# FENG SHUI THEORY WITH ARTIFICIAL NEURAL NETWORK TECHNIQUE FOR APPRAISING REAL ESTATE PRICE

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Feng shui is the scientific knowledge of Chinese ancient. In Taiwan, though some people thought that feng shui is the superstition, we can see the influence on the people's lives including of choosing good days, divination and house selecting. From the past researches, we know many factors affect the real estate price. Those factors are the announced land values, the building room age, building total number of floor and the transportation condition etc. But it doesn't include feng shui variables. We also discover the related references about feng shui and real estate price are fewer. Therefore, the present study pioneers in applying feng shui variables for developing a real estate price prediction system with BPN and FNN to compare. Our system combines factors affecting of real estate price with feng shui and surrounding environment of house for estate price appraisal. The research results demonstrated that the feng shui FNN model has the best performance in estate price appraisal.

## 1. Introduction - The relationship between feng shui and the real estate price

In the definition from wikipedia, the words 'feng shui' literally translate as "wind-water" in English. In Chinese culture, feng shui, plays a very important role in buying and selling houses. It determines the values and beliefs that dictate expectations as well as responses to housing prices (Tam et al., 1999). The transaction mode of between seller and buyer is an important research subject at housing market (Barlow et al., 2003). There is a phenomenon of Taiwan's property market that has been a decrease in Pre-Construction Real Estate and increase in older or brand new houses recently (Institute for physical planning and information, 2008). Houses are expensive commodities for Taiwanese, whereas about 87.83% of total households own houses (Housing State Survey, 2008).

Actually, geomantic taboos are also provide some rules of traditional building (Han, 1987). How to provide customers a simple and easy system that can estimate houses with feng shui is a develop importance of property market in the future (Juan et al., 2006). Besides factors affecting, thinking about feng shui at buying step is another bigger character of Taiwan housing market (Tam et al., 1999). Feng shui certainly has a relation between our live and Chinese building.

## 2. Literature Review

### 2.1. *Feng shui theory application in buying house*

Feng shui is a part of Chinese traditional culture. There is a term, feng shui, which first appears in the book, translated literally as Burial Book, which is attributed to Guo Pu. The theoretical foundation of feng shui lies in the cosmogonic concepts of "ch'i" (Hwangbo, 2002). We are able to have good interaction between buildings and environment through the chi which is around houses. It will be a ideal house which can gather wind and water (Han, 1987).

Feng shui has attached much importance to research and discuss in the world recently. And it has been applied to many domains widely. For instance, house design by surname in feng shui (Lu, 2000); integrating natural and cultural heritage: the advantage of feng shui landscape resources (Marafa, 2003); Feng shui and its impacts on land and property developments (Tam et al., 1999). And there are many scholars to bring out some studies continually about feng shui. For example, Mak and Ng (2005) bring up a point of feng shui to check up quality of architecture design; Chiou and Krishnamurti (1997) develop an interactive system which can assist us to measure size and located direction of traditional building; Hwangbo (1999) thinks feng shui theory can support architecture and planning design. At last, feng shui certainly can construct our living environment and buildings (Han, 1987).

### 2.2. Factors affecting of real estate price

From the past literatures, we discovered many factors affect the real estate price. Tam et al. (1999) pointed out many factors that are environmental setting, transport facilities, school network, shopping facilities, regional characteristics, including of three significant independent variables, feng shui, accessibility, and building age. According to the study of Juan et al. (2006), their study pointed out several critical factors which included living room, dining room, kitchen, study room, master room, bedroom, bathroom, and storeroom. Besides above factors, land size, age of the house, type of house, garages, amenities also affect the real estate price (Limsombunchai et al., 2004). Based on the results of these studies, we choose some significant independent variables of the real estate price as our variables. The list of variables is shown in section 3.

## 3. Artificial neural network applied in house price prediction

### 3.1. *Research Architecture*

In this study, we used both Model 1 without feng shui variables and Model 2 with feng shui variables which are from the perspective of Asian homebuyers to predict residential housing price and evaluate the forecasting accuracy of both models based on the twelve inputs.

### 3.2. *House Price Prediction Model*

The present study uses the Super PCNeuron 5.0 software for the various neural networks model training and testing. After repeating the validation test in the various network architectures, we use the parameter setting of the minimum RMSE as the criterion to construct our network model. The parameter setting of this model is depicted in Table 1.

**Table 1. Parameters setting among various network architectures (BPN, FNN)**

| Network architecture | Parameter | Model 1 | Model 2 |
|---|---|---|---|
| BPN, FNN | Number of input variables: | 12 | 16 |
| | Number of neurons in the first hidden layer: | 14 | |
| | Number of neurons in the second hidden layer: | 14 | |
| | Number of output variables: | 1 | |
| | Number of train examples: | 133, 114 | 152 |
| | Number of test examples: | 57, 76 | 38 |
| | Number of train cycles: | 150000 | |
| | Learn rate: | 1.0 | |
| | Learn rate reduced factor: | 0.99 | |
| | Learn rate minimum bound: | 0.1 | |
| | Momentum factor: | 0.9 | |
| | Momentum factor reduced factor: | 0.99 | |
| | Momentum factor minimum bound: | 0.1 | |

### 3.2. *Housing Data*

The training and test example of 190 housing information in the North District and the West District of Taichung City is selected from Sinyi estate agent's website (www.sinyi.com.tw) in June 2008. The statistics of our sample distribution are shown in Table 2.

**Table 2. Statistics of estate sample distribution**

| | | 6:4 | | 7:3 | | 8:2 | |
|---|---|---|---|---|---|---|---|
| | | Training data | Test data | Training data | Test data | Training data | Test data |
| West District | 110 | 66 | 44 | 77 | 33 | 88 | 22 |
| North District | 80 | 48 | 32 | 56 | 24 | 64 | 16 |
| Total | 190 | 114 | 76 | 133 | 57 | 152 | 38 |

### 3.3 Attributes of housing data

The attributes of housing data are summarized in Table 3. Different attributes have different code demand and can be directly coded into different numbers with integers, respectively, based on the attribute characteristic. When

the housing data have these feng shui taboos, the code of these attributes increases one value.

**Table 3. Attributes and Recoding book of housing data**

| Attribute | Value | ReCode |
|---|---|---|
| Bedroom | Continuous value | -- |
| Living room | Continuous value | -- |
| Bathroom | Continuous value | -- |
| House age | Continuous value | -- |
| Storey | Continuous value | -- |
| Land size | Continuous value | -- |
| Exposure | East | 1 |
| | West | 2 |
| | South | 3 |
| | North | 4 |
| | Southeast | 5 |
| | Northeast | 6 |
| | Southwest | 7 |
| | Northwest | 8 |
| Management | All day | 1 |
| | Daytime | 2 |
| | Nothing | 3 |
| semidetached house | Yes | 1 |
| | No | 2 |
| Construction | SRC | 1 |
| | SC | 2 |
| | RC | 3 |
| Parking facilities | Plane | 1 |
| | Mechanical | 2 |
| | Nothing | 3 |
| Amenities around the house | School district | +1 |
| | Park | +1 |
| | Transport system | +1 |
| | Major construction | +1 |
| Feng shui taboo | Housing appearance | +1 |
| | Door | +1 |
| | Window | +1 |
| | Toilet | +1 |
| | Stair | +1 |
| Housing price | Continuous value | -- |

## 4. Data Analysis

### 4.1. *Evaluation*

The measurement indicators which are RMSE, MAPE and FE be used to evaluate the accuracy of both models. These indicators are defined as follows:

1. Root mean square error (RMSE)

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(A_i - P_i)^2} \qquad (1)$$

2. Mean absolute percentage error (MAPE)

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{A_i - P_i}{A_i}\right| \qquad (2)$$

3. Forecasting error (FE)

$$FE = \left| \frac{(P_i - A_i)}{A_i} * 100 \right| \qquad (3)$$

where $A_i$ denotes the actual housing price, $P_i$ represents the estimated housing price, and n is the number of observations. The forecasting error results are classified into three major categories: (1) FE < 5% with higher predicted performance; (2) FE between 5% and 15 % which is a fuzzy predicted area and slightly unreliable; (3) FE > 15% with unsatisfying performance (Nguyen & Cripps, 2001).

### 4.2. *Accuracy comparison between model 1 and model 2 in various network architectures*

This study adopts the minimum RMSE as the performance indicator to construct our model for the first time (Lai, 2007). In order to find the minimum RMSE as the criterion to remove deviation, the number of training cycle is 50000, 100000 and 150000 iterations with various ratios (6:4, 7:3 and 8:2) be used in two models, respectively. The RMSE comparison among different train cycles are shown in Fig. 1.

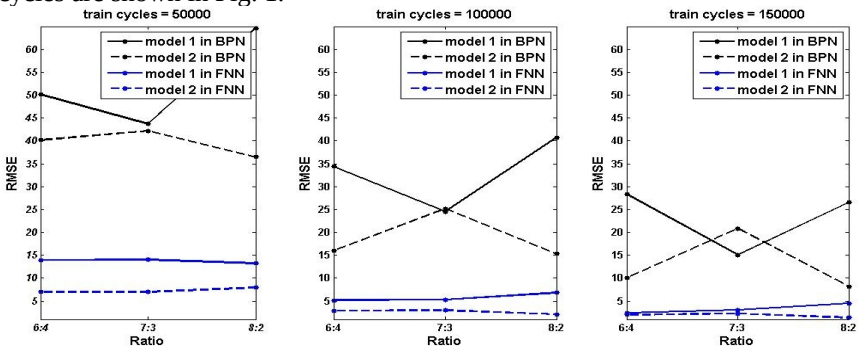


**Figure 1. RMSE comparison among different train cycles**

After removing the deviations which have over estimation price, we use the remaining data as training and test examples to get the better prediction performance. The accuracy comparison results are shown in Table 4. The best network architecture has the minimum MAPE, higher FE 5% and lower FE more than15%. Thus, the best network architecture is the FNN with 5.67% MAPE, 84.97% FE of less than 5%, 3.27% FE between 5% and 15% and 11.76% FE more than 15% in model 2 by a ratio 8/2. Another obvious result is the fact that the model 2 with feng shui variables can acquire better accuracy. Finally, the performance comparison among different network architectures is compared in Fig. 2. It proves a point that our novel model with feng shui

variables can improve the accuracy of traditional model without feng shui variables.

**Table 4. Results in various network architectures**

| | | | | FE | | |
|---|---|---|---|---|---|---|
| | | Ratio | MAPE | less than 5% | 5%~15% | more than 15% |
| BPN | Model 1 (102) | 7:3 (91:39) | 12.50% | 70.59% | 9.80% | 19.61% |
| | Model 2 (151) | 8:2 (121:30) | 9.86% | 82.12% | 4.64% | 13.25% |
| FNN | Model 1 (117) | 6:4 (70:47) | 9.80% | 68.38% | 11.11% | 20.51% |
| | Model 2 (153) | 8:2 (122:31) | 5.67% | 84.97% | 3.27% | 11.76% |

Note: Model 1 includes basic variables and spatial environment variables
Model 2 includes basic variables, spatial environment variables, and feng shui taboo variables

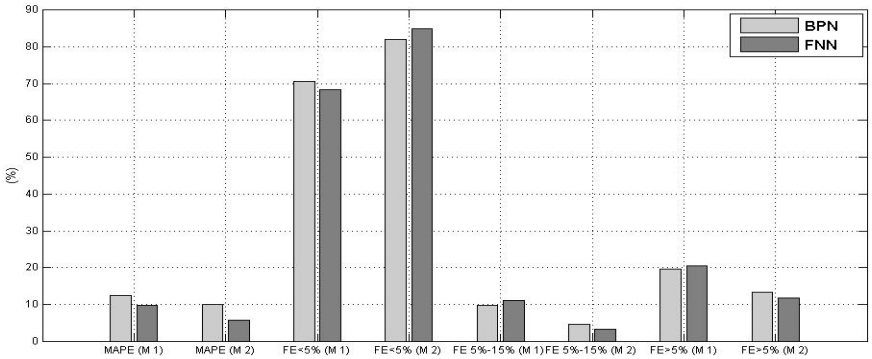


**Figure 2. Performance comparison among different network architectures**
Note: M 1 denotes model 1 and M 2 denotes model 2

## 5. Conclusions and Economical Implications

By comparing the accuracy with various network architectures, the result demonstrates that FNN is the best network architecture and model 2 with feng shui variables has a better performance in BPN and FNN. Furthermore, the prediction of real estate price system with feng shui factor has some advantages between sellers and buyers. First, our system can be combined with present estate agents' search system of real estate. We invite some professors of feng shui to analyze the houses which are sold or bought and set up some rules for the system. It can provide some suggestions about house conditions for buyers. They can use the system to seek their own house. Second, property developer can create much more perfect system to manage those houses. Many people in Taiwan just have one choice to buy their own house in their life. So, to buy adaptive house is very important. When those buyers want to buy their exclusive houses, the system can find adaptive house at once. And then they are able to choose one of them. In the future, as the database is created more complete, we can delete those bad houses which will harm people's health. At last, through the database system, architects can refer to those layouts which people want to buy or high price.

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