ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Diagnosis and Classification of Diabetic Disease Using Associative Neural Network

Neelamegam P[1*], and Rajalakshmi M[2]

[1]School of Electrical and Electronics Engineering, SASTRA University, Vallam, Tamilnadu.
[2]Research scholar, P.G. & Research Department of physics, A. V. V. M. Sri Pushpam College (Autonomous), Poondi, Thanjavur, Tamil Nadu

ABSTRACT

The major concern in medical fields especially to the doctor is getting the right diagnosis, classification and ultimately the right treatment. Diabetes is serious health problem in both developing and industrial countries especially in India and its incidence is increasing. Artificial neural network provides a powerful tool to help the medical professionals to clinically analyze the disease and get the best solutions. The aim of the present paper is to make best use of Associative Neural network in classification of diabetes into five classes (normal, mild, moderate, severe and chronic). The ASNN(Associative Neural Net work) is configured with 11 neurons in the input layer, 8 neurons in the hidden layer and 1 neuron in the output layer. The network is trained with 100 data sets. The trained ASNN network is used for testing. The result of this study shows that ASNN provides satisfactory results for the diabetic diagnosis and classification. The developed ASNN displays a high percentage of classification accuracy (94%) and excellent correlation (R^2 = 0.981). The results are cross -validated by Leave - One - Out (LOO) procedure. This model is helpful to the doctors as using this model they can decide the type of treatment, dosage of medicines depending upon the classifications.

Keywords: Diabetes, Associative Neural Network, Cross-validation

Corresponding author

INTRODUCTION

The major health problem rocking the entire world is the diabetes mellitus (DM). It is expected that more than 366 million people would suffer this major health problem across the globe during 2030 [1]. The threat is alarming in global parts viz India due to its unprecedented economic growth coupled with unwanted byproduct of the disease diabetes. As per the latest data nearing 35 million people in India are found to be suffering from diabetes out of the total population of 1 billion. The rest of the population has impaired glucose tolerance. It is further expected that more than 200 million people in our country roughly about 15% of the country's population will be affected by diabetes or its precursor.

Basically diabetes is identified as a metabolic disease which affects both lipid and protein metabolism as it affects glucose metabolism. Diabetes can be divided into two types as Type 1 and Type 2. In Type 1 diabetes, the insulin hormone is not secreted or the pancreatic β-cells are absent. While Type 2 diabetes mellitus (DM) is characterized by a progressive failure of insulin secretion by pancreatic β-cells [2]. Diabetes can be identified with symptoms and they are grouped as typical symptoms and another is symptoms due to complications of diabetes. The symptom Polyuria (excessive urination), Polydypsia (excessive consumption of water), weight loss (despite increased appetite), Polyphagia (excessive food consumption), Nocturia (excessive urination at night) are due to typical symptoms. Paraesthesia (loss of feeling on feet and/or hands), Diminution/decrease in urine quantity and Poor vision are symptoms due to complication of diabetes. Diabetes diagnosis is normally done on the basis of the above mentioned symptoms and on elevated blood glucose value. The blood glucose level at which DM is diagnosed is when the Random blood glucose level is equal to or higher than 120 mg/dl or when the Fasting blood glucose is equal to or higher than 80 mg/dl [3].

Even though diabetes is assessable on glucose value, the classification becomes precise and accurate on the basis of the diagnosis by ascertaining Diastolic pressure, Body mass index, Fasting Glucose, Urea, Serum insulin, Postprandial Glucose, Haemoglobin, Glycosylated Heamoglobin, Serum triglycerids. Glucose is metabolic control of insulin action. Insulin is the dominant hormone influencing the regulation of glucose metabolism. [4]. Impaired nitrogen balance coupled with lowered protein synthesis leads to increased concentration of urea and creatinine in the blood which results in renal failure in diabetic patients [5]. The most commonly observed lipid abnormalities in diabetes are hyper triglyceridemia. The level of glycosylated haemoglobin is monitored as a reliable index of glycaemic control in past 3 months of diabetes status. It is associated with a glycaemic control [6]. Lower Hemoglobin level in type-2 diabetic adults indicate subsequent decline in kidney function [7]. Due to the fact that medical information systems in upgraded modern hospitals and medical institutions become enlarged, it is very difficult to extract accurate and proximate information from medical information systems for decision support [8]. The conventional manual data analysis is less accurate and time consuming process and hence a proximate computer based medical analysis has become vital and necessary. The idea of inducting machine based learning into medical and clinical analysis is to bring out the best diagnostic accuracy and efficiency, reduce cost of surgery and manmade efforts. The advent of the increasing and far reaching scope of neural network has induced and kindled the various scientists and technologists to adopt the latest neural network for diagnostic studies for detecting the several other undetected diseases [9]. The aim of artificial neural networks in medical diagnosis is to develop cost effective and easily usable systems and procedures for supporting doctors. The advantage of using artificial neural networks is that it gets the solutions even for complex problems using conventional technologies. The reason being they do not have a complex and algorithmic procedure or approach. The induction of artificial neural network in medical analysis, diagnosis, bio medical analysis, drug development is proved too successful. Artificial neural networks help to successfully monitor a lot of health indices such as the rate of respiration BP, Glucose, serum level and even the response of the patient to specific therapy [10,11]. Neural network plays a pivotal role in image analysis also as they are used in processing of digital image in both the functions of the recognition and classification.

This study is chosen as the classification of diabetes using neural network has not far reached and it saves time. Classification systems can be used for diabetes disease diagnosis and other clinical diagnosis problems. In literature a lot of studies are reported focusing on diagnosis of diabetes disease [12, 13, 14, 15, 16]. This paper explains the Diagnosis and classification of diabetes into 5 classes (Normal, Mild, Moderate, Severe and Chronic) using ASNN.

MATERIALS AND METHODS

Database description

The data sets used in this research work are collected from Diabetic Research Centre, Thanjavur, India. The dataset is divided into subsets. Training set contains details of 100 diabetic patients and testing set contains details of 50 patients. The 11 attributes (input) and 1 attribute as output is are used for training ASNN. The training set is used to build models using Associative Neural Network (ASNN). The test set is used to evaluate the classification ability of the models obtained. (Software for ASNN is used from www.vcclab.org/asnn).

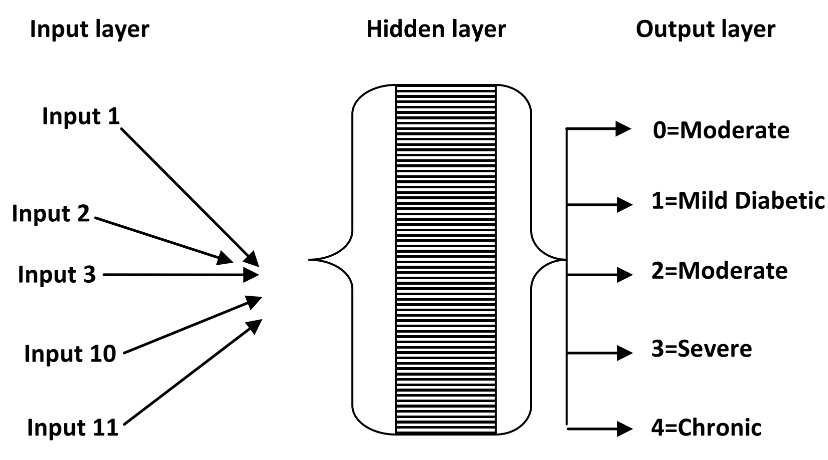

Fig 1. A Basic three layer neural network.

Neural Network

An artificial neural network (ANN) consist of large number of parallel and distributed computational structures composed of neurons (simple processing unit) interconnected with unidirectional signal channels called weights. There are three types of neurons known as input, output and hidden neurons. When input signals are received from outside the system they are known as input neurons. When they fire the signal out of the system they are known as output neurons. When both the signals are found within the systems they are known as hidden neurons [8,17] as illustrated in Figure 1. The ANN consists of three layers input, hidden and output layer. To generate the activation value for each neuron transfer function is employed. The transfer function may be a simple linear function or a complex function like a sigmoid function. Other functions that can be used are threshold logic, step function, or the hyperbolic tangent function. The transfer function is continuous and non-linear. The ANN is trained to perform a particular function by adjusting the values of the connections, or weights, between elements until a particular input leads to a specific output.

Associative Neural Network

Associative neural network plays a vital role to establish non-linear relationship between input (attributes) and output (class attributes). The conventional artificial feed forward neural network has no memory. It is to say that once the training is completed, all data about the input patterns is stored in the neural network weights and input data are not required. i.e., there is no definite storage of any example presented in the system. Quite opposed to it, Associative Neural Network (ASNN) is a group of memory-based and memory-less methods [18, 19]. The Associative neural network (ASNN) offers an innovative approach to integrate “on the fly” the user’s data. The extension of the committee of machines that goes beyond a simple/weighted average of different models is known as associative neural network. An ASNN means a combination of collection of feed forward neural networks and the K - nearest neighbour method. This technique uses the correlation between ensemble responses as a measure of distance among the analyzed cases for the nearest neighbor method. This offers an enhanced prediction by the bias correction of the neural network ensemble. It is very pertinent to note that ASNN possess a memory that can synchronize with training set. If new data become available the network further increases its predictive ability and provides a considerable approximation of unknown function without a need to retrain the neural network ensemble. This significant feature of the method enhances its predictive ability compared to the conventional neural network and K-the nearest neighbour techniques. ASNN has a special capacity to interrupt the results of the neural network by analyzing the correlations between the data cases in the space of models [20].

RESULTS AND DISCUSSION

The objective of this research is that the ASNN is a convenient and reliable diagnostic tool for the classification of diabetic activity based on the training of patient information. The selected attributes involved for training (eleven inputs parameters) are;

ISSN: 0975-8585

Attribute	**Description**
Age	Age in Years
Sex	1 = Male 0 = Female
BP	Diastolic pressure (mm)
BMI	Body mass index
FG	Fasting Glucose (mg/dl)
U	Urea (mg/dl)
SI	Serum insulin (µU/ml)
PPG	Postprandial Glucose (mg/dl)
HG	Heamoglobin (gm/dl)
GHb	Glycosylated Hb (%)
ST	Serum triglycerids (mg/dl)

The output attribute is considered as class-0(Normal), class-1(Mild), class-2(Moderate), class-3(severe) and class-4(chronic). The input attribute PP glucose concentration is considered for classification with the other attributes. Class-0 Normal (80-120), Class-1 Mild (121-179), Class-2 Moderate (180-250), Class-3 Severe (251-349), Class-4 Chronic (above 350).

Table 1 Training set with input parameters and output classification

S.No	Sex	Age (years)	Fasting glucose (mg/dl)	BP	Body Mass Index	Urea (mg/dl)	Serum Insulin (µU/ml)	PP glucose concentration (mg/dl)	Heamoglobin (gm/dl)	Glycosylated Hb (%)	Serum Triglycerids (mg/dl)	Class
1	1	35	224	160	33	45	87	458	10.4	9.4	99	4
2	0	47	82	123	22.87	31.42	73.56	124.49	13.36	4.46	47.98	0
3	1	50	102	138	24.24	33.45	78.94	197.32	11.14	7.67	62.9	2
4	1	65	83	120	21.65	31.47	72.48	122.25	13.47	5.73	43.17	0
5	1	40	226	165	27.78	43.25	85.18	432.83	8.58	8.75	95.32	4
6	0	56	197	142	23	37	78	321	10	7	71	3
7	0	42	85	112	20	31	72	122	13	3	42	1
8	1	43	82	122	20.45	31.24	71.21	123.56	13.32	3.12	43.46	0
9	1	44	92	141	23.54	43.25	76.35	146.25	11.54	6.23	54.24	1
10	1	44	93	142	24	44	75	147	10	6	55	1
11	0	45	82	122	22	31	73	124	13	4	47	0
12	1	48	102	137	24	33	78	197	11	7	62	2
13	1	63	83	120	21	31	72	122	13	5	43	0
14	0	61	192	140	22.78	35.21	77.74	300.54	10.9	6.78	70.46	3
15	1	44	94	142	29	47	78	155	11.4	7.4	64	1
16	0	45	86	122	27	34	76	132	14.4	5.4	56	0
17	1	48	105	137	29	36	81	205	12.4	8.4	71	2
18	1	63	86	120	26	34	75	130	14.4	6.4	52	0
19	0	43	79	121	21	30	72	120	14	4	46	0
20	1	46	98	134	23	32	77	190	10	7	60	2
21	1	63	81	120	25.47	33.21	73.89	129.78	15.18	5.94	51.47	0
22	1	37	224	161	33.45	45.56	87.56	458.98	11.27	9.87	99.48	4
23	0	61	194	140	27.78	38.21	80.74	308.54	12.3	8.18	79.46	3
24	0	42	82	110	24.23	33.21	74.25	128.79	15.86	5.27	50.48	1

ISSN: 0975-8585

25	1	40	83	121	21	32	72	124	12	4	44	0
26	1	46	97	134	28	35	80	198	11.4	8.4	69	2
27	1	61	78	119	25	33	73	129	14.4	5.4	51	0
28	0	42	83	110	19.23	30.21	71.25	120.79	14.46	3.87	41.48	1
29	1	44	83	122	21.45	32.54	72.98	124.41	12.71	4.98	44.1	0
30	1	42	80	120	20	31	71	123	13	3	43	0
31	1	43	90	141	23	43	76	146	11	6	54	1
32	1	61	79	119	20	30	70	121	13	4	42	0
33	1	35	220	160	28	42	84	450	9	8	90	4
34	0	55	192	140	22	35	77	300	10	6	70	3
35	0	40	83	110	19	30	71	120	14	3	41	1
36	1	37	224	164	32	46	88	440	9.4	9.4	104	4
37	0	56	195	142	28	40	81	329	11.4	8.4	80	3
38	0	42	85	112	25	34	75	130	14.4	4.4	51	1
39	1	43	887	120	25.45	34.24	74.21	131.56	14.72	4.52	52.46	0
40	1	44	92	141	28.54	46.25	79.35	154.25	12.94	7.63	63.24	1
41	0	45	84	121	26.45	33.21	75.24	128.45	15.61	5.76	55.48	0
42	1	47	100	135	28.56	35.54	80.45	198.54	12.18	9.05	69.83	2
43	0	40	82	110	24	33	74	128	15.4	4.4	50	1
44	1	40	83	121	26	35	75	132	13.4	5.4	53	0
45	1	44	94	142	29	47	78	155	11.4	7.4	64	1
46	0	45	86	122	27	34	76	132	14.4	5.4	56	0
47	1	40	93	143	24.25	44.21	75.84	147.98	10.25	6.85	55.27	1
48	0	55	194	140	27	38	80	308	11.4	7.4	79	3
49	0	40	82	110	24	33	74	128	15.4	4.4	50	1
50	1	40	83	121	26	35	75	132	13.4	5.4	53	0
51	1	37	226	164	27	43	85	432	8	8	95	4
52	0	57	197	143	23.45	47.54	78.94	321.73	10.69	7.49	71.47	3
53	0	43	85	112	20.47	31.25	72.57	122.65	13.72	3.71	42.79	1
54	1	53	176	141	26.12	37	71	142	11.4	4.12	46.2	1
55	0	51	185	137	20.6	33	72	238.66	8.05	5.4	67.8	2
56	1	51	102	137	24	33	78	197	11	7	62	2
57	1	32	139	113	21.22	30.66	68.66	126.1	13.9	4.11	41.45	0
58	1	42	140	140	23.65	41.65	71.2	128.5	15.4	6.6	46.67	1
59	0	71	141	113	25.55	34.3	76	135	10.2	8.8	67.75	4
60	1	42	82	120	25	31	74	131	14.4	4.4	52	0
61	1	43	94	141	28	43	79	154	12.4	7.4	63	1
62	0	55	194	140	27	38	80	308	11.4	7.4	79	3
63	0	45	82	121	21.45	30.21	72.24	120.45	14.21	4.36	46.48	0
64	1	47	100	135	23.56	32.54	77.45	190.54	10.78	7.65	60.83	2
65	1	63	81	120	20.47	30.21	70.89	121.78	13.78	4.54	42.47	0
66	1	37	222	161	28.45	42.56	84.56	450.98	9.87	8.47	90.48	4
67	1	48	105	137	29	36	81	205	12.4	8.4	71	2
68	1	63	86	120	26	34	75	130	14.4	6.4	52	0
69	1	37	224	164	32	46	88	440	9.4	9.4	104	4
70	0	56	195	142	28	40	81	329	11.4	8.4	80	3
71	0	42	85	112	25	34	75	130	14.4	4.4	51	1
72	1	43	887	120	25.45	34.24	74.21	131.56	14.72	4.52	52.46	0

ISSN: 0975-8585

73	1	35	224	160	33	42	87	458	10.4	9.4	99	4
74	0	55	194	140	27	35	80	308	11.4	7.4	79	3
75	0	40	83	110	24	33	74	128	15.4	4.4	50	1
76	1	40	82	121	26	35	75	132	13.4	5.4	53	0
77	1	37	224	161	33.45	45.56	87.56	458.98	11.27	9.87	99.48	4
78	0	61	194	140	27.78	38.21	80.74	308.54	12.3	8.18	79.46	3
79	0	43	80	121	26	33	75	128	15.4	5.4	55	0
80	0	43	82	121	26	30	75	128	15.4	5.4	55	0
81	0	42	82	110	24.23	33.21	74.25	128.79	15.86	5.27	50.48	1
82	0	42	82	110	24.23	33.21	74.25	128.79	15.86	5.27	50.48	1
83	1	46	100	134	28	32	80	198	11.4	8.4	69	2
84	1	61	81	119	25	30	73	129	14.4	5.4	51	0
85	1	44	92	141	28.54	46.25	79.35	154.25	12.94	7.63	63.24	1
86	0	45	84	121	26.45	33.21	75.24	128.45	15.61	5.76	55.48	0
87	1	47	100	135	28.56	35.54	80.45	198.54	12.18	9.05	69.83	2
88	1	63	81	120	25.47	33.21	73.89	129.78	15.18	5.94	51.47	0
89	1	44	93	142	29	47	78	155	11.4	7.4	64	1
90	0	45	81	122	27	34	76	132	14.4	5.4	56	0
91	1	48	103	137	29	36	81	205	12.4	8.4	71	2
92	1	63	83	120	26	34	75	130	14.4	6.4	52	0
93	1	37	225	164	32	46	88	440	9.4	9.4	104	4
94	0	56	196	142	28	40	81	329	11.4	8.4	80	3
95	0	42	85	112	25	34	75	130	14.4	4.4	51	1
96	1	43	84	120	25.45	34.24	74.21	131.56	14.72	4.52	52.46	0
97	1	44	93	141	28.54	46.25	79.35	154.25	12.94	7.63	63.24	1
98	1	46	97	134	28	35	80	198	11.4	8.4	69	2
99	1	61	78	119	25	33	73	129	14.4	5.4	51	0
100	1	35	224	160	33	45	87	458	10.4	9.4	99	4

The dataset has 150 samples. 100 samples are availed in training the network (Table-1) while 50 samples are availed in network testing (Table-2). The selected attributes listed in Table 1 are applied to the ASNN for training. During the training process, the network involves eleven neurons (attributes) in the input layer, eight neurons in the hidden layer and one neuron in the output layer (Class attribute) for 100 set of data. Number of hidden neuron is varied for choosing the best performance of the network. Out of the different configuration tested, a hidden layer with 8 hidden neurons produced the best result for classification of classes of diabetes patients. Seed number is used in to start sequence of random numbers for initialization of neural network weights and partition of initial training set data on training/test sets. The architecture of neural network is shown in Table 3.

Table 2 Testing set with input parameters and output classification

S.No	Sex	Age	Fasting glucose	BP	Body Mass Index	Urea	Serum Insulin	PP glucose concentration	Heamoglobin	Glycosylated Hb	Serum Triglycerids	class
1	0	41	87	110	27	36	74	133	15.55	4	79	1
2	1	43	88	120	29	38	75	120	13.55	5	81	0
3	1	46	99	145	32	50	78	160	11.54	7	92	1

4	0	47	91	125	30	37	76	125	14.59	5	84	0
5	1	51	110	140	32	39	81	210	12.57	8	99	2
6	1	65	91	120	29	37	75	135	14.62	6	80	0
7	1	41	250	165	35	49	88	445	9.55	9	190	4
8	0	58	220	145	31	43	81	334	11.59	8	156	3
9	0	44	90	120	28	37	75	135	14.66	4	79	1
10	1	45	78	115	28	37	74	122	15	5	80	0
11	1	46	97	145	32	3	79	159	13.2	8	91	1
12	0	49	89	125	29	3	75	120	15.94	6	83	0
13	1	49	110	135	32	49	80	204	12.45	9	97	2
14	0	53	210	140	24	36	72	244	8.24	5	95	2
15	1	53	107	135	27	39	78	202	11.26	7	90	2
16	1	36	154	120	24	36	69	131	14.25	4	69	0
17	1	45	145	145	27	36	71	120	15.8	7	74	1
18	0	73	146	115	29	34	76	140	10.48	9	210	4
19	1	44	87	120	28	45	74	136	14.8	4	80	0
20	1	45	99	145	31	37	79	159	12.76	7	91	1
21	0	45	87	125	29	34	75	118	15.86	5	83	0
22	1	48	120	135	31	46	80	203	11.75	8	97	2
23	1	63	86	120	28	33	73	120	14.86	5	79	0
24	1	37	254	165	36	35	87	463	10.74	9	227	4
25	0	58	180	145	30	33	80	313	11.79	7	174	3
26	0	44	85	115	27	45	74	133	15.94	4	78	1
27	1	42	84	120	29	38	75	124	13.88	5	81	0
28	1	46	100	140	32	36	78	160	11.82	7	92	1
29	0	47	87	120	30	38	76	125	14.95	5	84	0
30	1	50	110	137	32	50	81	210	12.88	8	99	2
31	1	65	89	120	29	37	75	135	14.98	6	80	0
32	1	39	250	170	35	39	88	445	9.79	9	198	4
33	0	58	210	145	31	37	81	334	11.88	8	146	3
34	0	44	89	110	28	49	75	125	15.02	4	79	1
35	1	45	87	120	28	43	74	137	15.37	5	81	0
36	1	46	85	140	32	37	79	159	13.52	8	92	1
37	0	49	89	120	29	37	75	120	16.33	6	83	0
38	1	50	100	130	32	49	80	204	12.75	9	97	2
39	1	65	85	120	28	36	74	135	15.91	6	80	0
40	1	39	240	160	36	39	88	464	11.82	10	250	4
41	0	63	198	140	31	36	81	314	12.91	8	150	3
42	0	44	86	110	27	49	74	134	16.67	5	78	1
43	1	46	84	120	29	41	76	137	14.84	6	81	0
44	1	42	99	140	32	36	79	161	12.27	8	92	1
45	0	49	89	125	31	39	77	120	15.56	6	85	0
46	1	53	115	140	32	50	82	210	13.23	9	100	2
47	1	67	80	120	30	37	75	135	15.7	7	81	0
48	1	42	260	170	36	39	88	446	10.55	10	233	4
49	0	59	240	145	31	37	82	335	12.79	9	160	3
50	0	47	85	120	28	49	76	136	16.01	5	80	1

Table 3 Architecture and Specification of the generated ASNN

No. of nodes in the input layer	11
No. Of nodes in the hidden layer	8
No. of nodes in the output layer	1
Seed value	78
Activation function	Logistic 1/(1+exp(-x))

After the training process, the ability of classification of the model is estimated from an external set data not included in the training set. The test data includes 50 set. The test data is given as the input to the trained network and the output of the network is computed from the trained network. The computed classification of diabetic for 50 patients using ASNN is given in Table-2. From the Table-2 it is observed that 18 patients are normal class (class-0), 13 patients are mild class (class-1), 8 patients are moderate class (class-2), 5 patients are severe (class-3), 6 patients are chronic class (class-4).

For the mild diabetic (class-1) patients, regular and periodic exercise/physical activity is necessary to keep the diabetes under control. Class 2 diabetic patients (Moderate diabetic) will have symptoms of Polyuria, Polydypsia, weight loss, Polyphagia, Nocturia. In addition to regular and periodic exercise they have to take fibre rich, low calorie healthy diet. Regular intake of low dosage of oral hypoglycernic agents such as sulfonylurea, meglitinidems, biguanides, alpha-glucosidase inhibitors and thiazolidinediones is recommended to the diabetes under control [21]. Severe diabetic patients (class-3), will have symptoms paraesthesia (loss of feeling on feet and /or hands, diminution in urine quantity and poor vision. It will cause the renal failure, adult blindness, Micro vascular disease, neuropathy which affects tiny vessels such as those supplying the retina, nerves and the kidneys. By regular physical activities and constant exercises coupled with reduction of intake of sweets and by supplementation of anti hyperglycernic agents such as sulfonylureas, meglitinides, biguanides, alpha-glucosidase inhibitors and thiazolidinediones severe diabetes can be controlled. These drugs enhance antihyperglycernic actions and improve insulin sensitivity. (Medicine plus Medical Encyclopedia). Class-4 (chronic diabetes) patients have the risk of kidney failure. High blood pressure often goes along with diabetic nephropathy. If diabetic kidney disease is not treated properly it leads to dialysis or a kidney transplant. Diabetic coronary heart disease is dangerous in diabetic patients because the level of serum lipids are usually elevated which represents the risk of coronary heart disease. The chronic condition indicates a five times greater risk of developing micro vascular complication [22,23]. People with chronic diabetes need compulsory exercise and physical activity, diet control, regular and periodical check up of glucose, BP, BMI, Urea, Serum insulin Hemoglobin, Glycosylated HB, serum triglycerides. Further regular treatment of anti hyperglycernic agents and insulin injection is necessary to control chronic diabetes [24].

Performance evaluation

The accuracy of classification is evaluated by using four parameters squared correlation co-efficient (R^2), Mean square error (MSE), Root mean square error (RMSE) and classification accuracy. The mean squared error (MSE) is the average squared difference between outputs and targets. Lower values are better while zero means no error value. The squared correlation-co-efficient (R^2) measures how well the predicted values from the output of the network "fit" with the actual data. The value of R^2 lies between 0 and 1. A correlation co-efficient greater than 0.9, is generally described as strong model, whereas a correlation co-efficient less than 0.5, is generally described as weak model. High value of R^2 and low value of RMSE or MSE indicated a more stable model. The classification accuracy A_i of a model depends on the number of data items correctly classified and is evaluated by the formula:

$$Ai = \frac{t}{n} \times 100$$

Where t is the number of data items correctly classified and n is the total number of data items.

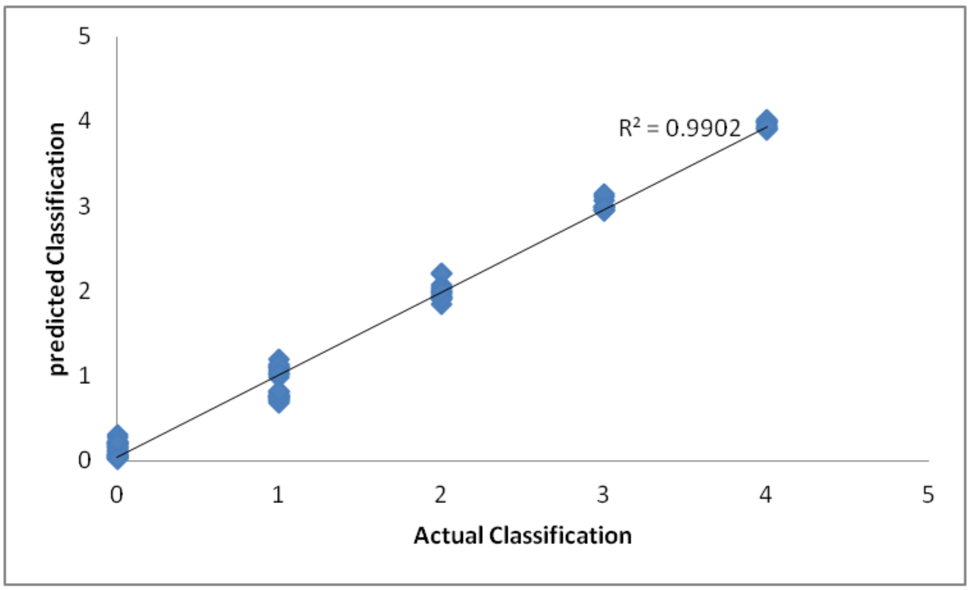

Fig 2. Actual vs predicted values of training set

The Root mean square errors of ASNN model for training and testing are 0.001 and 0.009 respectively. Squared correlation co-efficient (R^2) of 0.990 for training and 0.981 for testing confirms the suitability of the ASNN model and shows a good agreement of ASNN predicted values with experimental one. The percent correctly classified in the training and test set by the ASNN was 97 and 94 respectively. Fig 2 and 3 shows scatter plot of the ASNN predicted classification and Actual classification values (Diabetics patients) for training and test set.

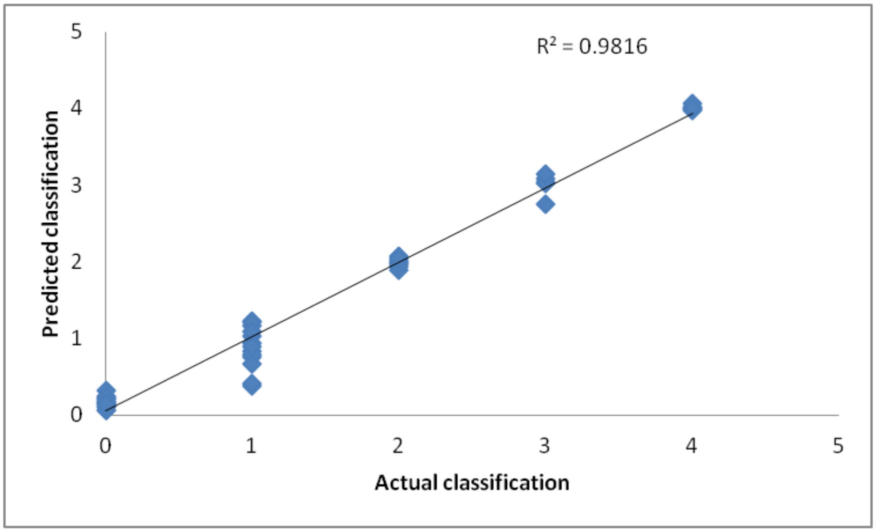

Fig 3. Actual vs predicted values of test set.

Internal validation

Table 4 Statistical results of ASNN with classification accuracy.

Mode	RMSE	MSE	R2	q2	Classification Accuracy (%)
Training	0.1206	0.09	0.99	0.955	97
Testing	0.1421	0.163	0.981	0.925	94

Cross-validation is a statistical method to evaluate the stability of developed models. In this study, the classification power of the models is checked by leave-one-out (LOO) cross-validation and the square of the cross-validated correlation coefficient (q^2) is used to measure the models classification ability. A good correlation is obtained with LOO correlation co-efficient q^2 =0.955 for training and 0.925 for testing. So the classification power of the ASNN model is very significant. The cross-validated results are included in Table 4.

CONCLUSION

In this study Associative neural network is used to construct a model for diagnosing and classifying the diabetic disease. The ASNN with 11-8-1 architecture produces low classification error. The results of this work indicate that it is possible to diagnosis and classify diabetic patients and give treatment accordingly. Associative neural networks have yielded scintillating outcomes in dealing with data represented in symptoms. It is also proved that the diagnosis and classification using the associative neural network is more ideal, dependable and trustworthy to the doctors for getting clinical clues and ideas regarding the therapy according to the severity of suffered patients. The results indicate 94% classification accuracy and R^2 of 0.981 for diabetic disease classification.

ISSN: 0975-8585

REFERENCES

[1] Wild S, Roglic G, Green A, Sicree R, King H. Diabetes Care 2004; 27: 1047-53.

[2] Burcelin R, Rolland E, Dolci W, Germain S, Carrel V, Thorens B. Ann N Y Acad Sci 1999; 875(18): 277-85.

[3] Ahmed N. Diabetes Research and Clinical Practice 2005; 67: 3-21.

[4] Tiwari AK, Madhusudana RJ. Current Science 2002; 83: 30-8.

[5] Asayama K, Nakane T, Uchida N, Hayashibe H, Dobashi K, Nakazawa S. Horm Metab Res 1994; 26: 313-315.

[6] Shepherd J. Atherosclerosis supplements 2005; 6(3): 15-9.

[7] Muragundla Anjaneyulu, Kanwaljit Chopra. Pharmacology 2011; 72: 42-50.

[8] Norsarini Salim. Medical diagnosis using neural networks, Generation5. 25th September 2004; 345-360.

[9] Dybowski R, Gant V. Clinical Applications of Artificial Neural Networks. Cambridge University Press, 2007, pp.789.

[10] [10] Maiellaro P, Cozzolongo AR, Marino P. Current Pharmaceutical Design 2004; 10: 2101-2109.

[11] Christos Stergiou and Dimitrios Siganos "NEURAL NETWORKS", April 2009.

[12] Carpenter GA, Markuzon N. Neural Networks 1998; 11: 323-336.

[13] Deng D, Kasabov N. On-line pattern analysis by evolving self-organizing maps. In Proceedings of the fifth biannual conference on artificial neural networks and expert systems (ANNES). 2001, pp. 46-51.

[14] Kayaer K, Yıldırım T. Medical diagnosis on Pima Indian diabetes using general regression neural networks. Proceedings of the international conference on artificial neural networks and neural information processing (ICANN/ICONIP) 2003; 181-184.

[15] Polat K, Gunes S. Digital Signal Processing 2007; 17(4): 702-710.

[16] Polat K, Gunes S, Aslan A. Expert Systems with Applications 2008; 34(1): 214-221.

[17] Tetko IV. Neural Processing Letters 2002; 16: 187-199.

[18] Freeman JA, Skapura DM. Addison Wesley Longman 1991; 87-97.

[19] Tetko IV, Villa AEP. Neural Networks 1997; 10: 1361.

[20] Jacek MZ. Introduction to Artificial Neural Systems, West Publishing Company, United States of America, 1992; 678.

[21] Chakrabarti R, Rajagopalan R. Current science 2002; 83(12): 1533-39.

[22] Gaede P, Vedal Parving H, Pederson O. Lancet 1999; 353(9153): 617-22.

[23] Viberti,GC, Hill RD, Jarrett RJ, Argyropoulos A, Mahmud U, Keen H, et al. Lancet 1982; 319(8287): 1430-32.

[24] Bell DSH, Ala MB. Southern Medical Journal 2002; 95: 24-30.