# High Blood Pressure Prediction based on AAA++ using J48 Algorithm

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***Abstract:*** **The heart pumps the blood around the body to supply energy and oxygen for all the tissues of the body. In order to pump the blood, heart pushes the blood against the walls of arteries, which create some pressure inside the arteries, called as blood pressure. If this pressure is more than the desired level we treat it as high blood pressure (HBP). Present days HBP victims are growing in number across the globe. Blood Pressure (BP) may be elevated because of the change in biological or psychological state of a person. In this paper, we considered attributes such as age, anger, and anxiety (AAA) and obesity (+), cholesterol level (+) of a person to predict whether a person is prone to HBP or not. Obesity and cholesterol levels are considered as post-increment of AAA, where obesity as one +, and total blood cholesterol as another + because experimental results reveal that their impact is less comparatively AAA. In our technique, we used different classifiers, where each classifier considers the impact of each A in AAA along with obesity and cholesterol level of a person in predicting the blood pressure. Experimental analysis is done on real-time data set. It consists of 1000 records which are collected from Doctor C, a Medical Diagnostic center, Hyderabad, India. Each record consists of age, anger level, anxiety level, obesity level, total blood cholesterol level and systolic blood pressure (SBP), diastolic blood pressure (DBP) of a person. We used 60% records to train the model, and 40% records to test the model.**

***Index Terms:*** **Blood Pressure, Stress, Age, Anxiety, Anger, Obesity, Blood Cholesterol, Hypertension**

## I. Introduction

BP is represented as SBP over DBP. If SBP exceeds 140 mmHg or DBP exceeds 90 mmHg on repeated measurements then it is treated as HBP [3]. Nowadays HBP is one of the prime cause of heart stroke and brain stroke. It may not be a serious problem if it is diagnosed and treated earlier, but undiagnosed HBP may cause a serious health problem. There are many reasons which may elevate the BP, like unhealthy diet, lack of physical exercise, excess bad cholesterol, obesity, age, anger, anxiety etc [5][9]. But in this paper, we focused on the impact of age, anger, anxiety, obesity level and total blood cholesterol levels in elevating the BP. Data is collected from a group of 1000 people aged between 20 and 65. High Blood pressure (HBP) mainly affected by the Cardiac Output (CO) and Total Peripheral Resistance (TPR) [2]. Mathematically, it can be written as

$$BP = CO * TPR \qquad (1)$$

Here, CO is affected by increased venous return or Stroke volume or Heart Rate or Sympathetic activity [1]. Whereas, TPR is affected by the resistance that acts against the blood flow in the arteries [10]. The arteries may show resistance to blood flow because of a blood clot in blood vessels or presence of fat inside the blood vessels or damaged blood vessels. CO affects the SBP, whereas TPR affects the DBP [12].

$$BP = Systolic/\ Diastolic \qquad (2)$$
$$Systolic\ /\ Diastolic = CO\ /\ TPR \qquad (3)$$

TABLE I.
Blood Pressure Range

| BP | Low | Normal | Borderline | High |
|---|---|---|---|---|
| Systolic | <90 | 90-130 | 131-140 | 140 |
| Diastolic | <60 | 60-80 | 81-90 | >90 |

We collected age, obesity level, and total blood cholesterol levels of persons from Doctor C, A medical Diagnostic center Hyderabad, India. Although stress, anger, and anxiety may not spike blood pressure for a longer duration of time [1], but uncontrolled anger may affect relationships, career, mental and physical health. Anger and anxiety levels are measured using the response of an individual for the set of predefined questions. For anger measurement, we set 10 predefined questions and for anxiety measurement, we set 20 predefined questions. 1000 people were interviewed and their response is noted on a scale of 0 to 3. The mean value of the response, for all the questions on anger and anxiety, is used in the prediction process along with age, obesity and total blood cholesterol levels. Table I represents the level of Hypertension [3][14].

## II. Impact Factors

Blood pressure of a person is elevated because of biological and psychological changes. Biological changes are like age, increase in obesity level and total blood cholesterol. Psychological changes like anger, anxiety, stress, depression, and fear. But the exact influence of each of these factors is left for research. In this paper, we considered AAA to predict whether a person is prone HBP or not. The rest of this section discusses how each A in AAA elevates the BP.

### *A. Impact of Age*

Aging is an inevitable consequence of human beings. Many attributes of human body changes as the person ages[4]. As we age heart muscle cells get degenerated and also become thin, blood vessels show decreased performance,

the ability of the body to process sodium decreases. When we age the elasticity nature of the arteries also decreases as they become stiff [9][11]. In such situation, to pump the blood throughout the body through arteries, the heart has to push the blood using more force. This may, in turn, elevate the blood pressure.

### *B. Impact of Anger*

Anger may be the result of impatience, frustration, irritation and many others. It may be a positive emotion at some point of time but most of the time it is not good for health and state of mind. The way how anger is handled has a significant effect on heart and mind. Frequent explosive anger may lead to serious consequences like elevated blood pressure, and the rise in the heartbeat and pulse rate. When a person gets angry then the fight or flight mode of Sympathetic Nervous System gets activated. As a response, nerves send more blood to muscles and brain, which elevates the blood pressure [12]. Though suppressing and ignoring the anger is not good for health but letting it go is also not good. So everyone should mastery over anger in a way that the impact of it to be as minimal as possible.

Anger Measurement**:** The literature says anger and blood pressure may not associate for a longer period of time. But our experimental results show there is a significant effect of anger along with the anxiety of a person in elevating the blood pressure. Our proposed technique measures the level of anger by using the responses obtained from the predefined questionnaire. Sample questions used for anger measurement are like waiting for anything annoys me, gets angry for the delay in completion of any assignment, gets angry if things won't go on my path, and I find difficult to forgive people who did wrong to me. We used 10 such questions and for each question, the answer is marked as one of the following option a) no, never b) yes, rarely c) yes, often d) yes, most of the time. In the data preprocessing phase option, a is considered as 0, option b is considered as 1, option c is considered as 2 and option d is considered as 3. Based on the mean value of all the answers we considered either floor value or ceil value of mean for experimental analysis.

### *C. Impact of Anxiety*

Stress and anxiety are slightly different, even though represented on the same scale. The active form of stress may be considered as anxiety, and the active form anxiety may be considered as depression. Nowadays stress is one of the key factors that impact the quality of our regular life. If stress is chronic, that happening frequently, it may become anxious. Anxiety response creates specific thought pattern in mind, which gets executed repeatedly. The person, who is a victim of anxiety, thinks again and again about the worst possible outcome of an ambiguous situation, where the possibility of happening best is more. Factors such as negative thinking, fear, insecurity, lack of something compared to others, thinking about a specific thing that may happen in future, lack of confidence, doing wrong things which are not ethical, not getting things right as per his or her perception, expectations from friends, relatives, and closed ones etc., may be the triggering factors for anxiety. When a person is anxious, fight or flight mode of Sympathetic Nervous System gets activated [14][15]. As said earlier it elevates the blood pressure. However, anxiety and long-term HBP may not be linked. The body produces a surge of hormones such as adrenaline and cortical when we are in the anxious situation. This, in turn, may tighten the arteries. Our experimental analysis also reveals that there is a significant impact of anxiety, in raising the blood pressure.

Anxiety Measurement: Our proposed technique measures the level of anxiety by using the responses obtained from the predefined questionnaire. Sample questions used for anxiety measurement are like, the existence of constant fear about something, facing breathing difficulty often, feeling of not having desired things in life, often scared without the clear reason, often aware of the heart beat without doing physical exercise, and sense of dryness in the mouth. We used 20 such questions and for each question, the answer is marked as one of the following option a) no, never b) yes, rarely c) yes, often d) yes, most of the time. In the data preprocessing phase option, a is considered as 0, option b is considered as 1, option c is considered as 2 and option d is considered as 3. Based on the mean value of all the answers we considered either floor value or ceil value of mean for experimental analysis.

### *D. Impact of Obesity*

Body Mass Index (BMI) is used to measure to find where you fall on the scale of obesity. BMI is a measure of weight proportionate to height. If BMI value is in between 18.5 and 24.9 is treated as normal. If BMI value is greater than 25 and less than are equal to 30 is treated as overweight [10]. If the BMI value is more than 30 then person treated as obese. Obesity is considered as increased fatty tissue in the body [7][8][11]. So for the livelihood of increased fatty tissues heart pumps the blood with some additional force to reach newly formed body tissues, which may spike the blood pressure.

### *E. Impact of Cholesterol*

Although for the birth and development of body tissues, cholesterol is needed but too much cholesterol in the body is not good for the wellbeing of human body. Lipoproteins (small packages) are transporters of cholesterol in the human body. Lipoproteins are two types, LDL (low-density lipoprotein) cholesterol which is bad cholesterol and not needed for the body [15]. HDL (high-density lipoprotein) cholesterol is called good cholesterol. Indeed, which is most required cholesterol for the functioning many hormones of the human body. HDL carries cholesterol from all parts of the body back to the liver, where cholesterol is filtered and sent out from the body. If LDL is high, this forms fatty substance inside the arteries. This fatty substance reduces the diameter of arteries and raising the blood pressure.

## III. Back Ground Work

This section reveals the existing work carried on each parameter in AAA++, which is the main reason for the elevation of blood pressure. Age: Arteries become stiff and narrowed due to aging and the elasticity nature of arteries gets also decreased [4][13]. Obesity: High BP problems are more common among inpatients with schizophrenia, mainly due to weight gain or obesity [14]. Cholesterol: increase in

cholesterol levels is able to influence BP, at least during sympathetic stimulation [11]. Anger & anxiety: The American Institute of Stress reports that Stress, "Pressure", "Tension", and "Anxiety" are often synonymous. US National Library of Medicine reports that our body produces a surge of hormones when we are in an anxious situation. These hormones increase your blood pressure by causing your heart to beat faster and our blood vessels to narrow. Though several researchers have addressed, how blood pressure is elevated based on physical and psychological factors, but these approaches suffer from the following drawbacks.

- Fail to find the exact risk of age in elevating blood pressure
- Fail to find the exact risk of obesity in elevating blood pressure
- Fail to find the exact risk of total blood cholesterol in elevating blood pressure
- Fail to find the exact risk of the combined effect of age, obesity and total blood cholesterol in elevating blood pressure
- Fail to find the exact risk of psychological factors such as anger and anxiety in elevating blood pressure

In this paper, our focus is on the combined effect of AAA++ in elevating the blood pressure.

## IV. Proposed Architecture

Although Anger and Anxiety may elevate the blood pressure temporarily repeated activation of these two may lead to long-term blood pressure also. Different factors which influence blood pressure of a person directly or indirectly are shown in Fig 1. Yellow colour represents that impact AAA is more than the impact of ++ (obesity, total blood cholesterol) in elevating the blood pressure. Fig 1 also represents an increase in blood volume, increase in heart rate, and increase in stroke volume also increases blood pressure. These are normally influenced by sympathetic and parasympathetic nervous system of human body.

## V. Proposed Methodology

In this paper, we used a data mining classification technique. Classification is the technique used to predict the class label of a data record or to represent a descriptive analysis of data record for taking effective decisions [2]. It is also called as a supervised approach. The classification model consists of two stages: In stage 1. Training stage, where the model is trained by a set of records, whose class labels are already known. In stage 2. Testing stage, where the model is going to predict class labels of a set of records whose class labels are unknown, also called as test records.

There are various classifiers but for Experimental analysis, we used classifier called as j48 supported by WEKA.

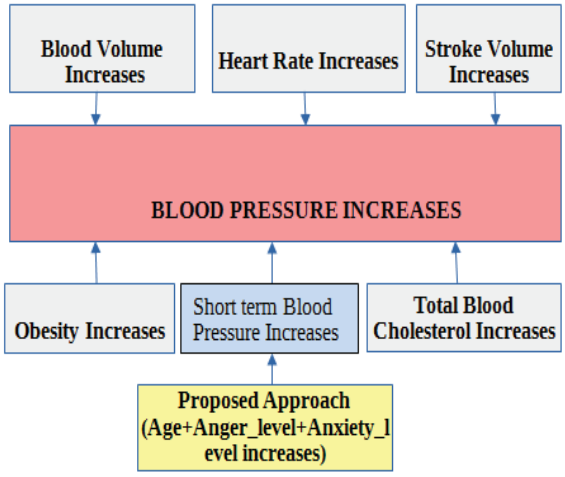


Figure 1. Block Diagram of the proposed approach and different parameters influencing the blood pressures

### A. J48 Algorithm

J48 is a Decision tree based WEKA implemented C4.5 classification algorithm. A Decision tree based classifier classifies the input instances by passing it through the tree starting at the top and getting down to the leaf node. Leaf node value represents the predicted output value for a given input instance. Initially, information gain is calculated for each Attribute of input instance. The attribute with highest information gain is selected as splitting attribute. Recursive approach is used to divide the remaining instance at each node. Information gain (IG) of an attribute $A$ is calculated at the selected node using equation 4.

$$Informatio\,nGain(S,A) = Entropy(S) - \sum_{v \in Values(A)} \left( \frac{|S_v|}{|S|} Entropy(S) \right) \quad (4)$$

Here TABLE II represents performance measures used to evaluate classifier performance. Where P is total number of positive records, N is total number of negative records, TP refers to the positive records which are correctly labeled by the classifier, TN is the negative records which are correctly labeled by the classifier, FP is the negative records which are improperly labeled as positive, and FN is the positive records which are incorrectly labeled as negative. In the equation 4,$S$ is the set of instances at that node and $|S|$ is its cardinality, and $S_v$ is the subset of $S$ for which attribute $A$ has value $v$. The entropy of the set $S$ is calculated using (5).

$$Entropy(S) = \sum_{i=1}^{n} - p_i \log_2 p_i \quad (5)$$

where $p_i$ is the probability of instances in S which belong to the $i^{th}$ class, and 'n' is a number of classes.

TABLE II.
MEASURES AND FORMULA

| | |
|---|---|
| Classifier Accuracy | $\frac{TP+TN}{(P+N)}$ |
| Classifier Error rate | $\frac{FP+FN}{(P+N)}$ |
| Recall | $\frac{TP}{P}$ |
| Precision | $\frac{TP}{(TP+FP)}$ |
| F-Measure | $\frac{(2\times precision\times recall)}{(precision+ recall)}$ |

## VI. EXPERIMENTAL RESULTS AND ANALYSIS

For the experimental analysis, we have collected real-time data set from 1000 people. Each person data is considered as one record, for each record age of a person, anger level, anxiety level, obesity, blood cholesterol, systolic and diastolic blood pressures are recorded. Based on the systolic and diastolic blood pressure values we calculated class label attribute. If anger level and anxiety level are below 1 we considered their floor value and more than one we considered their ceil value for the better prediction. TABLE I is used to convert systolic and diastolic blood pressure values to get the class label attribute. Performance of classifier [2], the details of the dataset are as shown in TABLE II, III. Data collection is done manually by interacting with the people using questionnaire mentioned in the sections, anger measurement, and anxiety measurement. We have used a data mining tool WEKA (Waikato Environment for Knowledge Analysis) for experimental analysis. It is open source software; consist of many machine learning and data mining algorithms. WEKA processes the input data using ARFF (Attribute file format). So data collected is converted into an arff file, in the data preprocessing phase.

TABLE III.
DETAILS OF ATTRIBUTES

| Attribute Number | Attribute | Minimum | Maximum | Mean | Standard Deviation | Attribute Type |
|---|---|---|---|---|---|---|
| 1 | Age | 20 | 65 | 37.898 | 11.021 | Numeric |
| 2 | Anger level | 0 | 3 | 1.797 | 0.618 | Numeric |
| 3 | Anxiety level | 0 | 3 | 1.141 | 0.664 | Numeric |
| 4 | Obesity level | 15.5 | 37 | 24.307 | 3.959 | Numeric |
| 5 | Cholesterol level | 102 | 258 | 168.129 | 31.39 | Numeric |

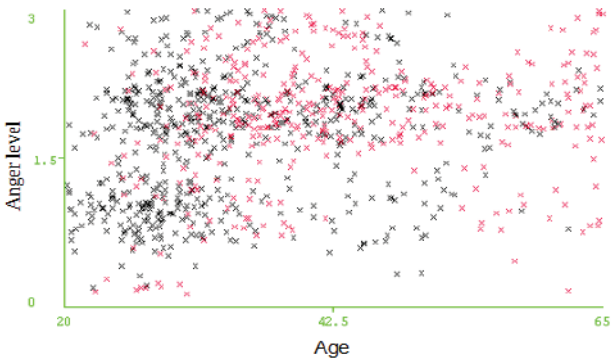

Figure 2. BP prediction using Age and Anger

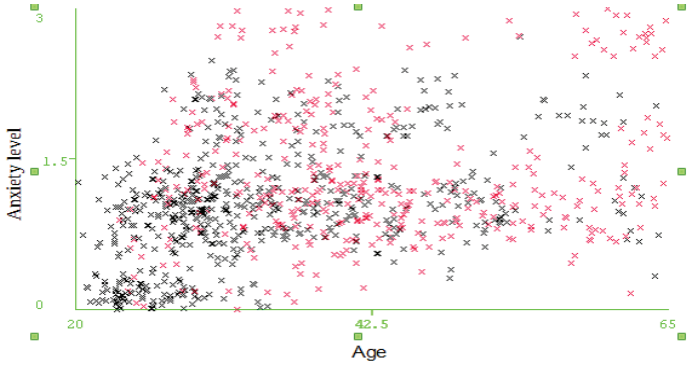

Figure 3. BP prediction using Age and Anxiety

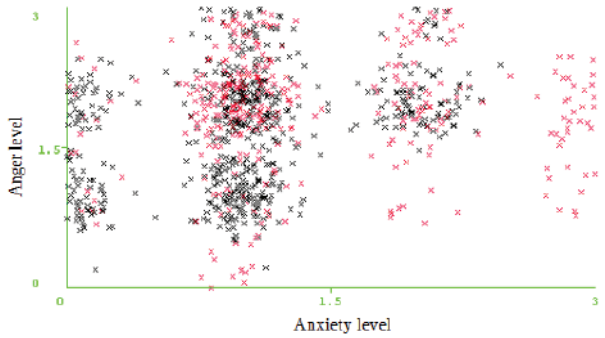

Figure 4. BP prediction using Anxiety and Anger

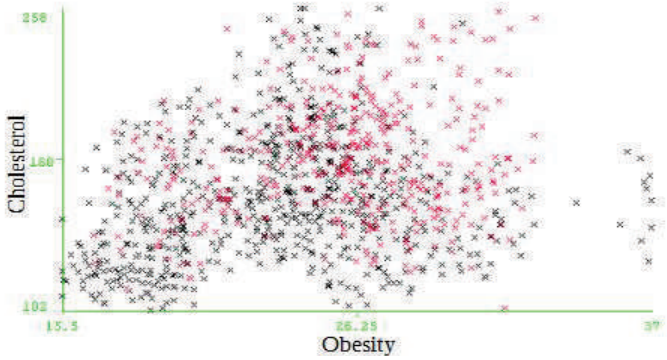

Figure 5. BP prediction using Obesity and cholesterol

Fig. 2 represents age on X-axis, where the minimum age is 20, maximum age is 65. Y-axis represents anger level, where minimum anger level is 0, and maximum anger level is 3. Here red 'x' represents data records which are predicted as YES, black 'x' represents data records which are predicted as NO. Fig. 3 represents age on X-axis, where the minimum age is 20, maximum age is 65. Y-axis represents anxiety level, where minimum anger level is 0, and maximum anxiety level is 3. Here red 'x' represents data records which are predicted as YES, black 'x' represents data records which

are predicted as NO. Fig. 4 represents anxiety level on X-axis, where the minimum age is 0, maximum age is 3. Y-axis represents anger level, where minimum anger level is 0, and maximum anger level is 3. Here red 'x' represents data records which are predicted as YES, black 'x' represents data records which are predicted as NO. Fig. 5 represents Obesity level on X-axis, where the minimum age is 15.5, maximum age is 37. Y-axis represents Cholesterol level, where minimum Cholesterol level is 102 and maximum Cholesterol level is 258. Here red 'x' represents data records which are predicted as YES, black 'x' represents data records which are predicted as NO.

TABLE IV.
CLASSWISE ACCURACY DETAILS USING J48 ALGORITHM

| Class | TP Rate | FP Rate | Precision | Recall | F-Measure |
|---|---|---|---|---|---|
| YES | 0.816 | 0.154 | 0.755 | 0.816 | 0.784 |
| NO | 0.846 | 0.184 | 0.888 | 0.846 | 0.866 |

TABLE V.
ACCURACY AND ERROR RATES OF J48 ALGORITHM

| S. NUMBER | ALGORITHM | ACCURACY % | MAE | RMSE | RAE % |
|---|---|---|---|---|---|
| 3 | J48 Algorithm | 83.5 | 0.1984 | 0.3427 | 41.8241 |

MAE: Mean absolute error, RMSE: Root mean squared error, RAE: Relative absolute error

## VII. CONCLUSIONS

In this paper, we used age, anger, anxiety, obesity and cholesterol levels of a person to predict whether a person is prone to HBP or not. From the experimental analysis we obtained, if the age of a person is greater than 34 and anger, anxiety levels are greater than or equal to two, obesity is more than 30 and cholesterol level is more than 205, then the person is most likely to become a victim of high blood pressure. Results unfold; the influence of anger, anxiety is more than the obesity, cholesterol levels in elevating the blood pressure.

The experiment also reveals that if the person age is greater than fifty irrespective of anger, anxiety, obesity and cholesterol levels, the person is more likely, to become a victim of HBP. Apart from this experimental analysis also unfolds many other interesting correlations, which are not listed here. In future; we would like to consider other attributes such as gender, smoking, alcohol consumption, and job satisfaction, marital status to improve the prediction performance of the classifiers.

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