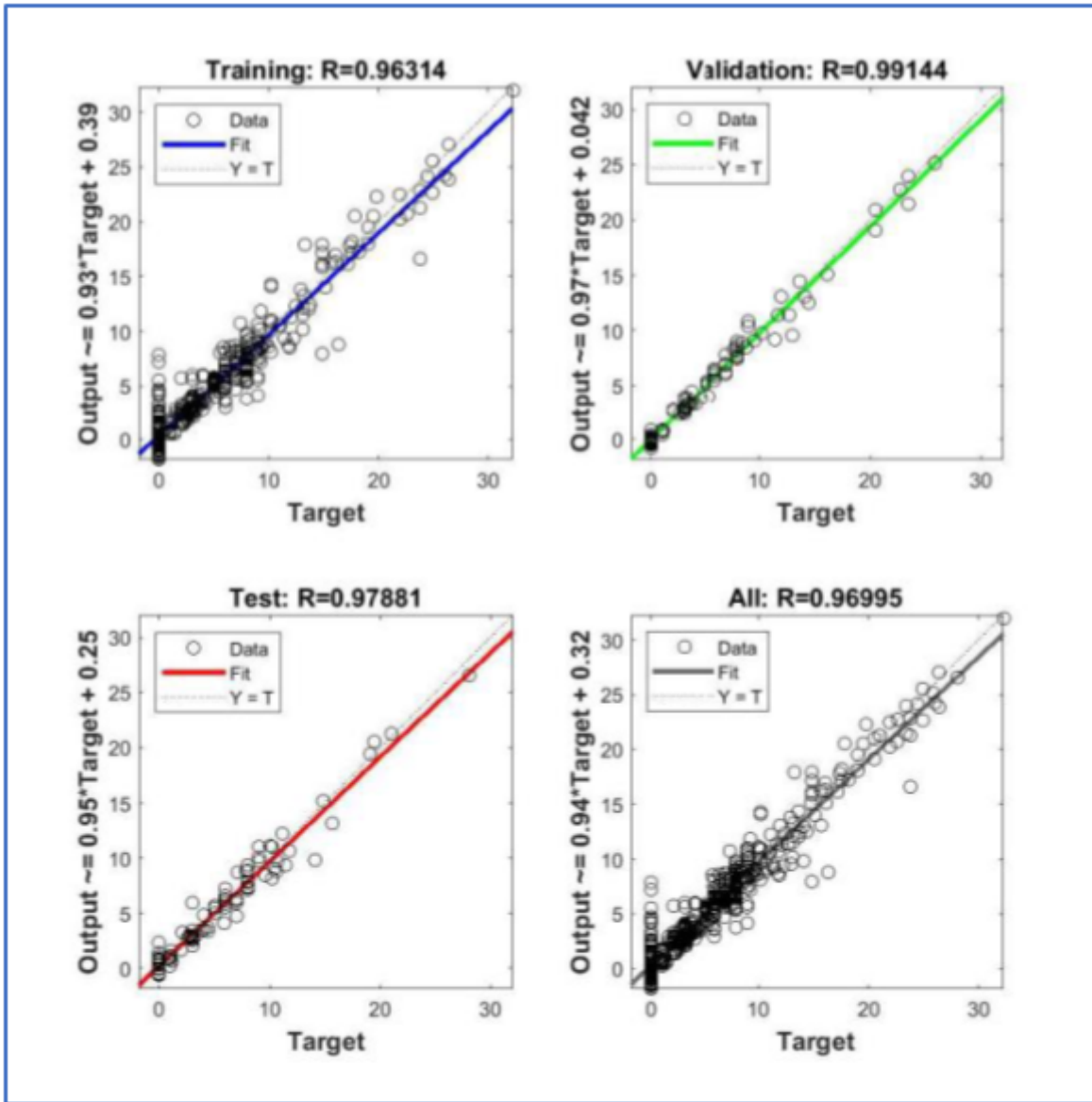


Figure 6

Regression Plot

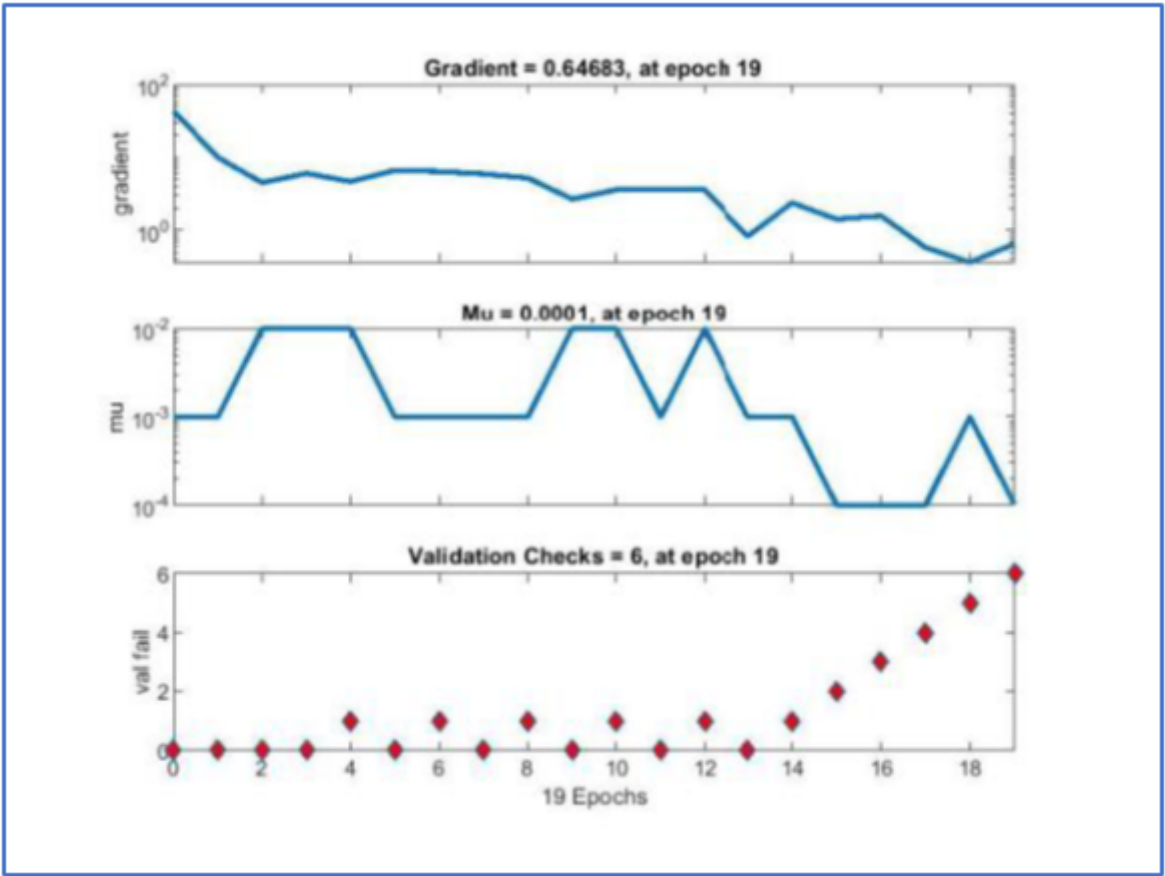


Figure 7

Training State Plot

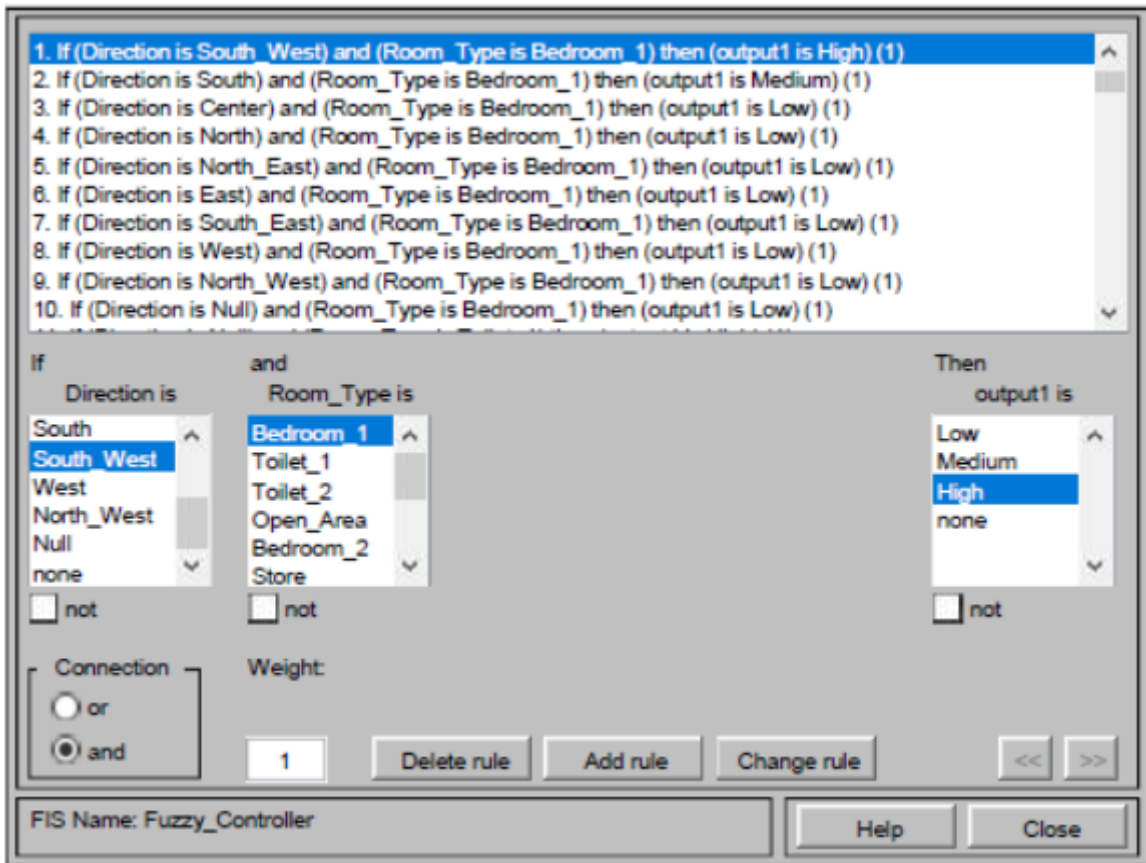


Figure 8

Snapshot of Rule Engine

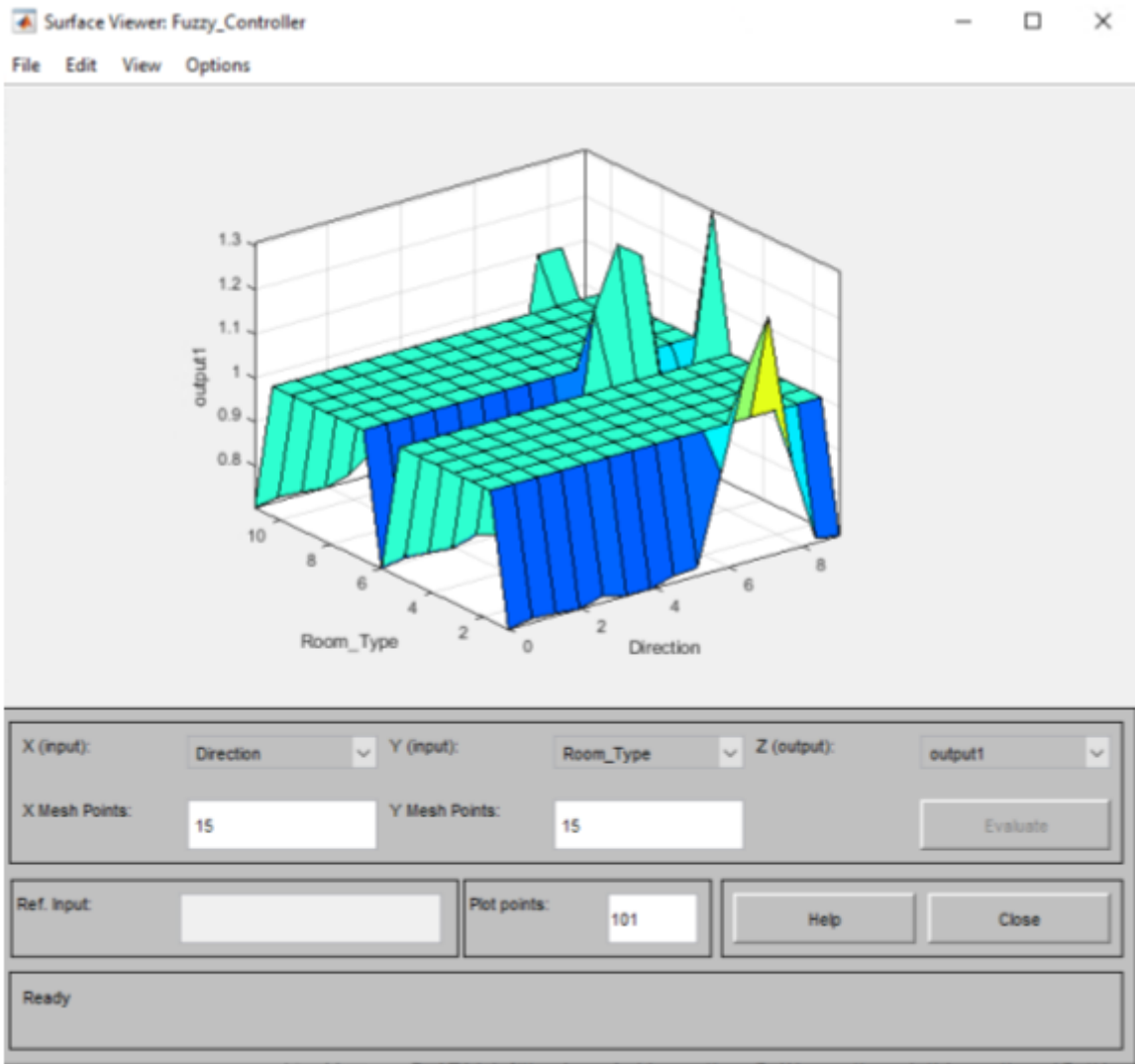


Figure 9

Snapshot of Surface Viewer