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Application of Artificial Neural Network in Social Computing in the Context of Third World Countries

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Abstract - **In the last decade, applications associated with artificial neural network (ANN) has been gaining popularity in both the academic research and practitioner's sectors. But unfortunately in underdeveloped countries this versatile tool has not yet been used. Here we consider some momentous sectors and explore the applicability of ANN in the context of third world countries. Here we explore the design of feed forward neural network for (1) assisting micro credit institutions to select appropriate locations to set up branches and (2) determining HIV risk of a locality. The simulation procedure and results are discussed accordingly.**

I. Introduction

Social problems vary form country to country. So researchers in the field of social science approach their native problems in their own ways. Huge amount of data analysis is involved in many problems of such kind. Finding different patterns from this data, inexact or hierarchical matching of patterns and making future predictions for intelligent decision making are the real challenges. For analysis of huge amount of data, application of computational tools like Artificial Neural Network, Association rules, Decision trees, Cluster Analysis are widely used.

The application of artificial neural network has been studied extensively in various sectors. Application in the field of finance is one of the most important sectors for the researchers and practitioners purpose for the last few decades. Many neural network applications are related to financial decision making. Hawley, Johnson and Raina [1] and Refenes [2] provide an overview of neural network models used in the field of finance and investment. Different forecasting about financial activities like currency exchange rate, bank failures, stock indices, bankruptcy, credit scoring have been analyzed greatly [3, 4, 5, 6, 7]. Neural network is not practiced only in the financial field. Researchers of various sectors have made efficient use of neural network. Image processing is such a field that can be cited here [8].

As the nature of most of the social problems varies widely from country to country, use of computational tools depends on the appropriate implementation considering specific aspects of those problems. That is why, social researchers in third world countries cannot use the tools developed in developed countries where this sort of application of computational methodologies are very common. Here lies the motivation of research on the part of computer scientists in underdeveloped countries. They have to come forward to apply computational analysis to solve the social research issues. From this motivation we have chosen two problems with unique aspects in the context of third world countries. The problems are:

1. Decision making on branch setup of micro-credit organizations
2. HIV Risk determination of a locality

Here we have used feed-forward Artificial Neural Network based on multi-layer perceptron (MLP) as our computational tool. This is a well known and extensively used tool which has inherent capability to discover hidden patterns in known (training) data and make almost accurate prediction later on in case of unknown (test) data. Construction of neural network architecture and determination of other parameters are discussed in the methodology section. Feature vector selection was very carefully done with consultation of domain experts and related research papers. The difficulty lies with availability of data. For world-wide recognized problems researchers find data from repositories offered by world famous research organizations and universities. As we are dealing with exclusively our local problems, data is not available as this sort of practice (use of computational tools for analysing social problems) is not well-known. But someone has to start. We have generated artificial data and developed the model which will hopefully encourage our organizations concerned to accumulate real-world data, use our model and find real world decisions.

The rest of the paper is organized as follows. In Section II we present primary definitions and concepts of artificial neural network. In Section III we describe our problem solving approach. Section IV deals with the implementation details of microcredit branch setup and Section V deals with HIV/AIDS risk determination problems including feature vectors selection. Finally we conclude in Section VI.

II. Preliminaries

In this section we discuss some definitions and related topics.

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network

function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are adjusted, or trained, so that a particular input leads to a specific target output. There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input/target pairs are used, in this supervised learning, to train a network.

Backpropagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by the user. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

Standard backpropagation is a gradient descent algorithm, as is the Widrow-Hoff learning rule, in which the network weights are moved along the negative of the gradient of the performance function. The term backpropagation refers to the manner in which the gradient is computed for nonlinear multilayer networks. There are a number of variations on the basic algorithm that are based on other standard optimization techniques, such as conjugate gradient and Newton methods.

Properly trained backpropagation networks tend to give reasonable answers when presented with inputs that they have never seen. Typically, a new input leads to an output similar to the correct output for input vectors used in training that are similar to the new input being presented. This generalization property makes it possible to train a network on a representative set of input/target pairs and get good results without training the network on all possible input/output pairs.

Backpropagation training functions are to train feedforward neural networks to solve specific problems. There are generally four steps in the training process: assemble the training data, create the network object, train the network, and simulate the network response to new inputs.

III. Methodology

In this section we discuss the methodology we use to solve the problems.

A. Feature vector selection and interpretation of output

Consultation of domain experts and study of relevant research work help us deciding feature vectors, that is important attributes of the problem which are likely to influence a decision. Some of these selected feature vectors may be directly expressed in numeric form. Most of them will be converted to a numeric value that significantly expresses its relative position. For a simple example, excellent may be represented by 1, very good by 0.8, good by 0.6, moderate by 0.5, bad by 0.3 and so on. Similarly a bit more categorical representations like 1 for very rich, .6 for solvent, etc.

The outcome of known data or later on predicted outcome also needs to be interpreted in numeric form. In case of micro-credit branch setup the choice of a place will be highly recommended if setting up the branch raises average income of target income-group people. This is the criterion of choosing a place among many alternatives. The higher raise is predicted, the higher the possibility of choosing this place. For a problem to predict risk of HIV infection in a locality may also be represented in numeric form, i.e., 0.8 to 1 will denote high risk; below 0.4 will denote low risk.

B. ANN architecture and necessary parameters determination

Construction of input layer depends on number of selected feature vectors. Empirical study is made to define hidden layer architecture which gives accurate result on training and validation data and also will work well on huge amount of data in consideration of convergence time. The desired output format defines output layer architecture.

C. Training, test, and validation process

The neural network model used in this study is feedforward neural network based on multi layer perceptron (MLP). MLP has been studied extensively by the researchers for a long time and has been accepted world wide. It is easy and efficient. These factors influenced us to adopt this method.

The design of ANN proceeds through several phases. First, the inputs are analyzed for discovering important attributes of the domain that are used as feature vectors. Then suitable network architecture is chosen and a significant training data set is used to train the network. After the network is being trained, a significant data set called validation data set is simulated with the network to check whether the network is worthy or not.

After selecting the relevant feature vectors our job was to select appropriate network architecture to optimize our objectives. The approach used in these implementations in order to construct neural network is totally empirical, and is not based on theoretical evidence. Indeed, the design of an MLP is by no means an exact science and no complete theoric explanation exists to obtain the optimal architecture of the MLP. For these reasons we had to rely on simulating different architecture and picking the best one. We search over various network architectures involving different number of layers and neurons and selected the configuration that incurred the least amount

of mean square error with an eye on the training time of the network.

Our final task is to train and validate the network with relevant data set. There is no such repository in third world countries and the institutions do not seem to be eager to publish relevant data for lack of infrastructural support and technical orientation. So we randomly generated feature vectors for training, validation and testing purpose.

We generate data by a computer program written in C language to train and validate the network. We fed the training data to train the network. Then we simulate the trained network with the validation data and check whether the accuracy of the network can achieve a significant level of accuracy. In case of failure, we train the network again with modified number of neurons. We go through this way recursively until the trained network can achieve the preset accuracy level. Then our network is fit for assisting the decision making of microcredit branch set up in a specified locality. Fig.1 demonstrates the whole process.

IV. Implementation

In this section we find out the feature vectors that are appropriate in the context of third world countries and give experimental results. First, we focus on the problem of microcredit branch setup problem.

A. Micro credit Branch Setup

In this section we reveal the most important attributes that can bias the decision of branch setup of microcredit institutions and suggest an appropriate feedforward neural network.

In recent years, the development community came to view microcredit as an increasingly important tool for poverty alleviation and economic empowerment. Microcredit institutions have been grown rapidly throughout the world. This huge success of microcredit programs often tend to overshadow the occasional failures of microcredit programs and these failures are now becoming too frequent to overlook. So an objective study of the suitability of microcredit program for a specific locality has attracted quite a lot of attraction among the researchers. And there has been dazzling revelations too. Our goal is to choose a place from alternative options to set up a new branch of a micro-credit organization which will maximize the goal of having positive impact on the income of target people. At the same time other inevitable issues like the risk of failure to collect repayment have to be considered. Hence, an objective study of the suitability of microcredit program for a specific locality has considerable impact in future in terms of repayment and actual effect on poverty level. Based on comprehensive consideration of the factors we have decided the feature vectors as described below:

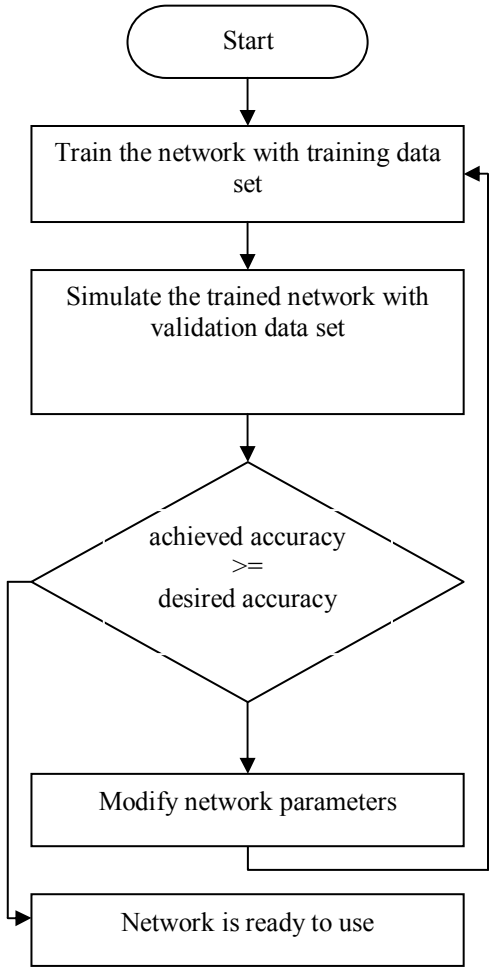

Fig. 1 Flowchart of the network building process.

- **Target population:**

There is no point in setting up a microcredit branch in the middle of desert for the simple reason that there will be no one to give credit to. So the target population is an important feature and indeed many microcredit institutions specify a minimum population to start a branch in their regulations. For example, 'Pride' (a Tanzanian company) specifies this minimum limit as 100000.

- **Average years of schooling:**

We have considered the average years of schooling of both the target population and the heads of families. The first one is obvious; certainly someone with a significant amount of schooling will know what to do with the money. A research on microcredit programs in Bangladesh shows that another year of schooling increases non agricultural assets by around 45% among microcredit customers [9]. The need of schooling of family is not obvious. But again research shows that this also has a positive impact. Additional year of schooling of household head increases asset accumulation by 7% [9].

- **Contribution of enterpreneurial activities towards GDP:**

Experience shows that most of the microcredit induced investments are in manufacturing of skill based economic activity. A recent work in this regard states, "Societies with little debt problem but strong enterpreneurial culture may thus be a better environment for offering untied microcredit than societies where entrepreneurial activities need decisive encouragement" [10]. Indeed, a region where enterpreneurship is common as opposed to predominantly agri-societies microcredit can fuel development more effectively.

- **Infrastructure:**

It may seem very selfish that microcredit programs are often commercial organizations making profit. At least they have to reach the break even point. So they want to have good communication link, electricity and other facilities. A relevant work reveals that "With the presence of electricity, asset accumulation increases by almost 42 percent" [11]. Also the presence of other financial institutions facilitates the transfer of cash.

- **Rate of unemployment:**

Extreme poverty forces people to consume credit for personal uses.

Critics usually respond that offering credit to very poor community lead them into debt and deepen their economic dependence. In such cases credit is never recovered and the program is doomed. So an extraordinary high rate of unemployment is a discouraging factor. However the unemployment rate of women is a controversial factor and should be measured as a function of the percentage of women who are currently in economic activities or willing to do so. So a door to door survey is needed to measure this factor.

- **Par Capita Income:**

For the same reason stated in the previous point, lending in extremely poor areas can be catastrophic for the institutions. Again estimating the par capita income of women target group presents a problem and should be estimated as a function of household income.

- **Natural Calamity:**

People located in areas prone to natural calamities are tricky since creditors may fail to repay the loans as they have to face natural brutality and struggle hard to get them over. So from the perspective of loan repayment such areas are penalized in points.

- **Distance to nearest health centre:**

This feature may seem bizarre at first; at least it did it to us. But statistics shows that there is strong correlation between health services and economic performance of the creditors. A relevant research shows that among the village characteristics, presence of rural health centre considerably increases women's performance, which is not surprising as better health definitely increases productivity of work force in general. Noticeable thing is the magnitude of increase. Women on the average accumulate 94% more assets than those women who do not have any rural health centre present in their village [11].

Table 1 Demonstration of actual output and simulated output.

Feature Vectors									Actual Output	Simulated Output
f1	*f2*	*f3*	*f4*	*f5*	*f6*	*f7*	*f8*	*f9*		
5	4	4	1	1	2	1	1	4	0	0
5	1	1	5	3	3	2	5	5	1	1
5	1	4	1	4	1	1	3	2	0	0
3	4	4	2	5	5	2	5	1	1	1
1	3	5	3	4	5	1	4	4	1	1
2	1	3	4	3	5	2	2	2	0	1
3	5	1	5	5	4	2	2	5	1	1
5	1	1	1	2	1	1	5	5	0	0

- **Existence of training facilities:**

Skilled population can utilize credit more effectively. So number of training centre in the locality is a direct indicator of enterpreneurship and influences setting up of the branch of microcredit institution positively.

B. Data and Result analysis

The features of an existing branch are known, although here we have assumed those for lack of real data. These are numerically represented as we have discussed in the methodology section. Table 1 demonstrates the result of a working example. Here *f1, f2, f3, ..., f9* are 9 feature vectors associated with the decision making about microcredit branch setup with 5 as the most influencing value whereas 1 is the least. Actual output indicates whether the microcredit branch should be set up or not with the value of 1 or 0 respectively. This output is generated by a computer program which manipulates some decision making heuristics. The training data set, validation data set and test data set are also generated by the same program. Now we simulate the same data by the trained feed forward neural network. And the simulated output in the table indicates the output generated from this network. Here, among 8 decision making situation, our network fails only in one situation resulting into 87.5% efficiency.

The experimental result is convincing enough to adapt in the real life. Our procedure can predict whether a branch should be set up or not with accuracy rate of around 90%. We trained the network with different simulated data set and all the time we found our network good enough to serve our purpose.

Now we proceed to our second problem .

V. HIV/AIDS Risk Determination

In this section, we reveal the motivation behind the need of HIV/AIDS risk determination for a particular locality and find out the factors that have to be considered to measure the risk from the perspective of third world countries. There is variation in different relevant factors even among the underdeveloped countries. So, we have

chosen Bangladesh, one belonging to this group, to analyze and determine the feature vectors.

HIV/AIDS has been a devastating threat to the world for the past few decades. Researchers around the world are storming their brain to control this epidemic. With prevalence rate of less than 1%, HIV/AIDS in Bangladesh [UNAIDS report] may not look like a major threat. Yet nothing can be further from truth. In a population of over 130 million, a mere 1% rise would mean an addition of more than a million to the numbers. The first case of HIV in Bangladesh was detected in 1989 and according to a 2004 UN study, HIV infections have tripled in the following six years. UNAIDS estimated that 11000 adults and children were living with HIV at the end of 2005 [UNAIDS global AIDS report, 2006]. So, definitely Bangladesh is on the brink of the epidemic and being a country where poverty, illiteracy and poor health are rife, the spread of AIDS presents a daunting challenge.

Since Bangladesh is densely populated and not much well organized, it is difficult to monitor the situation of the country as a whole. Moreover, unlike developed countries, Bangladesh lacks the scientific laboratories, research facilities, equipment, and medical personnel to deal with an AIDS epidemic. So, what we can do is to evaluate the risk of different location individually and take effective measure according to the vulnerability of a particular location. In this paper, we reveal a scientific methodology to evaluate the degree to which a particular locality is vulnerable to HIV/AIDS risk. And in this point, we unveil the tremendous capability of feed forward network to serve our purpose.

A. Feature Vectors

We consider different factors that can influence the risk determination of a region and settle down with some attributes that we think most relevant in the context of Bangladesh. In the rest of this section we elaborate each feature and describe why we think them important.

- **Access to sex workers:**

Sex work is central to this epidemic that is primarily spread by unprotected heterosexual intercourse. It is also a feature of all cultures, encompassing a wide range of people and behaviours. Sex work can involve men and transgender people, as well as women. People who are engaged in selling sex obviously have multiple sex partners and are therefore highly vulnerable to several Sexual Transmission Diseases (STDs/STI) and HIV/AIDS infection. Sex workers in Bangladesh have a higher client turn-over rate than in any other south Asian country, and consistent condom use during paid sex is rare (depending on the region, 0–12% of sex workers said that they used condoms with new clients), reports UNAIDS update of 2005. There are over 105,000 sex workers, both female and male, in the country. Brothel-based female sex workers reportedly see around 18 clients per week, while street-based and hotel-based workers see an average of 17 and 44 clients per week respectively [UNAIDS report]. So the existence of brothel as well as number of street and hotel sex workers is some factors that we should consider and evaluate properly.

- **Intravenous drug users:**

Intravenous drug users (IDUs) are open to the high risk of HIV/AIDS through the repeated use of same needle. A national survey data indicates that HIV incidence among IDUs jumped from 1.8% in 2001 to more than 4% in 2004. In one Dhaka “hotspot” the prevalence has jumped to 9%. A survey in Central Bangladesh revealed that more than 70% IDUs routinely share needles. This is comparable to levels in countries that are experiencing a concentrated and growing HIV epidemic. Illegal sale of blood by IDUs increases the threat of tainting the national blood supply. So it is not the case that only they themselves are at high risk, rather they endanger their society as well.

- **Homosexuality:**

This is the most common cause of spreading HIV in high income western country like USA. Statistics reveals that homosexuality among men (MSM) is responsible for 62% risk in USA (Fact Sheet - HIV/AIDS among Hispanics in the United States). There has been little research on the role of sex between men in our country's HIV epidemic. But still we have to be careful since sex between men is highly stigmatised in Bangladesh and is not openly talked about, making it easy for people to underestimate how commonly it occurs. So a tough and challenging survey is needed to measure this factor.

- **Migrant workers:**

Large numbers of people have moved around within Bangladesh, to neighbouring countries or overseas, in order to work. In many cases, migration does not change an individual's sexual behaviour, but leads them to take their established sexual behaviour to areas where there is a higher prevalence of HIV [12]. Long working hours, isolation from their family and movement between areas may increase the likelihood that an individual will become involved in casual sexual relationships, which in turn may increase the risk of HIV transmission. So regions with large number of migrant workers are vulnerable to the HIV/AIDS risk and hence penalized in points.

- **Number of truck drivers:**

This feature may seem strange first but in fact it has strong correlation with HIV/AIDS risk determination. Bangladesh has a large road network, involving thousands of drivers and helpers. Truck drivers spend long periods of time away from home, and it is common practice for them to have relations with sex workers while on the road. 24-34% of truck drivers of India, according to various survey results, have been reported to be engaged in sex with commercial sex workers [13]. Though there has not been such survey in Bangladesh, it can be stated without any fear of being wrong that situation is not much better in our country. A research work in this regard

states, "There is no entertainment. It is day-in-day-out driving... When they stop, they drink, dine and have sex with women. Then they transfer HIV from urban to rural settings" [14].

- **Medical malpractice:**

Bangladesh, being a poor country, is still lagging far behind from quality medical practices. Except some reputed hospitals and clinics, the proper screening of blood and restriction on repeated use of same syringe is not in practice. There has been no proper step to restrict professional blood donors who are mostly drug addicted. HIV prevalence among pregnant women attending antenatal clinics is also a major factor to be considered. Thus medical malpractice can clear the way for AIDS pandemic to explode in Bangladesh. So, we should carefully evaluate the medical standard of a region while measuring its vulnerability to HIV/AIDS risk.

- **Tourist spot:**

A lot of people from home and abroad gather in a tourist spot. Tourists often get involved in extra marital sex. And utilizing this fact, some dishonest hotel businessmen provide their clients with professional sex workers. These sex workers are open to the clients from both home and abroad. Hence, the condition of the HIV/AIDS epidemic may be aggravated in a tourist spot. And certainly a region which has some tourism values has to be penalized while measuring this feature vector.

- **Dependency of women:**

Most of the women in Bangladesh are not economically self dependent rather they depend on their husbands. This leads to a men dominant society where women are obsessed with the thought that they have to obey their husbands anyway. And unfortunately, women have no right to protest against being affected from their husbands who are in bad practice like unsafe sex with sex workers, homosexuality and drug addiction. The decision of using condom while encountering sex is entirely depends on the whims of their husbands. Although these things may seem very strange to the modern generation but the actual picture of most of the rural areas where illiteracy and poverty are rife, is no better than that.

- **Social factors:**

Here, we take the rate of literacy and religious sentiment into account while considering social condition as a feature that can contribute a lot to the HIV/AIDS vulnerability. Still in the twenty first century, high illiteracy rate is a trademark of third world countries. Ultimately unawareness along with superstition and stigma remains a problem in many areas. Many people do not know how AIDS spreads let alone how to prevent it. Awareness can restrict people from unsafe sex or at lest it can grow eagerness of using condom. It can also fuel the use of disposable syringe.

With the advent of sky culture and globalization, the young generation is motivated by the western culture that unfortunately makes the bind with the religion very loose. They vastly accept extra marital sex and many of them are sexually multilated. So we have to consider these social values very carefully.

B. Data and Result Analysis

The approach of data and result analysis for this case is exactly same as described in the Section IV (B).

VI. Conclusion

The model we have need to be applied with real data in the scenario of third world countries which may be done by people from organizations concerned by generating data set considering the features. The accuracy of the model can also be compared with other techniques like graph partitioning which we consider to be our future work. We hope that our effort will introduce the prospect and applicability of computational aids in the field of social science to solve the indigenous problems.

References

[1] D. Hawley, J. Johnson and D.Raina, "Artificial Neural Systems: A New Tool for Financial Decision Making," Financial Analysts Journal, pp. 63-72, 1990.

[2] A. P. Refenes, *Neural Networks in the Capital Markets,* Wiley, 1995.

[3] M. T. Leung, A. Chen and H. Daouk, "Forecasting Exchange Rates using General Regression Neural Networks".

[4] K. Y. Tam and M. Y. Kiang, "Managerial Applications of Neural Networks: The Case of Bank Failures," Management Science, pp. 926-947, 1992.

[5] M. T. Leung, H. Daouk and A. Chen, "Forecasting Forecasting Stock Indices: A Comparison of Classification and Level Estimation Models".

[6] Z. Yang, "Probabilistic Neural Networks in Bankruptcy Prediction," Journal of Business Research, pp. 67-74.

[7] H. Jensen, "Using Neural Networks for Credit Scoring," Managerial Finance, pp. 15-26, 1992.

[8] A. K. M. Rahman and C. M. Rahman, "A New Approach for Compressing Images using Neural Network," in Proc. CIMCA, 2003.

[9] H. I. Latifee, "Microcredit and Poverty Reduction," in Proc. International Conference on Poverty Reduction Through Microcredit, 2003.

[10] R. Faridi, "Microcredit Programs in Bangladesh, Assessing Performance of Participation," 2004.

[11] M. J. A. Chowdhury, "Evaluating the Impact of Microcredit on Poverty in Bangladesh: A Panel Data Approach"

[12] L. Gelmon, K. Singh, "Sexual networking and HIV risk in migrant workers in India ," in Proc. International Conference of AIDS, pp. 13-18, 2006 [5].

[13] P. Chandrasekaran, G. Dallabetta, " Containing HIV/AIDS in India: The Unfinished Agenda," The Lancet Infectious Diseases, vol. 6, no. 8, pp. 508-521, 2006.

[14] A. Christensen, "Truckers Carry Dangerous Cargo ," Global Health Council, 2002.