Soft computing to determine a Hemoglobin level of an early stage Multiple Myeloma patient by using Rectified Linear Units (ReLu) activation function

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Abstract— Artificial Intelligence (AI) has found various applications in many industries, from development of new alloys to cyber security and healthcare domain. By 2025 it is expected that the market for healthcare artificial intelligence tools will surpass 34 billion dollars. There is no doubt that the application of AI is going to lead to a real digital shift in traditional medical imaging, requiring AI and people to work together to meet the challenges of the medical industry. In our present work, we have tried to determine the hemoglobin level corresponding to Packed Cell Volume (PCV) and Red Blood Cells (RBC) count. In the Artificial Neural Network (ANN) architecture, PCV (%) and RBC count (mill/cumm) are the inputs while hemoglobin (g/dL) is the output. The result obtained is quite promising. Artificial Neural Network (ANN) trained on Rectified Linear Unit (ReLu) activation function showed 97.15% accuracy.

Keywords— Multiple Myeloma, Artificial Intelligence, Artificial Neural Network, Hemoglobin level

I.   INTRODUCTION

Multiple Myeloma gives arise to conditions like confusion, bone pain, restlessness, fatigue and loss of appetite. About 60 % of people who are diagnosed with multiple myeloma often experience fatigue due to low Red Blood Cell (RBC) count. The proper term for the low count of these cells is Anemia.

There are different factors which often lead to Anemia condition. Some people suffer from Anemia due to some disease that causes bleeding. Other factor could be the decrease in the production of RBC from the respective Bone marrow. Multiple Myeloma and Anemia go hand in hand. Multiple Myeloma indicates the overgrowth of the plasma cells count in the bone marrow as can be seen in the Figure 1.

Too many of these cells pile up and decrease the number of normal blood forming cells. This further leads to low RBC count. RBC contains hemoglobin which carries oxygen from the lungs to the different parts of the body. Anemia can be diagnosed if the person's hemoglobin level is below normal. Normal hemoglobin level foe women is 12 to 16 grams per deciliter (g/dL) while for men it is 14 to 18 g/dL.
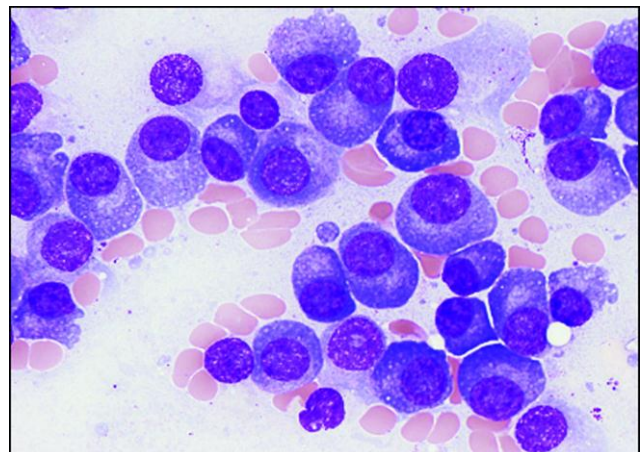

Figure 1: Bone marrow touch preparation showing mature and immature plasma cells, one of which is binucleate.

Multiple Myeloma treatment like chemotherapy and exposure to radiation also may cause a low blood count. Now let's talk about Packed Cell Volume (PCV). The mixture of cells and plasma constitute the blood. So, the PCV is a measurement of the proportion blood that is made up of cells as shown in the Figure 2. PCV is also called Hematocrit.
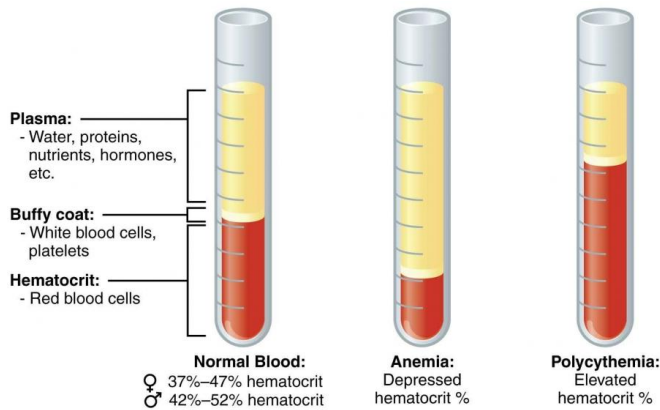
Figure 2: Representation of Packed Cell Volume.

The value of PCV is expressed as a % or fraction of cells in blood. For example, a PCV of 60 % means that there are 60 milliliters of cells in 100 milliliters of blood.

PCV is directly proportional to the number of RBC i.e. it increases with the increase in the number of RBC or when the total blood volume is reduced, as in case of dehydration. On the other hand PCV falls to less than normal value, when the person's body decreases its RBCs production which arise Anemia.

In our present work, we have trained Artificial Neural Network to determine hemoglobin level by using ReLu activation function in addition to 1000 epochs and adams as an optimizer.

II. RELATED WORK

Nowadays, the use of agent-based intelligent decision support systems (IDSS) in order to support decision making plays a vital role within the medical industry. The main reason is that they allow doctors and other medical staffs to quickly gather information and process it in various ways in order to assist with treatment decisions and making diagnosis [1]. In order to discuss and deliberate on practice, policy, and patient care and other health problems related to the introduction and implementation of AI in imaging, Canadian Association of Radiologists (CAR) has created an AI working group [2]. Soni et al. [3] provided a vivid survey of current techniques of knowledge discovery in databases using data mining techniques that are in use in today's medical research particularly in Heart Disease Prediction. Lo et al [4] also developed a double-matching method and an artificial visual neural network technique for lung nodule detection. The artificial convolution neural network acted as a final classifier to determine whether the suspected image block contains a lung nodule. They concluded that the proposed convolution neural network and its associated training techniques are useful tools for direct assistance in many diagnostic imaging areas such as micro-calcification detection and mass evaluation in mammography and interstitial lung disease pattern recognition in chest radiography.

III. METHODOLOGY

Complete Blood Count (CBC) test is done to determine haemoglobin level in person's body. A hemoglobin test may be used to:

- Screen for, diagnose, and measure the severity of anemia (low RBCs, hemoglobin and hematocrit) or polycythemia (high RBCs, hemoglobin and hematocrit)
- Monitor the response to treatment of anemia or polycythemia
- Help make decisions about blood transfusions or other treatments if the anemia is severe
- Determine eligibility for blood donation

For haemoglobin test, a blood sample is usually drawn from a vein or by a fingerstick (children and adults) or heelstick (newborns) as shown in Figure 3.

Figure 3: Blood sample of a patient collected for CBC test

In the present work, we have used 42 CBC test reports of the same patient who suffered from an early stage multiple myeloma condition. The dataset as shown in the Figure 4 are written down in excel spread sheet and is further converted to .csv file. Python programming language is used for coding purpose on Google Colaboratory platform. 80% of the dataset is used for training the Artificial Neural Network (ANN) while 20 % of the dataset were used for testing purpose. The schematic diagram of the architecture of ANN is shown in the Figure 5. It is clearly observed that the Artificial Neural Network does the sum of products of inputs(X) and their corresponding assigned weight(W) and applies an Activation function f(x) to it to get the output of that layer and feed it as an input to the next layer. In our present work we have used 2-4-8-1 ANN architecture. The main function of an activation function is to convert an input

signal of a node in an Artificial Neural Network to an output signal. Activation function basically introduces a non-linear property in the Neural Network. We can say that an ANN without any activation function is just a Linear Regression Model.

◢	A	B	C	D
1	PCV %	RBC Count (mill/cumm)	HB (g/dL)	
2	33.6	3.54	10.5	
3	30.6	3.46	9.9	
4	29.1	3.34	9.3	
5	28.9	3.3	9.3	
6	29.1	3.34	9.5	
7	21.5	2.46	7.1	
8	32.1	3.7	10.4	
9	30	3.41	9.6	
10	31.6	3.51	10	
11	30.1	3.37	9.5	
12	27.3	3.09	8.7	
13	24.8	2.73	8.3	
14	24.4	2.62	8.3	
15	26.5	2.81	8.4	
16	31.1	3.23	9.6	
17	25.1	2.67	7.6	
18	25.2	2.82	8	
19	24.8	2.85	8	
20	26	2.95	8.3	
21	31.9	3.58	9.9	
22	30.4	3.46	9.7	
23	28.6	3.15	8.9	
24	33.9	3.82	10.8	
25	33.2	3.7	10.4	
26	32.5	3.63	10.5	
27	31.9	3.59	10.2	
28	31	3.49	9.8	
29	29.8	3.34	9.6	
30	31.2	3.49	9.9	
31	31.2	3.44	9.8	
32	29.3	3.16	8.8	
33	29.3	3.23	9.1	
34	29.3	3.18	8.9	
35	29.7	3.21	9	
36	28	3	8.4	
37	32.3	3.51	10	
38	29.8	3.07	9.3	
39	27	2.91	8.3	
40	26.6	2.84	8.4	
41	26.6	2.78	8.1	
42	26	2.77	7.9	
43				

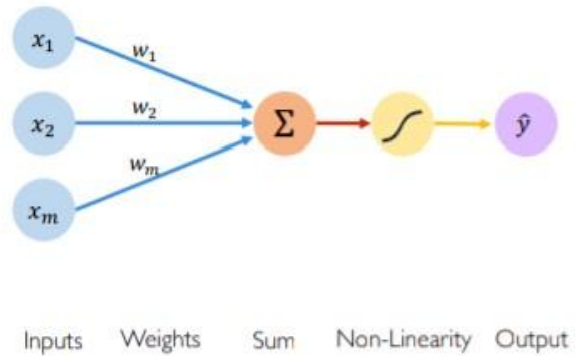Figure 4: CBC dataset of the patient

Figure 5: Architecture of an Artificial Neural Network (ANN)

In this recent work, ReLu is used as an activation function. In past couple of years it is observed that ReLu has become very popular. Nowadays, all deep learning models use ReLu as an activation function. ReLu results 6 times more improvement in convergence than Tanh function. The mathematical form of this function is just $R(x) = max(0,x)$ i.e if $x < 0$, $R(x) = 0$ and if $x >= 0$, $R(x) = x$. We can see that it is very simple and efficient mathematical function. The graphs of various types of ReLu activation function is shown in the Figure 6.
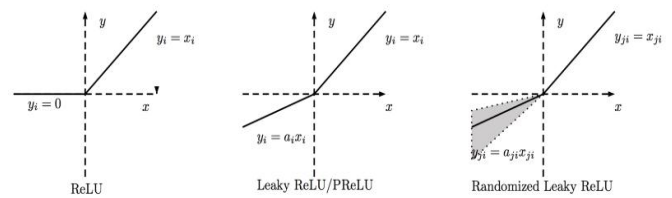

Figure 6: Various types of ReLu activation function

IV.   RESULTS AND DISCUSSION

Correlation coefficients between variables are shown by a Correlation matrix. This data representation method is used as a way to summarize data, as an input into a more advanced analysis, and as a diagnostic purpose for advanced analysis. The correlation matrix obtained from the experimental dataset is shown in the Table 1.

Table 1: Correlation matrix

	PCV (%)	RBC(mill/cumm)	HB (g/dL)
PCV (%)	1.00000	0.95767	0.96262
RBC (mill/cumm)	0.95767	1.00000	0.96992
HB (g/dL)	0.96262	0.96992	1.00000

Figure 7 shows the heat map obtained from the experimental dataset. In order to get more generalized view of numerical values, heat maps are used.
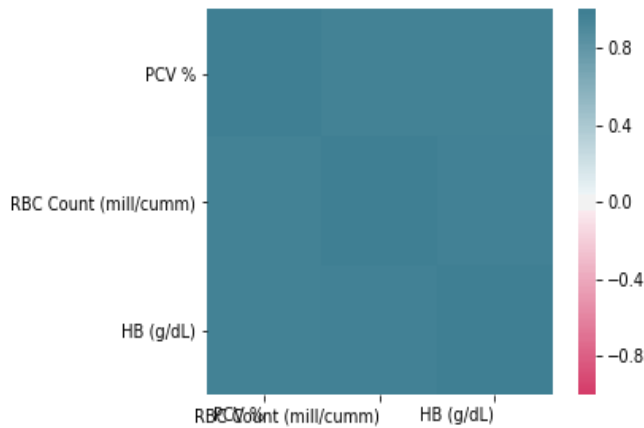

Figure 7: Heat Map of the experimental dataset

The dependency of hemoglobin (HB) on RBC count and PCV is shown in the Figure 8, Figure 9 and Figure 10.
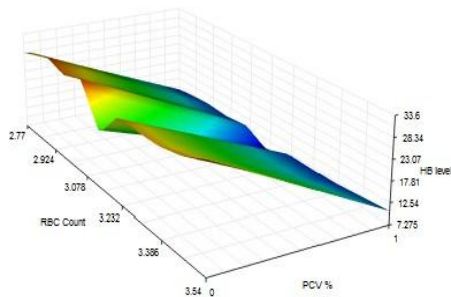

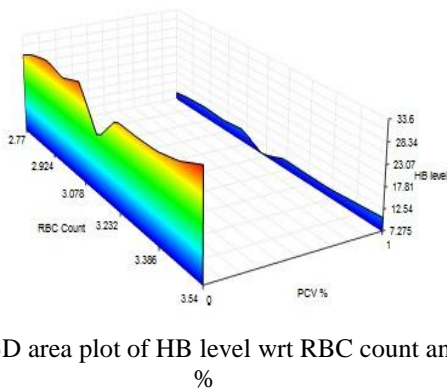Figure 8: 3D surface plot of HB level wrt RBC count and PCV %

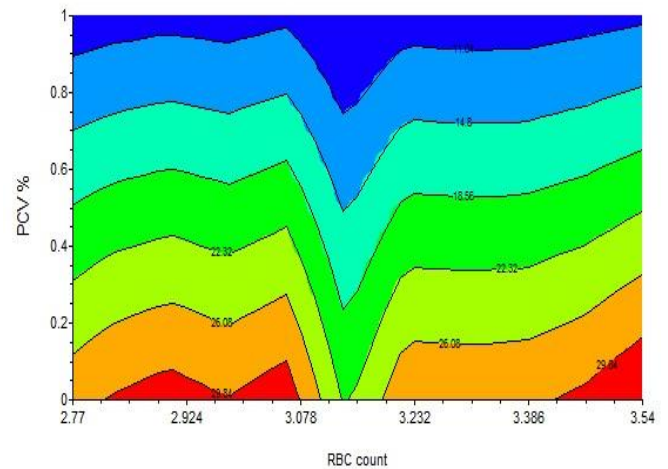Figure 9: 3D area plot of HB level wrt RBC count and PCV %

Figure 10: Contour plot of HB level wrt RBC count and PCV %

The accuracy % obtained after training and testing the given experimental dataset is 97.15 %.

V.   CONCLUSION AND FUTURE SCOPE

The main purpose of the paper is to apply the Artificial Intelligence based technique in the healthcare domain. It was observed that the accuracy obtained by the given Artificial Neural Network architecture is 97.15 %. So it is worth to say that the Artificial Intelligence (AI) technology learns from the old experimental dataset and predicts the output for the given dataset. More number of datasets used for training the ANN will result more accuracy in the output generated. We can think of AI as a "decision engine" which can exponentially increase the efficiency of healthcare organization.

So it can be concluded that the potential of artificial intelligence is difficult to ignore. The number of successful case studies and examples will continue to grow as we look toward the future, for the integration of AI in healthcare.

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Authors Profile

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