A

Course Project on

**Prediction of Exchange Rate using ANFIS**

Submitted By:

Mohit Tibrewal

B.Tech. Electrical Engg.

10115068

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# Abstract

The following project looks at a way of predicting the fluctuation of the INR to USD exchange rate. ANFIS is used as a system to predict the future actions of the exchange rate. ANFIS proves very simple to use and relatively fast, some stability problems do arise that need to be dealt with before ANFIS can be fully utilized to predict the exchange rate.

# Introduction

The exchange rate between currencies is very important – especially currently considering the week exchange rate between the Indian Rupee (INR) and the United States Dollar (USD). The exchange rate influences the Indian export industry greatly. The fewer INR you can get for every USD, the worse the bottom line is for these companies. This is largely due to the expenses being paid in INR such as salaries. The past few months have been particularly bad for the Indian export industry due to oil prices going up and the dollar going down. Oil price is directly linked to export cost. Any model to predict the exchange rate can help the private industry. If indications of large variation in the exchange rate were known in advance, preventive measures such as cutting cost or buying futures and options. Other useful applications could be to predict behaviors and trade accordingly. Many classical approaches to modeling the exchange rate exist. Most methods of time series analysis can be used for this purpose. The time series used for this project will be the final exchange rate (INR-USD) from 2010 until 2014. Data is available from the national bank going back to January 1st 1981, but this data is not useful in the modern environment since the national bank changed its policy from a fixed interest rate policy to a fixed inflation policy in 2001.

# The Data

The data used in this project is the daily value of the INR-USD exchange rate. The average between the asking and the offering price is used. The data was taken from the internet. This approach gives a total of 1082 observation points (From the 1st of January 2010 until the May 3, 2014).

The data contains the final price for each working day. The first 536 points will be used as training data and the last 536 as testing data.

# Theory - ANFIS

In the solution of this project ANFIS was used as another method of trying to estimate exchange rate.

To explain ANFIS we can take an example, say we are given a common rule set which contains two fuzzy if-then rules:

Rule 1: If x is A1 and y is B1 then

Rule 2: If x is A2 and y is B2 then

The following figure shows the architecture of the system that follows this logic:



A simple diagram of a two-input first-order Sugeno fuzzy model. Each of the fuzzy rules are then mapped into Membership functions. To view each layer and model behind them.

## Layer 1

Has i notes, these notes are adaptive and have node functions:

= for I = 1, 2 or

= for I = 3, 4

X is the input to node I and Ai (Bi-2) is a linguistic label (i.e. “big”) associated with the note. O is the membership function for example the generalized bell function:

Where { ai bi ci } are the parameters of the bell function.

## Layer 2

Every node is a fixed node and labeled π, the input is the product of all incoming signals:

I = 1, 2.

Each node is the firing strength of that a rule.

## Layer 3

Every node in this layer is a fixed node labeled N.

= = I = 1, 2

This is the normalized fire strength

## Layer 4

Every node I is an adaptive node

= =

p,q,r are the consequent parameters. This is an adaptive node.

## Layer 5

Overall output = =

Summation of all incoming signals.

# Results

First some general observations were made about the data. The Data series that was used looked as can be seen in the figure below. The data is as mentioned before from January 2010 until May 3, 2014.



Figure 1. INR/USD Exchange Rate

* An overall upwards trend seems to be ongoing, there seem to be steep fluctuations where the data moves very fast upwards or very fast downwards.
* No apparent signs of leveling off can be observed in the data.

## ANFIS

Matlab was used to train the ANFIS system. A small code was written to use on the 1082 exchange points available. Some time delays were put into the system. –7 –2 –1 days and +1 +2 days as well. These delays were chosen after having tried various combinations. Adding information didn’t seem to help the system and other combinations showed the same or a worse performance. The Data was divided into 2 equally long series, the first part of it was used for training and the second part was used for checking. A data set was created which contained the data, 7 lags 2 lags 1 lag 1 ahead 2 ahead and the data unbiased. This series was then used with the Genfis1 in order to create a Fuzzy inference system.



Figure 2. Membership Function plots

The membership functions for the 5 inputs into the system. As can be seen the membership functions are all the same, this is not surprising since the data essentially is the same although lagged a bit. When the membership functions for the checking data were also the same after the *anfis* command had been used. The resulting system that ANFIS gave was plotted against the inputs.



The above figure shows the training of the ANFIS. The result was not good since the ANFIS system became unstable towards the end of the checking data. The ANFIS result does not yield a good result. It is likely that actual inputs such as the interest rate, inflation rate and other factors would do a better job in conjunction with time lags to create a useful ANFIS system. The overall result regarding the ANFIS is that it is not enough to use only the data for the exchange rate; exterior factors need to be taken into consideration. ANFIS is better at catching actual price trends.

# Conclusion

ANFIS encounters problems with stability. This might be due to the fact that only the data it self with time lags was discovered. The main conclusion is that more investigations need to bake place before it is possible to use an ANFIS system to predict the exchange rate.

# References

1. Jang, Sun, and Mizutani, ***Neuro-Fuzzy and Soft Computing***, Prentice Hall, 1997

2. Homepage for data, URL http://www.sedlabanki.is

3. Henrik Madsen, Time series analysis, 2001.

# Appendix 1 – Matlab program (prediction.m)

clear all;

clc;

load dataINR

t = dataUSD2INR(:, 1);

x = dataUSD2INR(:, 6);

figure(1);

plot(t,x);

for k=9:1080,

% Putting one week, 2 and 1 day delay and +1 and 2 days

Data(k-8,:)=[x(k-7) x(k-2) x(k-1) x(k) x(k+1) x(k+2)];

end

len=size(Data);

% The Training Data

TRNData=Data(1:(len(1)/2), :);

% The Checking Data

CHKData=Data(((len(1)/2)+1):end, :);

FIS = genfis1(TRNData);

figure(2)

%plotting the membership functions

for i=1:5

subplot(2,3,i)

plotmf(FIS, 'input', i)

end

% Creating the ANFIS

[FIS,ERROR,STEPSIZE,CHKFIS,CHKERROR] = anfis(TRNData,FIS,[],[],CHKData);

figure(3)

% plotting the membership functions

for j=1:5

subplot(2,3,j)

plotmf(CHKFIS, 'input', 1)

end

figure(4)

TRN=[TRNData(:,1) TRNData(:,2) TRNData(:,3) TRNData(:,4) TRNData(:,5)];

CHK=[CHKData(:,1) CHKData(:,2) CHKData(:,3) CHKData(:,4) CHKData(:,5)];

output = evalfis([TRN; CHK], CHKFIS);

index = 1:len(1);

t = dataUSD2INR(:, 1);

% plotting the data and the predicted data

subplot(2,1,1), plot(t(index), [x(index) output]);

% plotting the error

subplot(2,1,2), plot(t(index), x(index) - output,'r');

figure(5)

plot([ERROR; CHKERROR]);