

# Performance Analysis and Enhancement of HealthCare Customer Relationship Management System

An innovative threshold to Medical Science

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**Abstract**—The CRM is defined as customer relationship management (CRM) is a process of interaction with the present and targeting future customers to improve organization quality, reliability, service, marketing, sales and revenue. Handling customer service is key challenge in current business world. Healthcare system moves to the value-based care, the importance of engaging patients and families continuously intensify. However, simply engaging patients and families to improve their subjective satisfaction will not be enough for providers who want to maximize value. Hence, it's a crucial need for development of a retrieval and prediction system to manage the patient data and software as a service approach with prediction system. Two machine learning predictive algorithms such as Support Vector Algorithm and Convolutional Neural Network Algorithm are thoroughly analyzed and used in this work. these two algorithms are combined in order to develop predictive CRM model. This predictive CRM model is applicable for all type of diseases. This research focus on breast cancer and gives 94% prediction accuracy and increases precision of 92% which leads to increase the performance of my predictive model. This research focuses on maintaining the data of patients and by analyzing and future predicting the data, the predictive model gives the prediction of diseases as early as possible this will help the patients and doctors to diagnose the disease as early as possible.

**Index Terms**—HealthCare, CRM, SVM, CNN, Predictive Model.

## I. INTRODUCTION

It is obvious that there is a change in pattern in every essence. Companies have started to maintain their customers rather than to have new customers and ensuring customer satisfaction at the same time creating an expression that the supplier will be able to fulfil his/her daily needs. It also reflects on the comfort and confidence the supplier can give to it's customers so that they can respond back in a better way. Suppliers can also have a pre-look on how business used to take place in olden days and move forward aiming profit by acting accordingly to the present scenario in terms of Customer Relationship Management. BUTTLE said, "CRM is clearly a business practice mainly focused on customers". At the same time, KERR and ANDERSON points CRM as a

master plan or a master tool which helps the companies to adapt with the changing marketing scenarios. Accordingly, CRM is important as it helps in building customer bonds. Customer Relationship Management means different for every person at different situations. While some people refer to CRM as Customer Relationship Management, others refer it to as Customer Relationship Marketing. DEANS mentioned that CRM helps companies to build and maintain long-term relationship with their customers. Researchers approved that by applying the method of CRM, customer service and satisfaction can be improvised and loyalty will be provided. CRM is an alternative to show off a company's products, goods and services. Companies concentrate on profits by implementing CRM. This helps companies by ensuring that the customers maintain contact with the companies [6].

Since years, commercial businesses are enjoying the profits by implementing CRM. Customers started to show active interest towards the companies who understand them well. On the other hand, CRM also in hands of the customer as the system completely depends on the customer response. The accurate meaning of Relationship Marketing was given by GRONROOS. They defined it as, "To establish, maintain and to enhance relationship with customers and other partners, at a profit, so that the objectives of the parties involved are met.

This is done by a mutual exchange and fulfillment of promises". Last, but not the least, it is customer bonding that helps companies to realize customer satisfaction. According to DEANS, customer loyalty, customization, community building and unique services with branding leads to more reliability of the companies. CRM's customer strategy is aimed only for gaining profit. In medicinal field, CRM plays role in maintaining the records of the patient's illness and entire details of a particular person.

The main challenge faced by the companies in the present age of freedom and globalization is to keep healthy relationship with the customers. In olden days, companies considered customers as granted, as at that age, customers didn't demand or had the need for alternative sources for

products. At those times, the companies only had very less commitment to the customers. But now, the situation has entirely changed. The variation in business environment is classified into many, like, economic liberalization, rising competition, high consumer choice, a well-educated consumer, more attention on the quality and value of purchase etc. Present marketing aims more than developing a product, pricing the product, promoting the product and availability of products to the consumers. CRM demands building bonds and a value added relationship with the customers to win their hearts. Nowadays, the companies aim at winning the consumer's hearts permanently by valuing the customers, designing products to suit their needs and developing life time customers through the principle of customer delight, approval and enthusiasm. Patient's needs are most important for the hospitals. Personal contacts and relationships are very necessary in healthcare environment. As there is more demand for healthcare in the present situation, it is considered as a rising industry. At present, the concept of health care has changed from health consciousness to health sensitivity. CRM in a hospital is a business strategy to maintain customers for a long time. CRM requires needs a customer-focused business philosophy and background to maintain strong marketing, sales and servicing processes. Developing relations with customers may be easy but maintaining it is a must. CRM is a "chain relation" set off with new strategic initiatives rather than by that which one can initiate at work process, or lower, at the technology level. From a view of a small competition, this is the main reason for the hospital's survival. With the effect of CRM, hospitals offer better services at higher rates for patients [8].

The main objectives of this Research are to explore the efficient usage of CRM in healthcare system with Big data analytics and explore the functional and non-functional requirements to deal in order to achieve high performance of predicting the diseases.

**II. DESIGN MODEL OF HEALTHCARE CRM**

The design of CRM health care system with big data is discussed. Design issues and architecture of CRM and prediction system are presented in detail. The various modules in the health care system is also discussed.

Design is the crucial step in the development phase of any engineering product or system. The primary objective of the design phase is to create a design that satisfies the requirements of the application to be developed thus making it a crucial in the overall product or service development process. In this phase various techniques and principles are applied I detail to permit the physical realization of the proposed model, product, application service etc.

System architecture is the highest-level concept of any system in the environment. The architecture of a system (at a given

time) is its organization (health care) or structure of significant components (such as CRM, Patients, Predication system) interacting through interfaces, those components being composed of smaller components, sub-systems or even systems and interfaces [5].The architecture consists of three modules as shown in below figure.1) Patients Module.2) Health care system module.3) Prediction system.

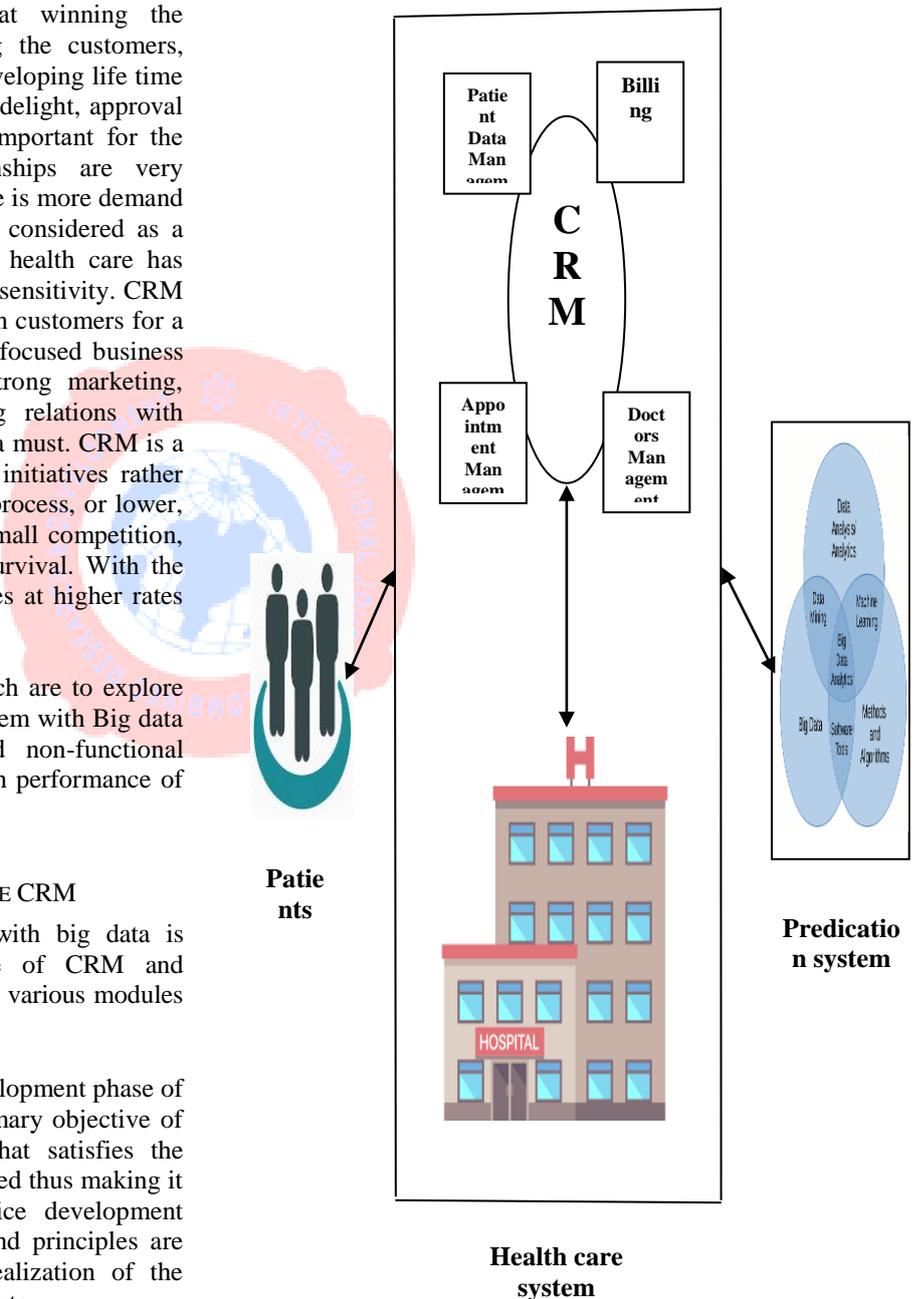


Figure 1: Health care CRM system architecture

**Patients:**The patient is the person who is suffering from diseases and that person requires medical care. Patient identification is a key issue for medical record services. To identify the particular patient in the country, there is a need to identify Unique patient characteristics. Some of the unique patient characteristics are (i) a national identification number (ii) a social security number (iii) date of birth (iv) health insurance number (v) mother's maiden name (vi) mother's first name(vii) father's first name(viii)in case new born babies, finger print or foot print will take as unique patient characteristics. The person age will not consider because it will change, and the address of patient will not consider unique patient characteristics. In this research, patients are referred to those who are suffering from various diseases, but it focuses mainly on cancer patients.

**Healthcare System:** Healthcare system includes all organizations, people and actions whose primary goal is to promote, regain or maintain health. This contains endeavor to influence determinants of health as well as more direct health-improving activities.

Some of the health care services provided to the patients

- 1) Without discrimination on the sex, race, age, religion, ethnicity, disability, creed, colon, national origin, marital status, nationality, atypical hereditary cellular or blood trait, sexual orientation, gender identity or expression, veteran status, in sum or substance, 'any other category protected by state or federal law' ability to pay, or source of payment. The healthcare system should provide treatment and services.
- 2) If the patient is in critical condition, the healthcare system should give the information to one of the given family members or to a guardian whose is responsible of that patient.
- 3) The healthcare system should be informed in writing to the patients that (i)The services available in the hospital. (ii)Gives information regarding filing the complaints if the service is not good.
- 4) Receive enough time before discharge to decide for health care needs after hospitalization.
- 5) The health care system should be assured that the patient's details will not share with third party .so that the health care system maintains confidentiality of patient details.
- 6) To be transferred to another facility only for one of the following reasons, with the reason recorded in the patient's medical record: (i) The transferring hospital

is unable to provide the type of level of medical care appropriate for the patient needs. The hospital shall make an immediate effort to notify the patient's primary care physician and the next of kin, and document that the notifications were received or (ii) The transfer is requested by the patient or by the patient's next of kin or guardian when the patient is mentally incapacitated or incompetent. In this research, the healthcare system collects the information from the patients and stores in his database as dataset.

**Prediction System: Complexity** in a prediction system is its built-in characteristic. Rules are formed manually in Prediction systems. As the number of inputs grows the rules become more complicated and it leads to more difficulty in predicting an event. Application of Engineering technology and mathematical models helps to build a prediction system that could adapt to the increasing number of inputs and frame rules accordingly. The accuracy and speed obtained is accurate compare r to manual prediction schemes.In this research, Prediction system directly interacts with healthcare CRM; it fetches the patient dataset from healthcare system and predicts future event based on the current uncertain knowledge.

**A. Context Model of Prediction System**

Context diagram is a high-level view of a system. This diagram defines the boundary between system, or part of the system and its environment, showing the entities that interact with it. Context diagram can be developed with the use of 2 building blocks a) Entities b) Relationships, shown in below figure.

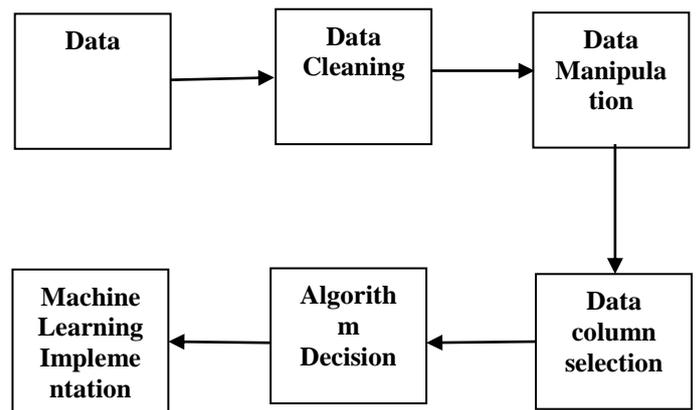


Figure2: Context model of Predication System.

The data collected from UCI repository contains noises so that there is a need to clean the data in the dataset. Data pre-processing is mandatory before applying the data mining techniques. Data cleaning is a method of eliminating noisy data present inside the dataset (database). The purpose of cleaning data is to avoid unpredictable results. If data is inconsistent in the database, we will call these data as noisy data. In order to conduct data analytics in a right way we need various data cleaning techniques after that only data is ready for analysis. Nearly, 20% of time spent for analyzing the data remaining 80% of time spent for cleaning the data. By using Data Wrangling tools data cleaning is going to be performed as batch processing customers [4].

In data cleaning methods shown in fig 3.3, carries the following steps.

- 1) Copy all data from dataset to excel.
- 2) Remove all trailing spaces and extra spaces between the words, if the data contains extra spaces between words these types of data can be cleaned by using Trim function. Trim function takes one single argument which could either be the text or it could be the cell reference.
- 3) Fill all blank cells with some appropriate text. This is difficult to do manually, because so many blank spaces will be there in huge dataset. So to do this, first select entire dataset and then go to find and select option and then select special button, click on blank radio button and then select ok. So, it will replace entire blank spaces with some appropriate text.
- 4) Convert numbers stored as text into numbers.
- 5) By using conditional formatting, remove all duplicates.
- 6) Highlight the identified errors and change text to lower/upper/proper case.
- 7) Finally check the spellings and delete all formatting.

Data manipulation is one of the low-level data analysis techniques. Data manipulation works well for unstructured data present inside the dataset. When the user is not sure where to begin, begin with data manipulation. In order to find an event occurred at first time we need to sort our data chronologically. To identify the data from highest to lowest values, the data is going to be sorted numerically. Data manipulation operations are i) Row and Column Filtering ii) Aggregations iii) Join and Concatenation iv) Transformation like replacement, conversion, standardization and new feature generations [8].

- i) Row and Column Filtering: Filtering is used to create a subset of data from a huge data set according to the requirements. This can be done in excel by using auto filter under the data tab. Without using

formulas, filters allow us to do a lot of tasks. Filters will provide the data only for visualization it will not allow the user to alter the data.

- ii) Aggregations: Aggregation methods are going to apply for groups and subgroups of data. Groups and subgroups of data is identified by the values of dataset features like column names.
- iii) Join and Concatenation: In order to extract data from multiple datasets there is a need to join multiple datasets by using common attributes between the datasets.
- iv) Transformation: Data transformation is nothing but transforming the data from one format to another format. Data Transformation strategies are a) Smoothing b) Aggregation c) Generalization d) Normalization e) Attribute construction.

### III. IMPLEMENTATION AND RESULTS OF PROPOSED MODEL

The implementation and results of proposed model are discussed in detail. Prediction of diseases and Comparison model to predict different types of cancer diseases using different algorithms are explained. Support vector regression and Predicted positive and predicted negative manifested with associated graph.

In this research, I have combined two algorithms for the prediction of any diseases. The two algorithms are

- (i) Support vector machine algorithm (SVM).
- (ii) Convolutional neural network (CNN) using back propagation.

Support vector algorithm is a supervised well-trained machine learning algorithm which is mainly used for classification problems. In this research, SVM algorithm is used to classify the data obtained from the results of objective 1. SVM uses the technique called kernel trick. The kernel trick is a function which can transform low dimensional input space and transform it to a higher dimension space generally called kernel trick technique as kernel function.

The main drawback of SVM algorithm is for large dataset SVM doesn't perform well and SVM doesn't perform well when noise is more on the dataset and SVM directly doesn't provide probability estimates. To overcome the drawbacks of SVM, I combined convolutional neural network algorithm with SVM.

CNN is a part of artificial neural network which is mainly used for predictive modeling is used generally in such a case where what has happened in past is repeated almost exactly in same way. CNN will perform multiple recalibrations for each weight in the linkage so it will take less time for calculation of

weights for even large data volume. Recalibration of weights is an easy but a lengthy process. Recalibration is a function to calculate error rate on output nodes.

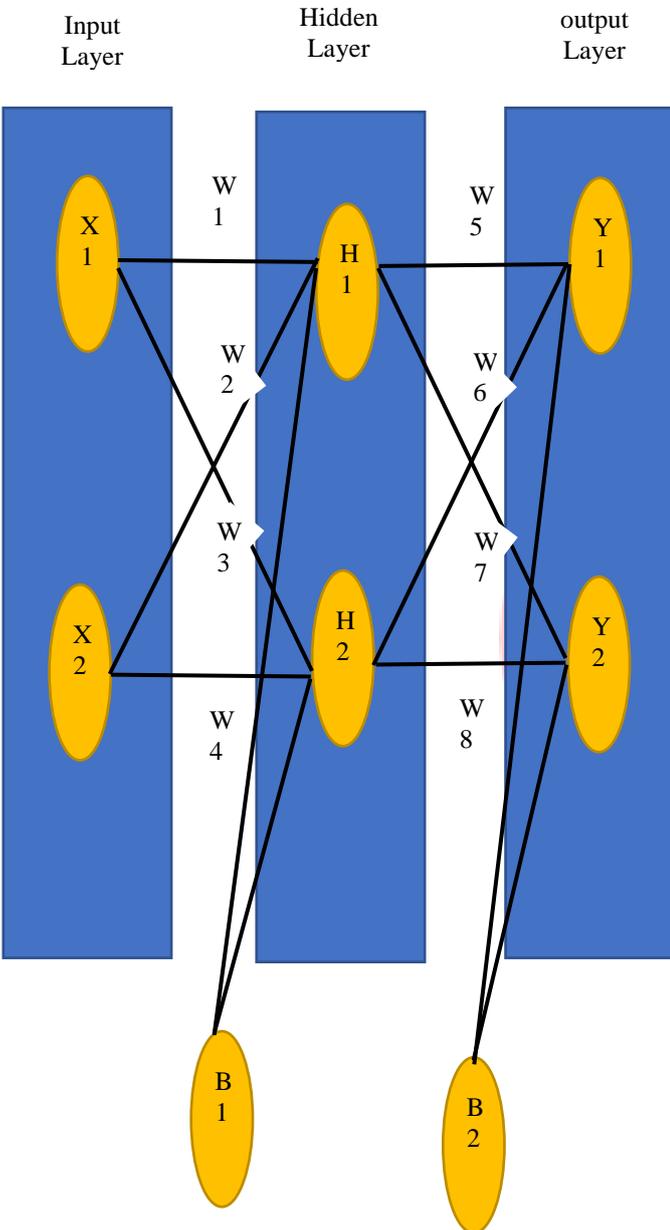


Figure 3: working of predictive model.

The output of hidden layer and working model of predictive model as shown in figure 3.

$$H1 = x1 * w1 + x2 * w2 + b1$$

Apply activation function on H1, the output of activation function is

$$H1 = \text{sigmoid} = 1 / (1 + e^{-H1})$$

The neural network works,

(1) I will initialize all the weights and biases randomly.  $x1$  and  $x2$  are the input values and our target values are nothing but output values that is  $y1$  and  $y2$ . these values also defined early.

(2) I will calculate for H1, so

$$H1 = x1 * w1 + x2 * w2 + b1$$

And then calculate activation function for H1, So

$$H1 \text{ output} = 1 / (1 + e^{-H1})$$

(3) repeat for H2, so

$$H2 = x1 * w3 + x2 * w4 + b1$$

And the activation function is

$$H2 \text{ output} = 1 / (1 + e^{-H2})$$

Now, I got H1 and H2 values.

By using H1 and H2 values we will calculate  $y1$  and  $y2$ , For calculating  $y1$ ,

$$Y1 = H1 \text{ output} * w5 + H2 \text{ output} * w6 + b2$$

Apply activation function on  $y1$ , so

$$Y1 \text{ output} = 1 / (1 + e^{-y1})$$

Similarly, for calculating  $y2$ ,

$$Y2 = H1 \text{ output} * w7 + H2 \text{ output} * w8 + b2$$

Apply activation function on  $y2$ , so

$$Y2 \text{ output} = 1 / (1 + e^{-y2})$$

Now, outputs of  $y1$  and  $y2$  are available. Compare  $y1$  and  $y2$  with target values. If the output values are matched with target values then stop the process and gives the results. If the output values are not matched with target values then we calculate error.

For calculating error,

$$\text{Error total} = \sum 1/2 (\text{target} - \text{output})^2$$

Apply this formula for calculating total error

$$\text{Error total} = 1/2 (t1 - Y1 \text{ output})^2 + 1/2 (t2 - Y2 \text{ output})^2$$

Now, I got total error at  $y1$  and  $y2$ , so we have to propagate back for updating weights

Now, I will calculate error at  $w5$

The formula is,

$$\text{Error at } w5 = \Delta \text{error total} / \Delta w5$$

$$\Delta \text{error total} / \Delta w5 = (\Delta \text{error total} / \Delta y1 \text{ output}) * (\Delta y1 \text{ output} / \Delta y1) * (\Delta y1 / \Delta w5)$$

After getting the result of  $\Delta\text{error total}/\Delta w_5$ , next I want to update  $w_5$ .

For updating  $w_5$ , the formula is

$$W_5 = w_5 - \eta * \Delta\text{error total} / \Delta w_5$$

Here,  $\eta$  is nothing but learning rate, this will contain a value between 0 and 1. In this research, I took 0.5.

In the similar way, I will calculate  $w_6, w_7$  and  $w_8$ .

In the next step, I want to update  $w_1, w_2, w_3$  and  $w_4$ .

Now at hidden layer, for updating  $w_1$ .

Error at  $w_1 = \Delta\text{error total} / \Delta w_1$ ,

$$\Delta\text{error total} / \Delta w_1 = (\Delta\text{error total} / \Delta H_1 \text{ output}) * (\Delta H_1 \text{ output} / \Delta H_1) * (\Delta H_1 / \Delta w_1)$$

These results are used to update  $w_1$ , so

$$W_1 = w_1 - \eta * \Delta\text{error total} / \Delta w_1$$

In similar way, I have updated  $w_2, w_3$  and  $w_4$ .

After /updating all weights, again I perform operation in forward direction and then calculate  $y_1$  and  $y_2$ .

After getting the results of  $y_1$  and  $y_2$ , compare these results with target values.

If the output values of  $y_1$  and  $y_2$  are exactly or near to the target values, then we stop the process and gives the results.

If the output values of  $y_1$  and  $y_2$  are not same as target values, then the process repeats until output values exactly or near to the target values. so this will increase the accuracy and the precision.

The support vector regression (SVR) uses the same principles as the svm. The goal of SVR is to minimize the error, individualizing the hyperplane which maximizes the margin.

Figure 4: outcome of support vector regression.

In below graph, it describes prediction accuracy against patient data samples. In the graph there are three output lines one is high another one is low and third one is actual output. High indicates predicted positive and low indicates predicted negative. The predicted positive of the model is high compared to predicted negative which is indirectly increases the accuracy of the prediction model because it coincides with actual output shown in figure 5.

PATIENTS RECORD IN KILO	HIGH	LOW	OUTPUT
10	93	90.1	93.6
20	93.1	91.1	93.7
30	93.9	92	94
40	93.7	84.6	93.9
40	93.8	90.1	94
60	93	89.2	93.8

Table 2 output of proposed predictive model

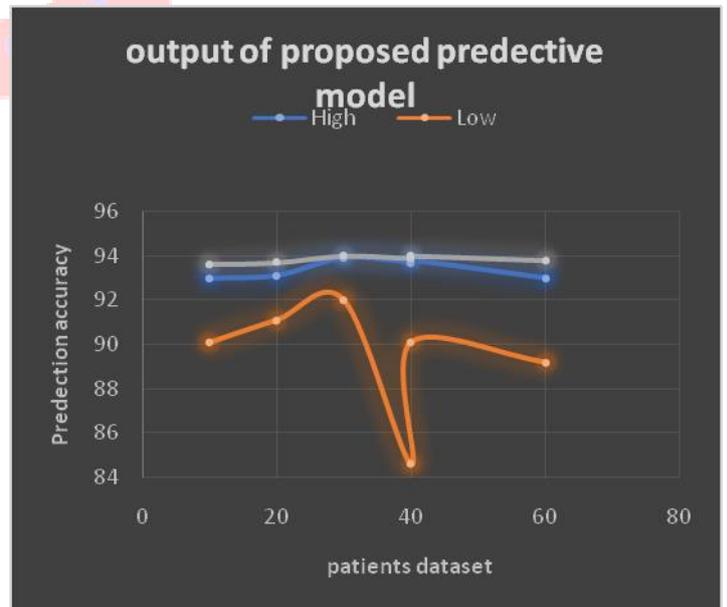
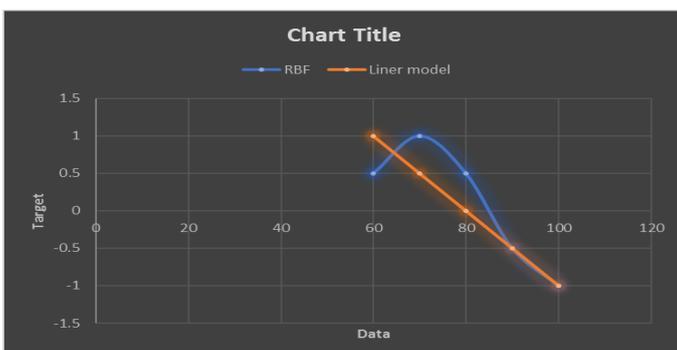


Figure 5: output of proposed predictive model..

Dataset	RBF	Liner model
60	0.5	1
70	1	0.5
80	0.5	0
90	-0.5	-0.5
100	-1	-1

Table 1 support vector regression



#### IV. CONCLUSION

In this research, I focused on the development of predictive CRM model using supervised machine learning methods. I have used two machine learning predictive algorithms in this research. The first algorithm is Support Vector Algorithm and the second algorithm is Convolutional Neural Network Algorithm. The Convolutional Neural Network Algorithm comes under artificial neural network. I combined these two algorithms in order to develop predictive CRM model. I have taken one case study called breast cancer. This predictive model gives accuracy of 94% and also increases precision which leads to increase the performance of predictive model.

This Predictive model can provide accurate results in predicting of any diseases. In this research I have taken one case study that is the prediction of cancer diseases. Based on experimental results, I got 94% of accuracy and 92% precision of predictive model. In this research, I have taken accuracy and precision are the two performance parameters. This predictive model is best based on the performance parameters of accuracy and precision to any other predictive model.

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