

An Analysis on The Effects of Parenting Style on Offspring's  
Behavior Using Machine Learning

by

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A thesis submitted to the Department of Computer Science and Engineering  
in partial fulfillment of the requirements for the degree of  
B.Sc. in Computer Science

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# Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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# Approval

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# Abstract

Parents are usually the most important person for a human being as they encourage and support an offspring's physical, emotional, social, and intellectual development from infancy to maturity. An individual faces various challenges as they grow up. Proper parenting plays a prominent role in handling and abating those challenges. This paper aims to show various consequences on the attachment style and handling of depression, anxiety, stress, anger due to different types of parenting style. These consequences of parenting styles are to be figured out in an automated way so that one can acknowledge these factors on their own and bring various positive changes to their parenting. The term "parenting style" refers to a collection of tactics that have various effects on children. These methods can have an impact on children' minds that lasts long into adulthood, both positively and negatively. This research makes use of machine learning algorithms in order to differentiate between various parenting styles through various aspects of their life such as stress, anxiety, depression, attachment style, anger management etc. The lack of publicly accessible data prompted us to compile my own data set, which consisted of 2206 survey responses from students(school, college, university). Afterward, the survey data was stored and pre-processed. Then, machine learning algorithms such as Decision Tree, XG-BOOST, KNN, Support Vector Machine and Random Forest are utilized to detect parenting style by analyzing the effects of parenting on their offspring and the accuracy of these models are 84.70%, 76.71%, 87.30%, 87.30% and 85.185% sequentially.

**Keywords:** Parenting style, Attachment style, Stress handling, Anger management, Depression, Anxiety, SVM, KNN, RF, Decision Tree, XGBoost.

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# Nomenclature

The next list describes several symbols & abbreviation that will be later used within the body of the document

*AI* Artificial Intelligence

*ASQ* Attachment Style Questionnaire

*FN* False Negatives

*FP* False Positives

*KNN* K Nearest Neighbor

*ML* Machine Learning

*PAQ* Parental Authority Questionnaire

*RBF* Radial Basis Function

*RFs* Random Forest

*SMQ* Stress Management Questionnaire

*SVM* Support Vector Machine

*TN* True Negatives

*TP* True Positives

*XG – BOOST* Extreme Gradient Boosting

# Chapter 1

## Introduction

### 1.1 Motivation

The most crucial aspect of our lives is our parents since they take care of us. One's response to a circumstance in life depends on their parenting style. A substantial influence on a person's life can be exerted by one's parents in either a positive or negative way. The act of parenting entails seeing to the requirements of a kid in order to ensure that they will grow up to be content and healthy adults. The processes of a child's development, education, and health, as they relate to the child's life and are carried out by the parental figure, are considered to be the function of parenting. [10]. Parents can have a major and direct influence on the growth and development of their children by engaging in social activities with them. A collection of techniques used by parents to raise their children might be referred to as their parenting style. The three fundamental parenting controls identified by Baumrind are authoritative, authoritarian, and permissive [7]. However, the Uninvolved parenting style discovered by Maccoby and Martin [15]. Every method to parenting has a somewhat different take on how children should be brought up, and these variations can be observed in a variety of different ways. A parent's parenting style can have both immediate and long-term effects on a child's development. While concurrently implementing supportive rather than punitive discipline techniques, the authoritative parenting style promotes children's independence. Despite the fact that authoritative parenting has a significant favorable effect, according to the findings of other researches, the other three parenting style offers a greater number of positive advantages than authoritative parenting. [5]. Additionally, the permissive parenting approach promotes open communication between children rather than enforcing it, which leads to fewer instances of discipline being utilized. Conversely, Authoritarian Parenting establishes guidelines that are more restrictive than encouraging. As a result, parents prevent their children from acquiring traits and set limitations that are more restrictive than encouraging. Additionally, this kind of parent expects their child to obey them without question and sets up a one-way communication style for them. There is also a subset of parents who attend to their children's fundamental requirements but do not participate in their day-to-day activities, as for their lack of participation, they are referred to as "uninvolved parents."

Parenting influences the attachment style of a child. An individual's interpersonal communication style is referred to as their attachment style. If one develops a se-

cure attachment style, connecting with others comes naturally. Negative parenting styles, on the other hand, result in insecure attachment styles (anxious, avoidant, disorganized), which cause a lot of problems in life since they make it difficult to connect with others. In general, a parent has a greater influence on their child's life than other people do, and they may help the youngster resolve their problems.

Children who have parents that are depressed, angry, stressed, or anxious. Anger is an emotion that may be described as both an illness that hardens the heart and an essential survival strategy [4]. Anger is a strong emotion of indignation because it is brought on by mistaken rage. A youngster can communicate his anger in a variety of ways, such as via tantrums, poor behavior, despair, slamming, and a wide range of other behaviors. However, this idea is frequently misconstrued, and experts are divided on whether it is a good or detrimental reaction. Therefore, specialists must be aware of the feeling of anger, associated emotions, and behaviors, as well as their influence on a kid, in order to identify the need for the appropriate interventions. Due to injustices they encounter or tiny annoyances they encounter, children are unable to manage their rage. Although we cannot control this, we may concentrate on managing our anger to prevent despair, hostility, and violence from becoming associated with anger [4]. When we react to actual events and become ready to meet a challenging scenario with focus, energy, stamina, and enhanced attention, we experience stress. Stressors are situations that cause stress. Stress has the potential to affect many aspects of life. Additionally, stress has an impact on abilities, behaviors, emotions, and physical health. Anxiety, major depressive disorder, and depression are frequent medical conditions that produce a variety of symptoms that influence how a person feels, thinks, and behaves. In addition to being difficult to deal with, these illnesses increase the risk of heart disease, panic attacks, and dementia, resulting in extreme anguish and functional impairment. Anyone may experience it. And most of the time, a person's appearance does not accurately represent their mental condition. Depression, anxiety, and a wide range of other illnesses can affect those who are dealing with mental health issues of any kind.

## 1.2 Research Problem

- Figuring out the connection between parenting style and the attachment style of their offspring and their way of handling of depression, anxiety, stress and anger management.
- Differentiating the effects of parenting style on offspring of different level – high school, college and university.
- Creation of short but effective survey to relate various effects of parenting style on offspring development.
- due to the lack of judgment and proper experience, parents sometimes require parenting guidance.
- General online suggestions for parenting steps may often not be applicable due to the cultural and social diversity.
- Dedicated parenting suggestion guiding may come with extra cost. Therefore, automation is necessary.
- There is not any viable automation technology that provides parenting guidance -Lack of sufficient dataset for parenting guidance.

As increase with problems every parents need helpful directions to practice positive parenting

- Acquiring data by survey
- Apply different machine learning methods upon data (KNN,RF, Decision Tree, Support Vector Machine and XGBoost)
- Compare and measure the accuracy of different methods for prediction

## 1.3 Research Objective

This research intends to prepare a model that is capable of detecting the parenting style, show an analysis of how the parenting style establishes the attachment style of an offspring, as well as children's ways of dealing with depression, anger management, stress handling, and anxiety and highlight the importance of positive parenting. In this way, build positive parenting in order to increase an offspring's sense of contentment. Through this analysis, the suffering that individual experiences in life will be lessened, they will gain an understanding of all of these factors, and both parents and the individual themselves will be able to contribute to lessening the effects, developing a secure attachment style, and experiencing genuine happiness in life. The relationships between parents and children will become increasingly strong [9]. People still find it difficult to discuss the challenges they have with their mental health owing to the social stigma and the humiliation associated with doing so in the culture in which we live. In addition, the majority of individuals who struggle with attachment difficulties, depression, anxiety, anger issues, and stress are unaware that they have a problem. This is due to the fact that some

people are unaware of the problems, while others are unable to detect the signs of these issues. There is a sizeable portion of the population that doesn't have access to care for mental illness, and among those who do, there is still a problem, there is a frequent reluctance to participate in mental health screenings. Because of their reluctance to get regular checkups for their mental health, they are unable to determine whether or not they struggle with conditions such as attachment anxiety, chronic stress, and depression, or uncontrollable outbursts of rage, and as a result, they do not receive treatment for these conditions. At the beginning of the therapy process, both the psychologist and the counselor may find it beneficial to have this information. They can use this information to choose the therapy method that will be most effective for the patients. Therefore, in our research, We propose a system that, using machine learning algorithms, would identify a human's method of parenting based on the results of that person's method of parenting that they have had on their child's development.

# Chapter 2

## Literature Review

### 2.1 Parenting Style

[15]Parenting styles refer to the many approaches that adults take in the process of bringing up their offspring. This can refer to the level of demands, productivity standards, rule compliance, and such that the parents have for their children, as well as the method of punishment that the parents employ to ensure that their children live up to these expectations. There are four distinct approaches to the role of a parent :

- **Authoritarian Parenting:** The authoritarian parents nurture their offspring by enforcing severe standards without question. High expectations, low responsiveness. Parents apply strict rules without taking into account their children's feelings or behavioral and social needs. The majority of parental involvement is one-way. This method of strict parenting makes use of harsh discipline, which is typically justified as being an expression of "tough love." Authoritarian parents typically converse with their children, but they do not solicit their children's advice or criticism. This helps the parents maintain complete control.
- **Authoritative Parenting:** It is a situation in which parents create rigorous household rules while allowing open communication with their children. High responsiveness, high demanding. Great reactivity and high demand. While exhibiting tolerance and compassion, sets firm rules and expectations for their offspring. They hold discussions, listening to and assessing their child's interests, ideas, and beliefs. Provides natural events to occur (for example, a child failing a midterm due to a lack of readiness), but makes the most of the opportunities to look after their children, engage in self-reflection, and conduct research Parents that exercise authoritative parenting are typically empathetic, attentive, and aware of their children's requirements on a regular basis. They have open and honest conversations with their children in order to inculcate in them morals and a sense of reason. Authoritarian parents raise children who are more soulful and capable of logical reasoning.
- **Permissive Parenting:** It occurs when parents have the little discipline for their children but expect a lot from them. High reactivity with low demand. Publicly speaks with their children and, instead of issuing commands, usually

allow them to make their own choices. Norms and regulations are not in place or are only enforced sporadically. Usually goes to great lengths to keep their children happy, sometimes at their own cost. People who are more permissive are significantly more likely to see their relationship with their offspring as that of a friend rather than that of a parent. They wish to avoid conflict, thus in order to do so, they typically comply with children's requests for help at the first hint of trouble. These parents often allow their children to do whatever they choose, and they provide nothing in the way of direction or counsel.

- **Neglectful/Uninvolved Parenting:** It's when parents aren't involved in their children's upbringing. Low response and low demand. Enables their offspring to rely on themselves, potentially as they are uncaring about their needs or otherwise engaged. Families just provide the bare minimum of love, direction, and concern. Has a lot of personal issues and has a hard time forming strong relationships. This parenting style, often described as uninvolved parenting, is marked by an overall lack of attention. Uninvolved parents only interact with the offspring on a limited basis and rarely impose standards. They can come across as cold and callous at times, although this isn't always on purpose because they are often coping with personal issues.

## 2.2 Attachment Style

[13] The way in which a person engages in social interaction with other people is referred to as their attachment style.

- **Secure Attachment:** The parent-child relationship is described as helpful and loving in this attachment style. The child learns to form meaningful experiences with others and feels secure and adored. In their personal connections, these youngsters are engaged and confident. Those who acquire stable patterns of attachment as children are more likely to sustain them as adults and have no difficulty maintaining long-term relationships beyond feelings of abandonment.
- **Insecure Ambivalent Attachment:** children with this type of attachment explore their surroundings, they often experience fear, which leads to dread rather than delight, because they lack trust in their parents. They continually seek acceptance from their caregivers and incessantly examine their surroundings out of the terror of being ignored. Adults who have grown up with this type of attachment are generally emotionally dependent. Adults who developed attachments in such a way are often emotionally reliant.
- **Insecure Avoidant Attachment:** When a child's parents don't demonstrate concern or attentiveness beyond supplying basic needs like food and shelter, they grow up with an avoidant attachment style. Individuals with the 'un-trusting' disposition have learned to accept that their wants and requirements will most likely go unmet, and that they will continue to feel rejected and inadequate.
- **Disorganized Attachment:** It happens if the parents consistently fail to answer properly with their child's vulnerability, or when a parent's response

to their child's anxiety or distress is inconsistent. Inter generational parenting styles frequently result in disorganized attachment.

## 2.3 Anger management, Depression, Anxiety, and Stress handling

Adolescent rage is frequently influenced by negative early experiences with anger. It is therefore extremely important to comprehend all the developmental triggers that result in adult rage. Gaining independence, expanding one's social network, and developing sexual identity are some of these developmental provocations. Common methods of showing anger include depression, frequent disagreements, rebellion against rules, sarcasm, demeanor shifts, and irregular sleeping habits. Research by Singer (1995) revealed a strong correlation between rage and prior exposure to violence. The preponderance of the link between anger symptoms and domestic violence was another key finding of this study.

According to Paul, a researcher, rage is a normal, energizing emotion [6]. Additionally, he said that rage is a powerful communicator and that it is the only way for youngsters to communicate their displeasure with developmental limitations. In order to understand the rage, it is also necessary to take cultural context into account. In every culture, there are legal and practical ways to manage anger. Inhomogeneous civilizations, this is easily transmitted from adult to kid so that the youngster learns when to be angry and how to be angry. Eisenberg and Fabes carried out the study to gain a full understanding of how a youngster reacts to various frightening activities. However, this coping method varies from child to child as well as depending on the specific circumstances that led to the child's rage. A key finding was that violent responses were rarely utilized, unless when a physical assault had caused the rage [2]. Additionally, it was shown that youngsters who were respected were less likely to engage in angry confrontations and were more likely to respond to anger provocations in a direct and non-aggressive manner [2]. Another study indicated that as preschoolers experience unpleasant adult interactions, they incorporate negative coping strategies into their own social relationships [1]. However, the way that wrath is expressed changes from time to time.

In these situations, a person's gender and the manner they display their anger are crucial factors. It has been demonstrated in several researches that how men and women express their anger and use coping mechanisms differ. In his research, Kollar (1991) found that while females were more inclined to voice their annoyance verbally, males were more likely to physically assault items when they were furious [3].

However, few studies have looked at the effectiveness of anger management approaches, and even fewer have looked at how well-suited the programs now in place are for children, teens, and adults who are aggressive, hostile, or violent. A kid experiences problems with their anger coping mechanisms when their healthy wrath is not well handled over the course of years [6]. The damaging effects of uncontrolled rage include depression, behavioral disorders, and animosity. Paul then discussed the significance of excellent anger management techniques. However, anger is a nec-



essary and important feeling that frequently denotes a problem with the kid and/or his or her environment.

The parenting style and temperament of the parents is an important factors in children's temperament. Parent and child characteristics accounted for 14% to 46% of the variance in parenting styles. A father's tolerance for anxiety problems among children increases their likelihood. The authority of a mother protects against childhood anxiety problems. Anxiety problems are more likely to manifest in kids who are less sociable. Since anxiety syndromes can range from mild symptoms to severe anxiety difficulties, they are more likely to emerge during childhood [8]. If this anger issue is not managed, children may experience difficulties in their academic, personal, and social functioning. This will also cause temperament problems in adults. Therefore, it is crucial to learn to control your anger from a young age since otherwise, it can have both short- and long-term impacts. A wide variety of factors, including qualities of the parent and the child, might have an effect on the parenting approach taken. It is generally agreed that the most significant aspects of parenting are the characteristics of the parents as well as the interactions and relationships the parents have with their children. It is possible for a parent's personality traits to influence the psychological consequences of their children, and certain personality features may encourage healthy development from childhood into adulthood. [11].

However, this study suggests that children who have more authoritative moms have a lower likelihood of developing anger problems. This has a rather straightforward explanation. When a kid grows up in a caring, supportive, understanding, and still individualistic setting, their behavior becomes remarkably stable, which is crucial for controlling anger issues and increases their level of competence in both their personal and social lives [14]. As a result, children with authoritative parents frequently display better levels of self-assurance, act in a less disruptive manner, and show higher levels of self-control, as well as higher levels of social and cognitive skills and favorable evolutionary outcomes [16].

According to various research, parental personality is not directly linked to anxiety disorders in children; rather, parental personality is linked to parenting practices, which are linked to anxiety disorders in children. An undesirable personality feature can lead to disputes, bad judgments, impulsive acts, ineffective coping strategies, etc., which can all contribute to the creation of a stressful environment. These have clinical repercussions, such that when children present with anger or rage issues, it may be necessary to examine the parents for such traits. It is also necessary to determine whether environmental pressures from parenting styles are causing such aggressive behavior in a child, which results in mal adaptive personality traits when a child is an adult.

Depression is a mental disorder that causes a lingering sensation of sadness and boredom. According to [19], it can cause a variety of mental and physical problems and has an impact on a person's behavior, cognition, and action. Major depressive disorder or clinical depression are common names for it. It might make it difficult for someone to go about their daily lives as usual and occasionally lead them to wonder what their purpose in life is. Weakness is not depression. It's difficult to break out

of it. For this mental illness to be cured, prolonged therapy may be required. It could sound frantic or frightening. However, for the majority of people, treating depression with medication, psychotherapy, or both is quite likely to be successful. It is acknowledged as a real condition that can get worse without the right care. In just a half month, those who seek therapy frequently report improvements in their symptoms [20]. It is a severe mental disorder that has a negative impact on one's feelings, actions, and thoughts [18].

The reaction brought on by many outside factors is known as stress, and it may either be a beneficial or harmful experience. According to Fontana, stress is a physical and mental order created to maximize one's capacity for adaptation. Tension may become an effective motivator and vice versa when such talents are able to handle the request and embrace the opportunity in the issue. Feedback to pressures is likely to vary by individual and the comparable environment might produce various outcomes, to put it in distinctive terms. Some people might succeed, while others might crumble under the pressure. According to Cox Brockley, stress is an understanding event that results from a disparity between the demands made and the capabilities of a person to successfully do the task. In this sense, unstable conditions will lead to stressful situations, which will eventually lead to stressful reactions. People naturally feel this way when they are unable to handle a situation or amount of strain. It is generally recognized that diseases brought on by excessive and prolonged stress have effects that go beyond simple devotion to health. These disorders can have an impact on students' quality of life. Stress is frequently categorized using a wide range of criteria, leading to a large number of labels for the many types of stress. Physical signs of stress include headaches, muscular aches, heartburn, indigestion, chest discomfort, rapid heartbeat, etc., while emotional signs include being easily upset, perplexed, fickle, feeling repelled, having difficulties sleeping, having poor self-esteem, feeling worthless, avoiding others, etc. Another significant psychological problem that affects about 30% of individuals at some time in their lives is anxiety disorder [22]. It entails intense worry and dread. Stress, anxiety, and despair can all lead to suicidal thoughts and self-injurious behavior.

# Chapter 3

## Methodology

The diagram below depicts our research's Proposed Model Workflow. Initially, a dataset was created using survey replies. The necessary data was then labeled accordingly. The data was then pre-processed by encoding and eliminating any null values. In the encoding section, first renamed all the columns, then the choices to numbers, and finally the labels to numbers so that the computer can correctly comprehend the data. Following that, the data was divided into 70:30 train and test datasets, both of which used for the purpose of training machine learning models. After then, the efficiency of the models was evaluated to one another and evaluated using a number of different evaluation criteria.

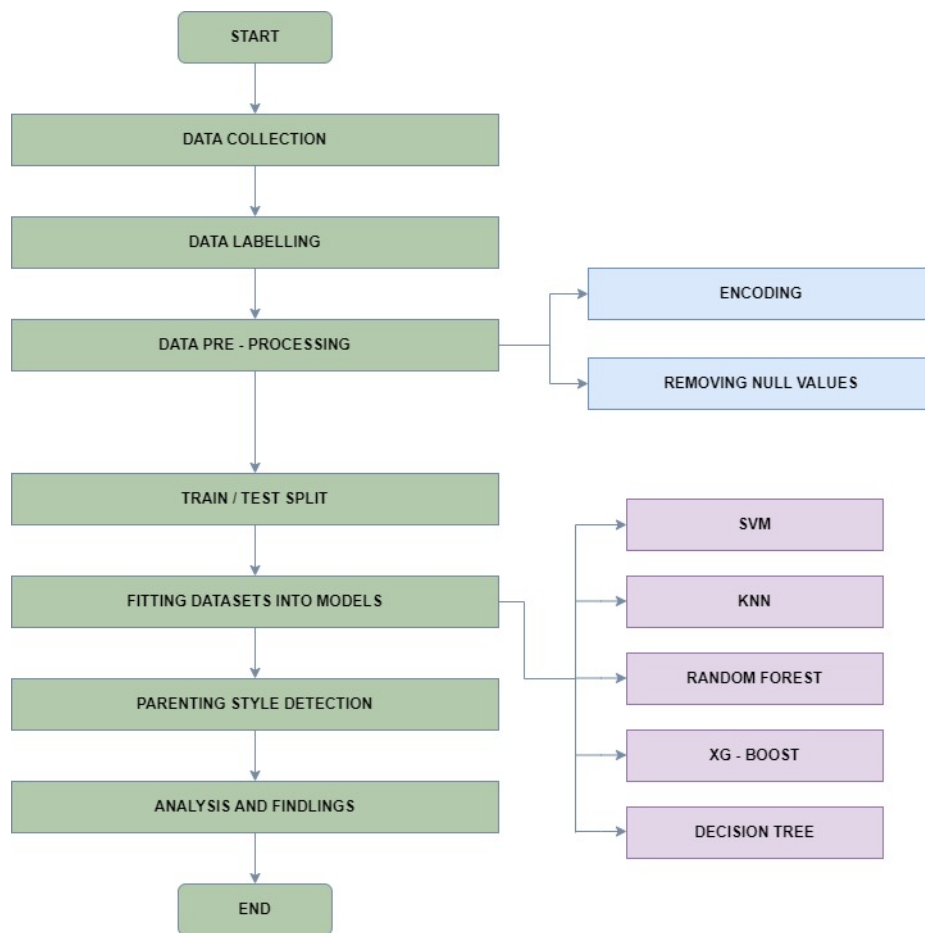


Figure 3.1: suggested model process flow

### 3.1 Data Collection process

There is little discussion in the AI literature concerning one’s attachment style, stress management, anger management, anxiety, and depression as a result of parenting style. So, we created our own dataset by creating survey through google form from the university student and for the school and college students we collected the data through hard copy then shifted it into soft-copy. For making the questions, we took help from the Bracu counsellors and trustworthy websites. To determine parenting styles, our survey questions were impacted by the Parental Authority Questionnaire (PAQ), the Attachment Style Questionnaire (ASQ), the Stress Management Questionnaire (SMQ), the Anger Styles questionnaire, the PHQ-9 for depression, and the GAD-7 for anxiety. BRAC University counselors review and approve the questions. The questionnaire included sixteen multiple-choice questions to assess parenting styles, attachment styles, and levels of anger, stress, anxiety, and depression. Before distributing the questionnaires we make sure that the information of students is fully anonymous and we are not taking any personal information of them. Following the survey, 2206 data were collected.

### 3.2 Data Labeling

The guidance, counselors and psycho-socialist from the counseling section of BRAC University provided some rules for labeling that will be labeled to the responses. Responses relating to parenting practices have been labeled as authoritarian, authoritative, permissive, and uninvolved. Responses related to attachment style have taken into 4 categories. These are secure, insecure ambivalent, insecure-avoidant, and disorganized. The responses that are given for each of these two sorts of questions show an individual’s parenting style as well as their attachment style. The traits that most accurately depicted the parenting style and attachment style were mostly gleaned from the responses of the audience, and they have been labeled appropriately. After that, scores were summed up for the items pertaining to depression, anxiety, handling stress, and anger management as scores were set to each options of the questions accordingly. These scores were then categorized into one of three levels: mild, moderate, or severe. If the total score for stress and depression is three or less, it categorized as mild; if the total score is four to seven, it categorized as moderate; and if it is more than seven, it categorized as severe. For the questions on anxiety and anger management, if the total score is two or less, it categorized as mild. If the total score is between three and five, it categorized as moderate. Other scores categorized as severe.

### 3.3 Summary of Dataset

In total of 2206 data, 1100 data were collected from university, 700 data from college and 506 data were from school. The male students are 790, and the female students are 468. When it comes to the approach to parenting, there are a total of 176 entries that are authoritarian, 812 entries that are authoritative, 236 entries that are permissive, and 34 entries that are uninvolved. and for attachment style, there are 572 secure responses, 382 insecure ambivalent responses, 186 insecure avoidant re-

sponses and 183 disorganized responses. For anger management, stress handling, anxiety and depression, the states are categorized in 3 - mild, moderate and severe. 748 responses - mild, 420 - moderate and 90 - severe responses for anger management; 718 responses - mild, 410 - moderate and 130 - severe responses for stress handling; 572 responses - mild, 472 - moderate and 270 - severe responses for anxiety; and, 363 responses - mild, 626 - moderate and 270 - severe responses for depression.

## 3.4 Machine Learning Models

### 3.4.1 Support Vector Machines

The acronym "Support Vector Machines" (SVM) refers to a group of closely similar supervised machine learning techniques that can be applied to the classification and regression processes. Using this method, the data are depicted as plots in n-dimensional spaces. The number n refers to the total number of characteristics that are considered. Each feature has a value that correlates to the values of a specific coordinate, and these values are used to describe the feature. Data is used as inputs by the SVM, and the result is shown in the form of a line that divides the data into the specified number of classes. Finding the hyperplane, which in turn requires distinguishing the two classes rather clearly, is how the classification is accomplished. The decision boundaries that aid in the classification of the data points are represented by hyperplanes. When dividing two unique groups of data points, it is feasible to select the appropriate hyperplane from among a large number of available options. In addition, as seen in the image below, the entire range of features that the hyperplane possesses is what determines its size. This fact accounts for the hyperplane's size. When the data can be separated linearly, a support vector machine (SVM) will compute the hyperplane that creates the largest margin between the class border and the training examples. This hyperplane is sometimes referred to as the best possible hyperplane. For support vectors, which represented in the image below, are data points that are placed closer to the hyperplane and have an effect on the location and orientation of the hyperplane. [12], are utilized in order to maximize the margin of the classifier.

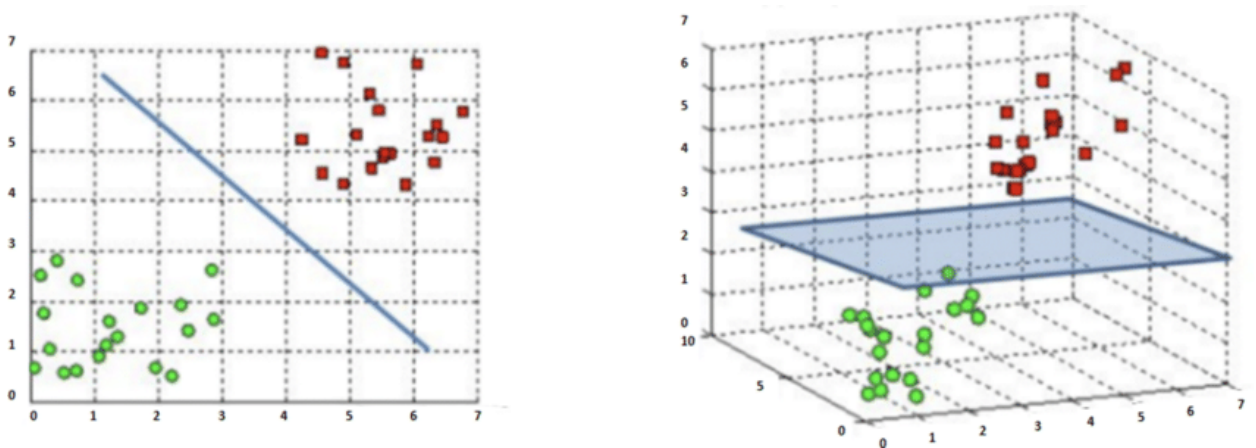


Figure 3.2: Hyperplanes

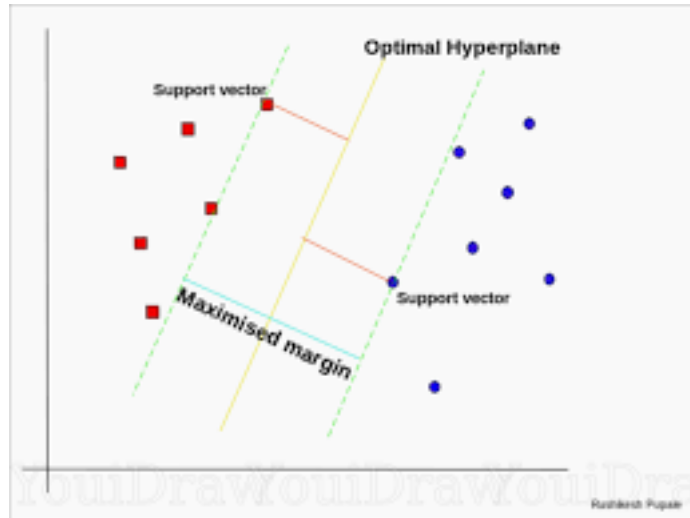


Figure 3.3: Optimal Hyperplane

Despite the fact that non-linearly separable data may exist, instances are mapped to a high-dimensional space such that a separating hyperplane may be calculated. This is accomplished by introducing a third dimension, designated as the z-axis. Consequently, we have an equation,

$$z = x^2 + y^2 \quad (3.1)$$

where z is essentially the square of the distance that the point is from the origin of the expression. As a result, it is now possible to linearly differentiate between the classes, as seen in Figure. The kernel function is the name given to the technique that specifies this mapping process of transforming a low-dimensional input space into a high-dimensional input space. The method achieves a high level of performance in the field of microarray data, which enables it to function as an effective classifier [17].

### 3.4.2 K-nearest neighbor

K Nearest Neighbor, sometimes known as KNN, is an algorithm for supervised machine learning. It is one of the simplest, most effective, and easiest-to-implement machine learning algorithms there is. In addition, it is one of the most straightforward. KNN is employed in the resolution of issues relating to both classification and regression. It is an algorithm for learning that is both non-parametric and lazy [22]. It does not make any assumptions about the distribution of the underlying data, which is what is meant by the term "non-parametric." The data are used to direct the construction of the model's structure. According to what we already know about life in the actual world, the vast majority of data do not adhere to the theoretical assumptions stated in the linear regression algorithm. As a result, the KNN algorithm is an excellent option for classification research when there is little prior knowledge of the distribution of the data. On the other hand, due to the fact that it does not need any training data point for generalization, it is known as a lazy algorithm. It also indicates that the algorithm does not have an explicit training phase or that it just

has a tiny amount of training phase, which is the reason why the training phase is so quick. The data from the training phase are stored away for use in the testing phase.

How does a KNN algorithm function? The algorithm is fundamentally based on the similarity of features. By feature similarity, we imply that the classification of a batch of data is dependent on the degree to which out-of-sample characteristics match our training set.

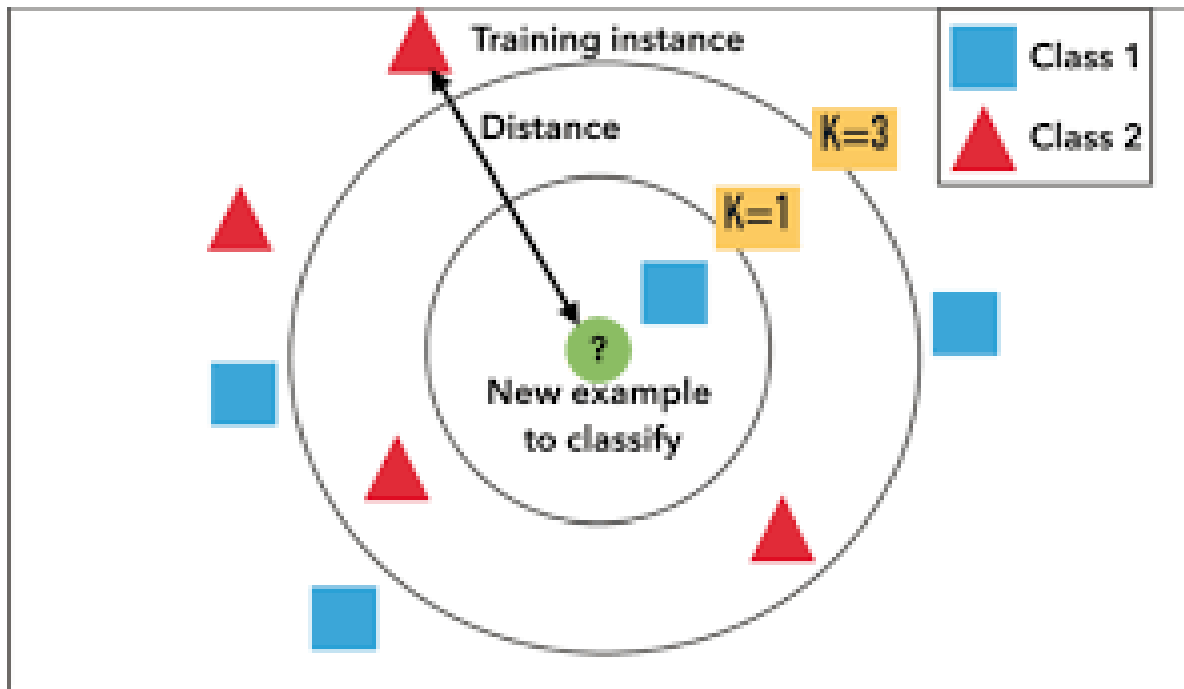


Figure 3.4: Example of KNN classification

As can be seen in the above figure, the sample that is being tested must be placed in either the first class (class 1) or the second class (class 2). When  $K$  is equal to three, the sample will be placed in class two because there are more triangles than squares within the circle. However, when  $K$  is equal to five, the sample will be placed in class one because there are more squares than triangles outside the outer circle. This is because there is a higher ratio of squares to triangles outside the outer circle.

As was just said, KNN algorithms may be utilized to solve problems relating to both classification and regression. Nevertheless, we are going to apply it to the issue of answering classification issues in our work. As a result, a sample is classified based on the majority vote supplied by its neighbor, and the sample is given the designation of belonging to the class that is the most prevalent among its  $k$  nearest neighbors, as was discussed before [22]

When it comes to classification, on the other hand, an acceptable value of  $K$  needs to be selected in order to use the algorithm. This value is critical to the achievement of successful classification. In the research article that we conducted utilizing parameter tweaking, we discovered the value of  $k$  that yields the most favorable results. The distance between two data points can be measured using a variety of distance



measures, including the Euclidean distance, the Hamming distance, the Manhattan distance, and the Minkowski distance. Using the distance, the K neighbors that are physically closest are identified. After then, each point is assigned a category based on the vote that received the most support among its k neighbors. Each item casts a vote for the class that best represents it. Then the class that received the most votes is considered to be the best indicator [22].

### 3.4.3 Decision tree

When the Decision Tree is used in a model, it takes in certain aspects of the data and then makes a prediction about the goal based on those aspects. The data are processed in such a way that allows Decision Tree to make hypotheses about them and organize them into groups or classes. This method makes it simple to explain how classification issues may be solved. Let's imagine, for example, that all of the features are labeled, and each of those labels may take one of a limited number of values. The algorithm has to be able to accurately predict one of the labels, which is the target. The decision tree organizes all of the labels into nodes according to their relevance. The classification tree is another name for this technique because of this reason. When an arc begins at a node that is labeled with a certain input feature, it will either end at a subordinate decision node that is associated with a different input feature or it will be labeled with each of the possible values associated with the target feature. Every leaf node may be thought of as a class.

Each entry in the data will give rise to the formation of one class within a decision tree. The nodes that are considered to be leaf nodes in a Decision Tree are considered to be the offspring of the node that is considered to be the root. In order to accomplish this structure, the data were separated into many parts. In a recursive fashion, the node is categorized based on the qualities that it possesses in each and every subset. When all of the leaf nodes have reached the objective that was intended to be anticipated, this procedure will come to an end [19]. The following format is utilized for the recording of the data:

$$(x, Y) = (x, x, x, x, \dots, x, Y) \tag{3.2}$$

Y represents the target that needs to be forecasted in this situation. While x is a vector that includes all of the features or labels in its structure. A graphical depiction of a decision tree is presented below.

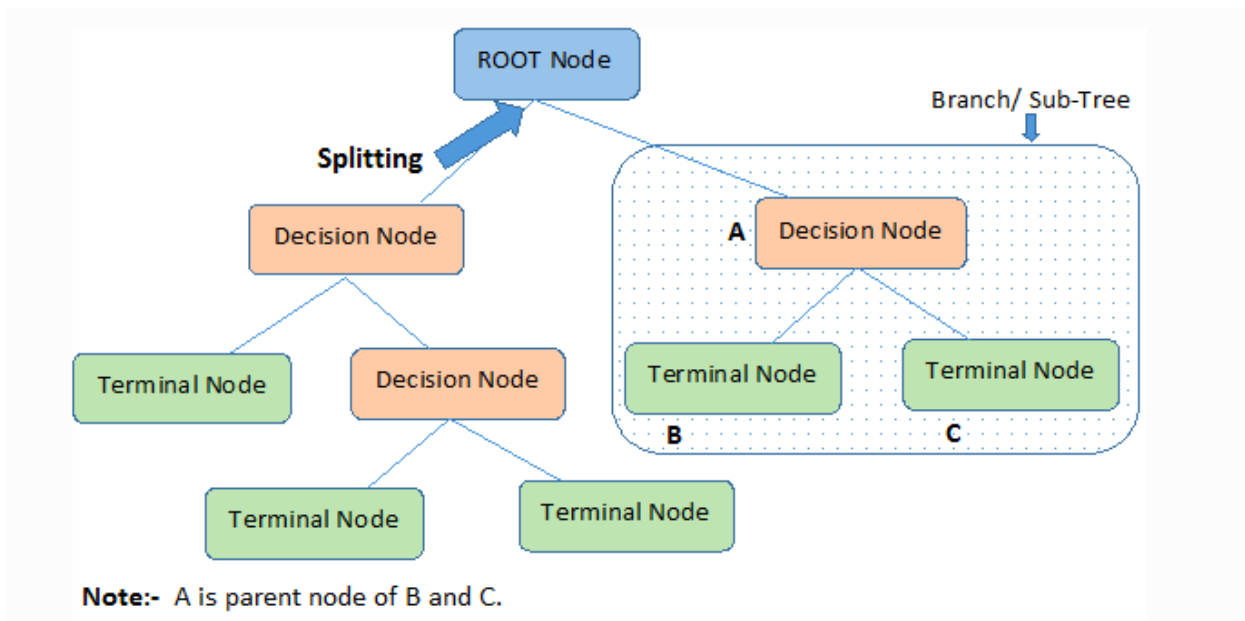


Figure 3.5: Decision Tree Infograph

### 3.4.4 Random Forest

The Random Forest Regressor was applied in order to accomplish the supervised learning-based study that we set out to undertake. However, in addition to its value in solving classification issues, this technique has other applications. The Random Forest algorithm is one that is frequently utilized in machine learning. Because it involves labels in a dataset, this issue is classified as a supervised problem. It makes a prediction about the target based on the features that are provided. Fitting the adjustment of the dependent variable  $Y$  (target) and the independent variable  $x$  (labels), Random Forest will then create the appropriate quantity ( $n$ ) of decision trees in a manner that is completely random. A conclusion may be deduced from each decision tree. After then, Random Forest will provide a decision based on the outputs that received the most votes from the  $n$  different trees. It is possible to attain the objective by adjusting the value of the random states and the number of trees [21].

The method for breaking a node into many nodes only takes into account a random subset of the features. It is possible to make trees more random by applying random thresholds for each feature (just like a conventional decision tree does), rather than searching for the best possible thresholds [18]. This is a method that is viable.

The relative importance of each parameter on the forecast can be easily calculated with the help of this ensemble technique, which is another one of the algorithm's beneficial features. Sklearn provides a useful instrument for determining the significance of a feature by analyzing the degree to which the tree nodes that make use of it contribute to the overall impurity of the forest. After the training is complete, it assigns a score out of one to ten to each of the characteristics and then adjusts the weights of each discovery until the overall importance equals one. When it comes to picking features for a model, Random Forest may be an extremely useful tool.

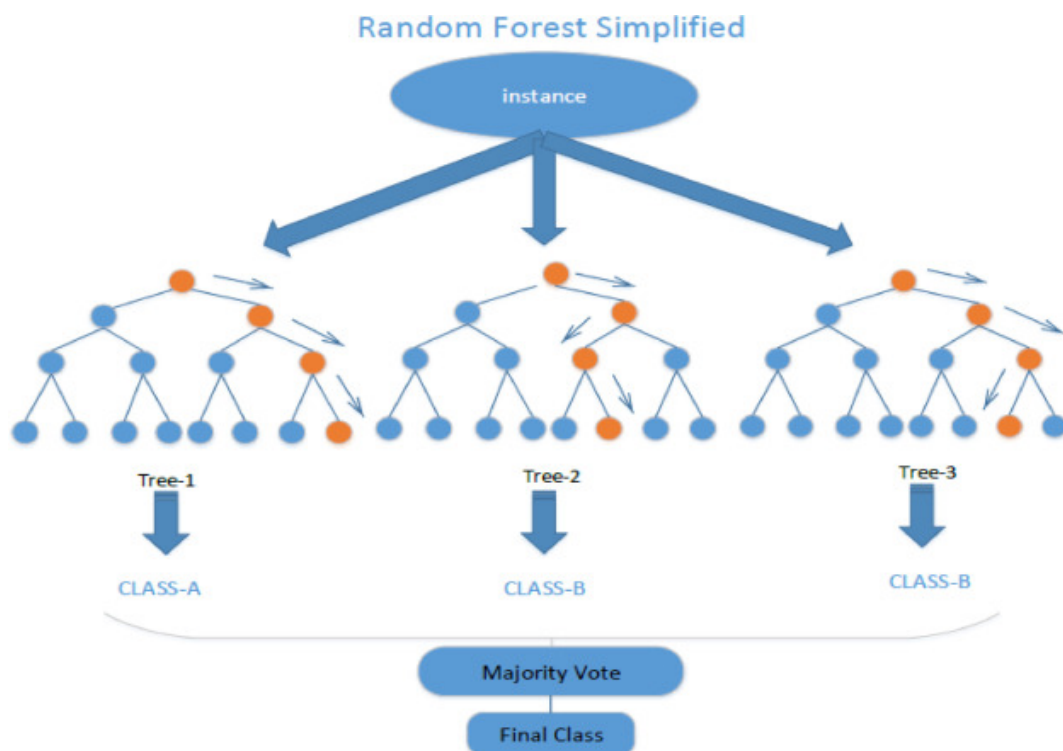


Figure 3.6: Random Forest Demonstration

Finding out which aspects are less crucial than others can make the data processing go more smoothly and increase the pace of the calculation as a whole.

This algorithm decides which features to disregard depending on the relevance of those features, on the grounds that such features do not contribute sufficiently to the prediction process, or in some cases, do not contribute at all. This is crucial because, in machine learning, the following rule applies: the more features that are provided, the greater the likelihood that the model would suffer from over-fitting, and vice versa.

### 3.4.5 XGBoost

An example of a machine learning algorithm is XGBoost, often known as the strong gradient boost. They are utilized in the process of enhancing tree algorithms. This approach is utilized extensively for supervised learning situations, which are those in which several features of the training data are used to predict a prediction regarding the desired result. Because it draws on the analytical skills of a number of different students to arrive at the solution, this strategy is incredibly strong and efficient. It includes both a linear model solver and a tree learning algorithm as part of its makeup. Additionally, it provides support for a variety of objective functions, including regression, classification, and ranking, in addition to the extra capability for cross-validation and discovering relevant variables. It contains a number of parameters that need to be adjusted in order to get optimal model performance. In the beginning, the students are not very good. These slow learners contribute information that can be used for prediction. A capable learner is developed as a result

of the accumulation of all new information. This capable learner can now lower bias and variance to acceptable levels. The tree ensemble model is comprised of a predetermined number of classification and regression trees (CART). In contrast to decision trees, which only make the decision values available in the leaf node, CART gives each leaf its own genuine score, which allows for more accurate interpretation.

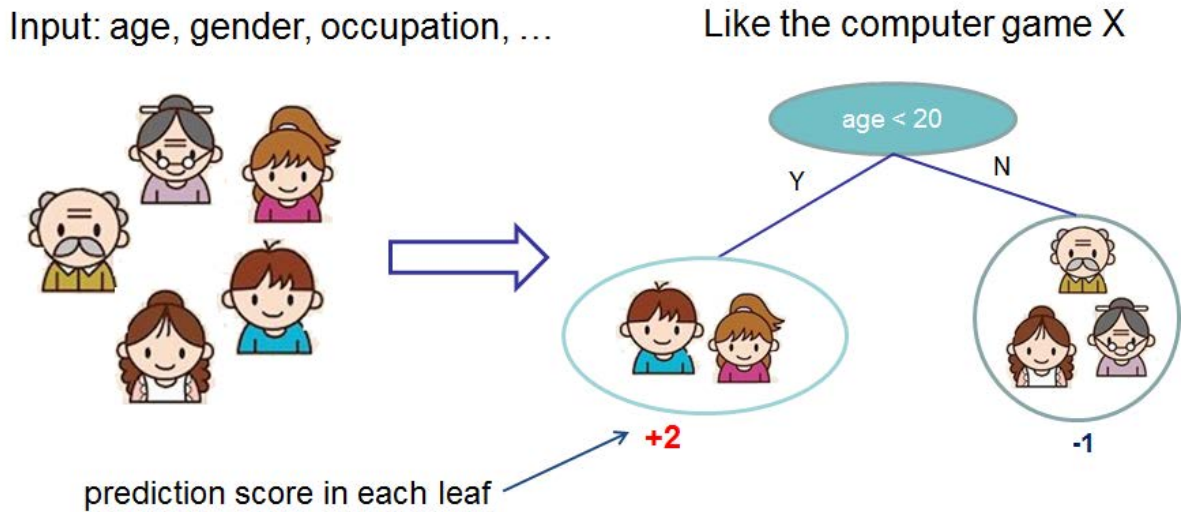


Figure 3.7: Example of CART model

The model is trained to get the outcome that is most similar to the correct fitting for the training data that contains  $x_i$  and labels that contain  $y_i$ . The objective function, which quantifies how well the model matches the training data, helps to attain this goal.

Bagging is being done in a simultaneous fashion to construct the trees. Boosting trees in a sequential fashion such that each subsequent tree improves upon the accuracy of the tree that came before it. As a consequence of this, the tree that comes after the one that came before it is always the updated version of the one that came before it. This type of approach is known as additive strategy.

The whole procedure may be broken down into the following steps .

1. Fitting out how well a model fits the data:

$$f_1(X) = Y \tag{3.3}$$

2. Fitting a model to the observations of the residuals:

$$h_1(x) = y - f_1(x) \tag{3.4}$$

3. Establishing the parameters of the new model:

$$F_2(x) = F_1(x) + h_1(x) \tag{3.5}$$

This can be generalized into the following formula:

$$F(x) = F_1(x) + h_1(x) \dots F_M(x) = F_M(x) + h_M(x) \quad (3.6)$$

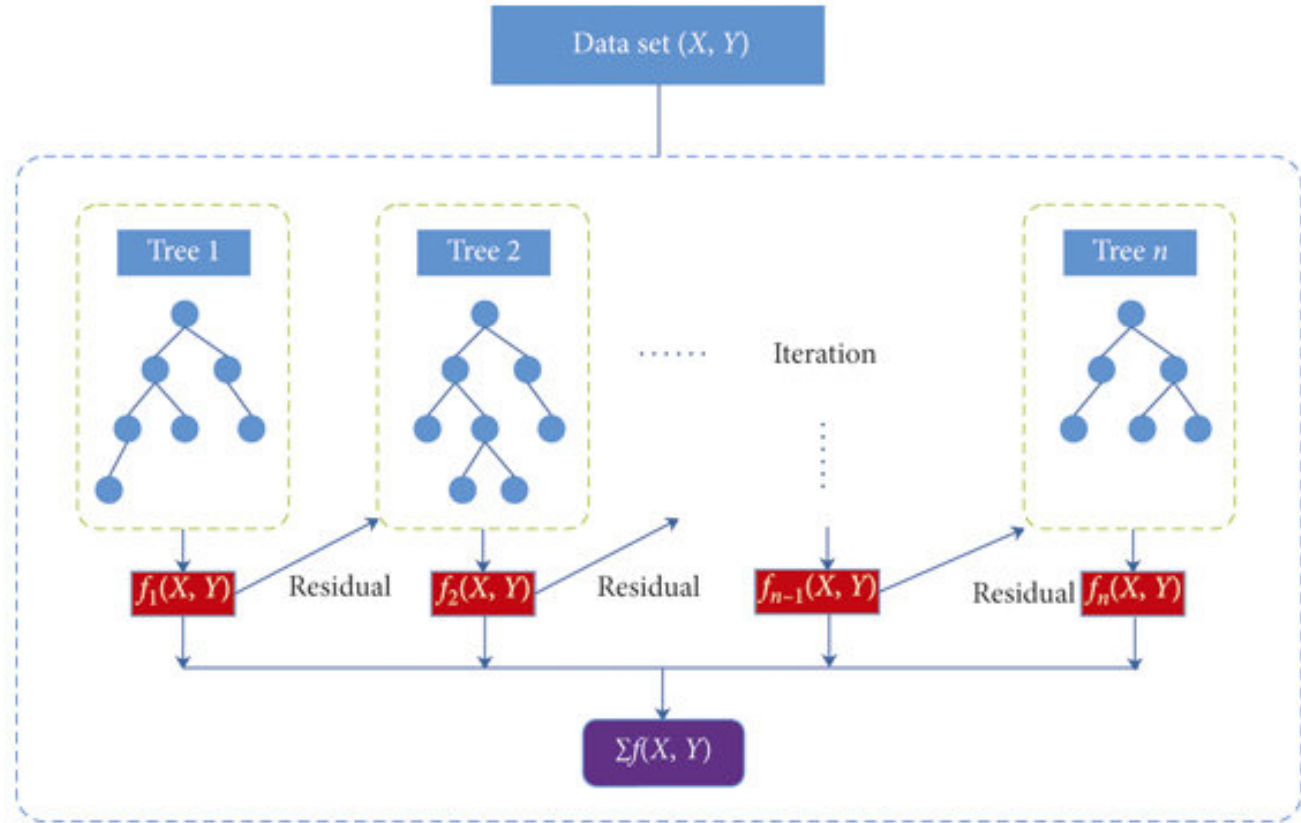


Figure 3.8: Sequential Tree Structure

The calculation of the residual occurs at each stage as follows:

$$h_m(x) = y - F_m(x) \quad (3.7)$$

can refer to any model in this context. Consider a scenario in which, rather than training  $h_0$  on the residuals of  $F_0$ , one trains it on the gradient of the loss function,  $L(y, F_0(x))$ , with regard to the prediction values provided by  $F_m(x)$ . Because the samples in  $h_m$  have been clustered together into leaves, it is possible to compute an average gradient, which may then be multiplied by some factor in order for

$$F_m + h_m \quad (3.8)$$

to lower the loss function for the data in each leaf. In actual reality, a different component is selected for each individual leaf. For the iterations ranging from  $m = 1$  to  $M$ :

- Determine the gradient of line  $L$  at the point  $s_{m-1}$  on the graph.
- Adjust the "step size" such that it "steps" in the direction of the steepest gradient decline (the negative gradient). Which suggests that  $1/s_m$  is equal to  $s_{m-1} L'(s_{m-1})$ .  $s_m$  will be the minimum value of  $L$ 's position if  $\eta$  is tiny and  $M$  is sufficiently large enough to meet the requirement. Additionally, XGBoost possesses amazing features, which distinguish it as being one of a kind, and these features include Handling sparse data: Data can be rendered sparse due to the absence of values or stages in the processing of the data, such as one-hot encoding. For the purpose of split discovery, XGBoost employs a sparsity-aware algorithm that is capable of accounting for a wide variety of sparsity patterns present in the data.
- Weighted quantile sketch: A tree-based algorithm that finds split points even when the data points all have the same weights (using quantile sketch algorithm). However, weighted data cannot be processed in any way. XGBoost is equipped with a distributed weighted quantile that is capable of managing weighted data in an efficient manner.
- Block structure for parallel learning: XGBoost is able to utilize many cores on the CPU in order to perform computations more quickly. This algorithm, in contrast to others, makes it possible to reuse the structure of the data in subsequent rounds, rather than having to compute it afresh each time.
- Cache awareness: In order to obtain the gradient, XGBoost has to make non-continuous access to the memory by row index. Because of this, it was intended to make the most possible use of the hardware.
- Out-of-core computing: Out-of-core computing is a feature that, when enabled, optimizes the disk space that is usable and maximizes the amount of that space that is put to use while computing datasets that are not memory compatible.

# Chapter 4

## Result and Findings

### 4.1 Evaluation Metrics

The measures that are used to evaluate the effectiveness of the ML models that are used in this research include accuracy, F1 score, recall, and precision. It is feasible to predict how effectively the models will function when these parameters are applied. Except for the F1 score, the results of each of these parameters are based on the True Positive, True Negative, False Positive, and False Negative values, accordingly. Contrarily, the F1 score considers the significance of both recall and precision.

- **True Positives (TP):** The model made an accurate prediction for the positive class.
- **True Negatives (TN):** The model made an accurate prediction for the negative class.
- **False Positives (FP):** The model made an inaccurate prediction for the positive class.
- **False Negatives (FN):** The model made an inaccurate prediction for the negative class.
- **Precision:** When evaluating the efficacy of a machine learning model, precision is a common and useful parameter to use. It is an indication of how accurate the model's optimistic forecast was. In order to calculate the precision, we utilize the following formula:

$$precision = \frac{TP}{TP + FP} \quad (4.1)$$

- **Recall:** Recall refers to the proportion of valid positive class predictions made by an algorithm with the total responses in a dataset where the prediction was positive. When calculating recall, we make use of the following formula:

$$recall = \frac{TP}{TP + FN} \quad (4.2)$$

- **F1-score:** In terms of recall and precision, the F1-score represents the harmonic mean. A different way to spell it is f1. The computation that follows boils precision and recall down to just one number:

$$F1 - score = 2 * \frac{precision * recall}{precision + recall} \quad (4.3)$$

- **Confusion matrix:** Confusion matrix primarily acts as a summary of how well the models have performed. The confusion matrix is a visual representation of the many different ways in which the classification model gets confused as it is trying to make predictions. This helps to overcome the challenges that occur with depending only on the accuracy of categorization.



## 4.2 Result Analysis

### 4.2.1 SVM

SVM gave 84.70% accuracy for parenting style detection and the train test accuracy is 90.68%. Gamma and c seem to be the useful parameters of the Radial Basis Function (RBF) kernel in the Support Vector Machine (SVM), which means they are among the parameters that the SVM has. The gamma parameter demonstrates the extent to which the training example has an impact on the model. The concept of 'near' is typically associated with high values, while 'far' is typically associated with low values. However, c acts in SVM as the parameter that controls the regularization process. It does this by adjusting the classification of training samples in light of the goal of maximizing the margin of the decision function. This keeps the tradeoff under control. With the exception of the cache size parameter, the gamma parameter was set to the value that is normally associated with it. The value of the cache size variable determines how much data is stored in the kernel cache (in MB). During this stage of the parameter tuning procedure, our dataset's 200 MB is treated as if it were 200 MB. Because of this, the accuracy has increased as a result of using these hyperparameters.

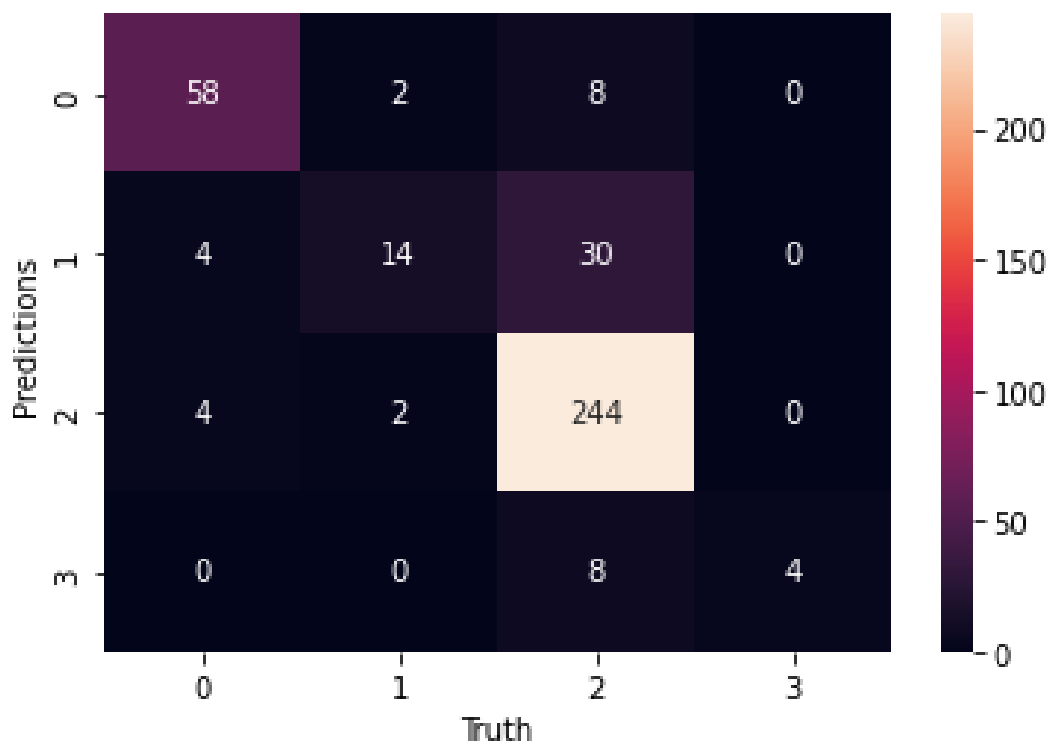


Figure 4.1: Confusion matrix of SVM

Here, label-0 is authoritarian data, label-1 is permissive, label-2 is authoritative, and label-3 is uninvolved. We can see that the model predicted from the confusion matrix that was just presented, 58 instances correctly and predicted 4 instances wrong for label-0. For label-1, it predicted 10 instances correctly and predicted 6 instances wrong. In label-2, it predicted 246 instances correctly and predicted 50

instances wrong and in label-3, it predicted 4 instances correctly and predicted no instances wrong.

## 4.2.2 KNN

KNN accuracy was 76.71%, and the accuracy of the train test was 88.41%. K is the number of neighbors in the KNN algorithm. K can have a value between 1 and 133 . We've used 5 in this instance. A crucial variable for our dataset is the mixed measure. It is the metric used to determine how far apart the data points are. The Euclidean, Hamming, Manhattan, and Minkowski distances - are the 4 variant of distance meausrements and Euclidean is the best one for our dataset. The length of the line segment that connects any two particular data points is known as the Euclidean distance between them. Kernel type is the third crucial variable. Radial kernels were shown to be the most effective form for our dataset.

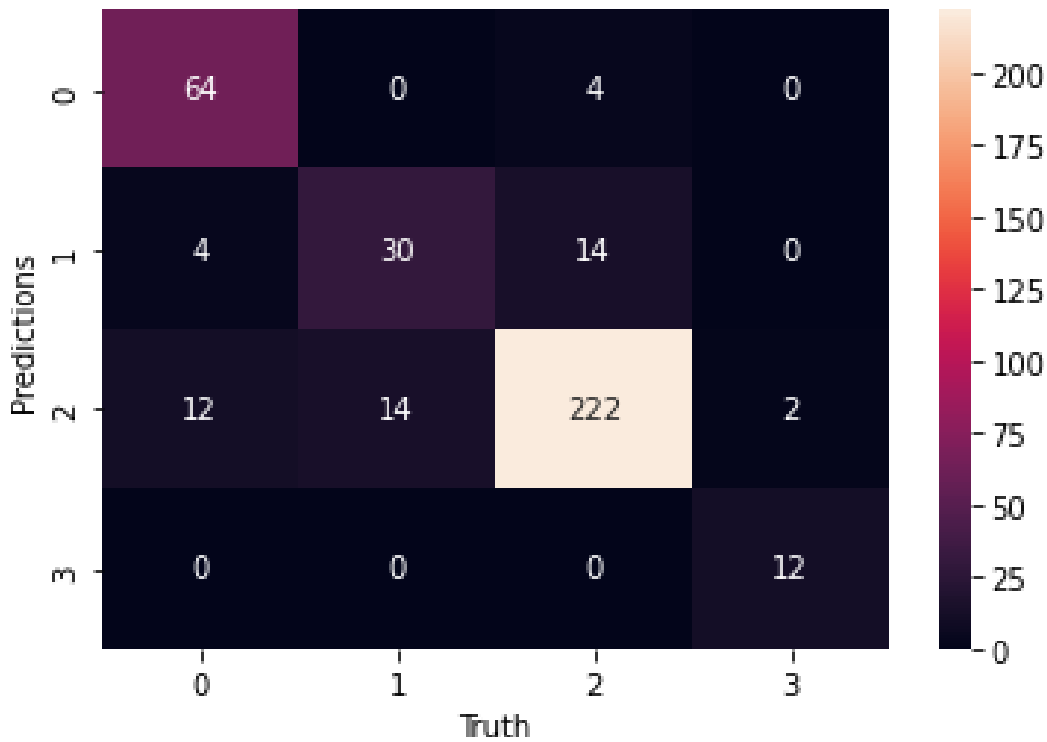


Figure 4.2: Confusion matrix of KNN

We can see that the model predicted from the confusion matrix that was just presented, 54 as label-0, 12 as label-1, 224 as label-2, parenting style for the tested data, whereas the true results are there are 38 instances of label-0, 22 instances of label-1, 274 instances of label-2 data.

### 4.2.3 Random Forest

Random Forest gave 87.30% accuracy and the train test accuracy is 96.82%. For training using Random Forest Classifier, the parameters were set in the following manner. `min_samples_split` which denotes the minimal number of samples needed to divide an internal node was set at 50, the criterion used was “gini” and the `n_estimators` value was set at 100 which determines how many trees there are in the forest.

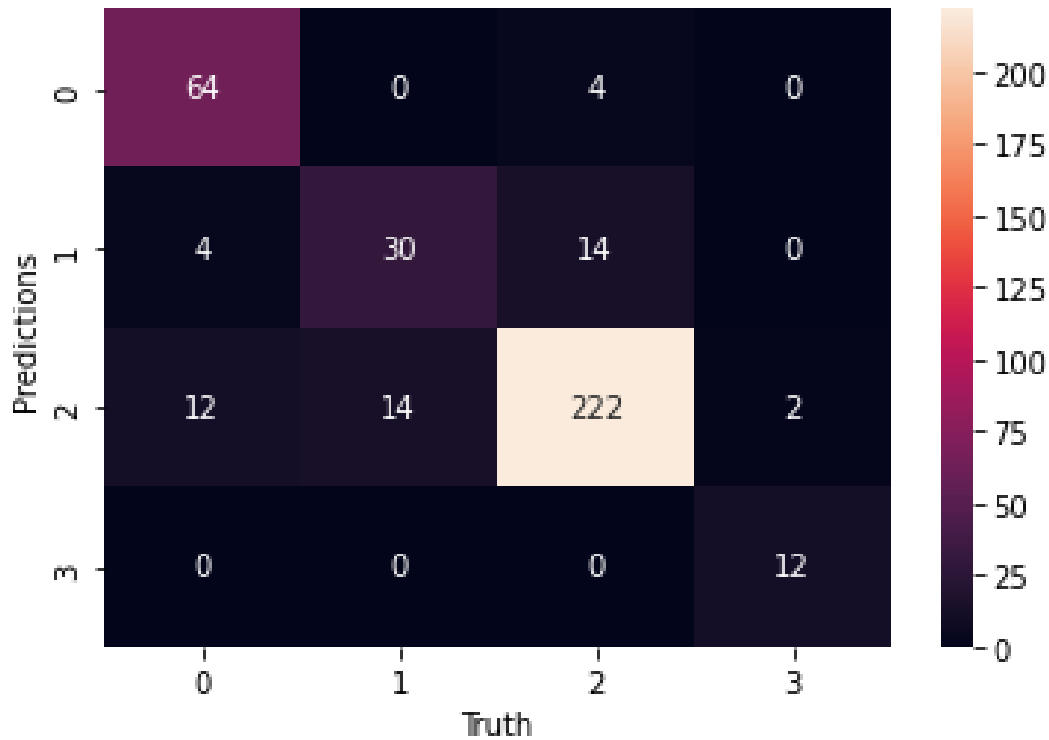


Figure 4.3: Confusion matrix of RF

We can see that the model predicted from the confusion matrix that was just presented, 58 as label-0, 26 as label-1, 242 as label-2, and 4 as labe-3 of parenting style in the test data, whereas the true results are 60 instances of label-0, 34 instances of label-1, 280 instances of label-2, and 4 instances of label-4 data.

#### 4.2.4 XGBoost

XGBoost gave 87.30% accuracy and the train test accuracy is 92.73%. For training using XGBoost, the parameter booster used was “gbtree” which uses tree-based models, the eta value was set at 0.3 which is comparable to the learning rate in GBM, and max\_depth was 6 which indicates the maximum depth of a tree.

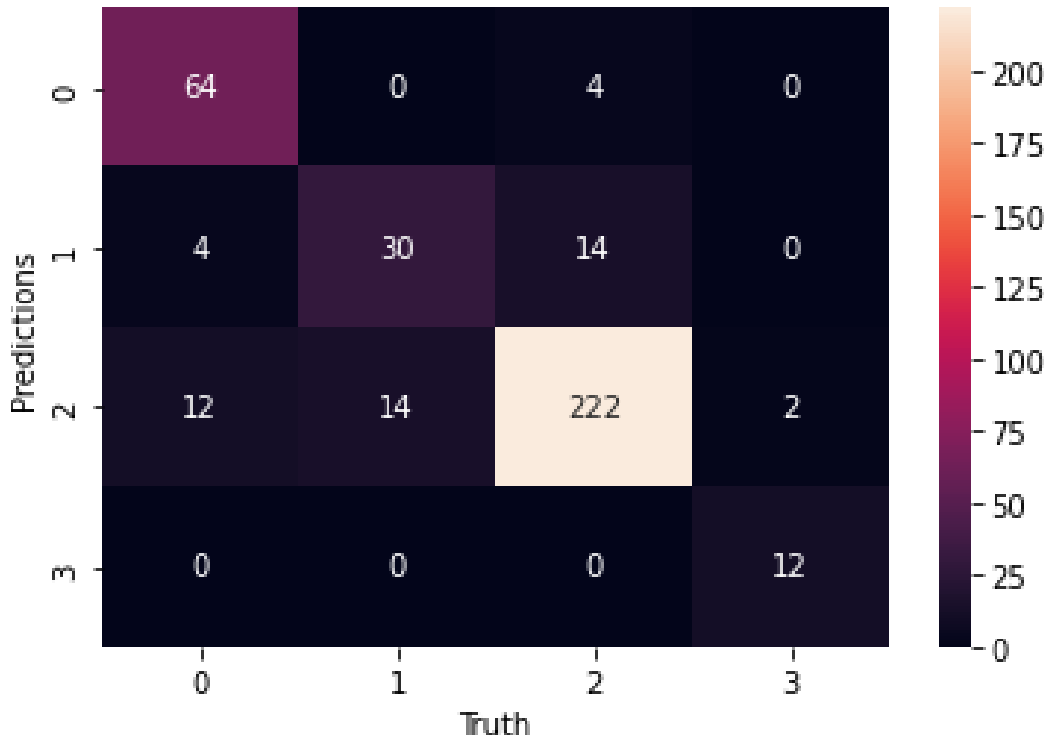


Figure 4.4: Confusion matrix of XGBoost

We can see that the model predicted from the confusion matrix that was just presented, 56 as label 0, 26 as label-1, 236 as label-2, and 12 as label-3 of parenting style for the tested data, but the true results are 60 instances of label-0, 40 instances of label-1, 264 instances of label-2, and 14 instances of label-4 data.

## 4.2.5 Decision Tree

Decision Tree gave 85.185% accuracy and the train test accuracy is 96.82%. For training using the Decision Tree Classifier, the parameters were set in the following manner. `min_samples_split` which denotes the minimal number of samples needed to divide an internal node was set at 50, the splitter used was “best” to choose the best split at each node and the criterion used was “gini”.

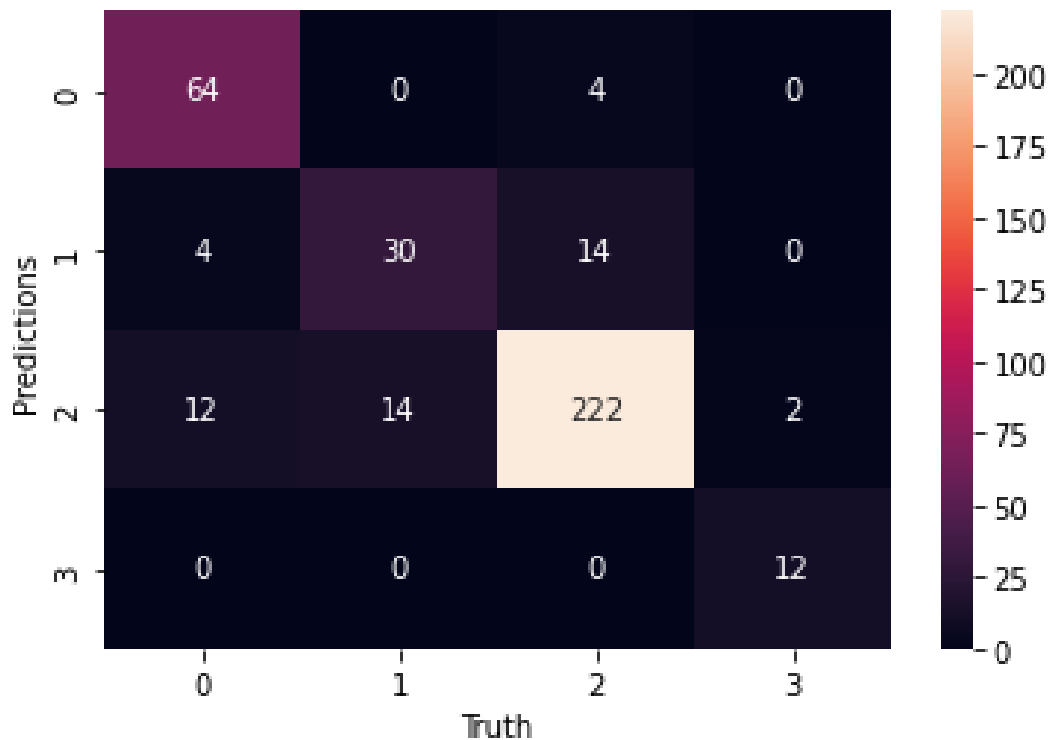


Figure 4.5: Confusion matrix of DECISION TREE

From the confusion matrix we can find that the model predicted 62 as label-0, 32 as label-1, 218 as label-2, and 10 as label-3 of parenting style in the tested data, whereas the true results are 80 instances of label-0, 50 instances of label-1, 240 instances of label-2, and 12 instances of level-4 data.

## 4.3 Model Comparison

Below the comparison between the values of precision, recall and F1-score of the models is shown.

### 4.3.1 Precision

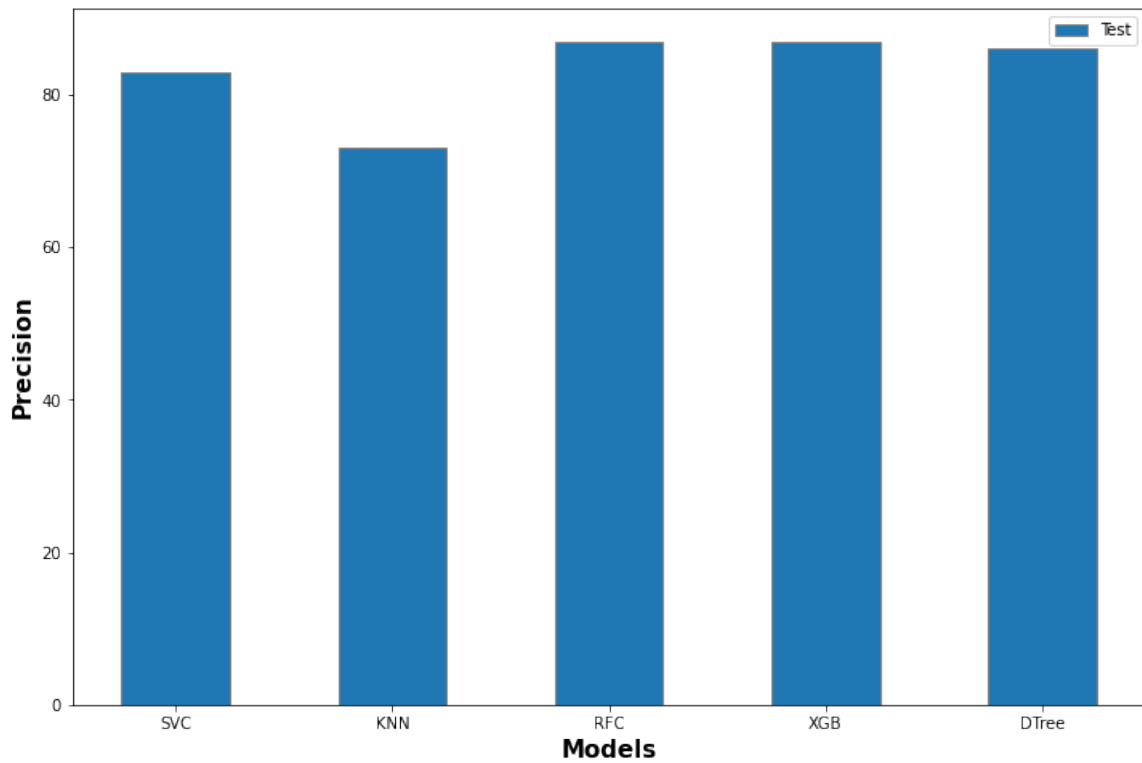


Figure 4.6: PRECISION

The precision score for KNN is 73, SVC is 83, Decision Tree is 86, RFS is 87, and XGBoost is also 87. In terms of precision score value, RFS and XGBoost perform the best.

### 4.3.2 Recall

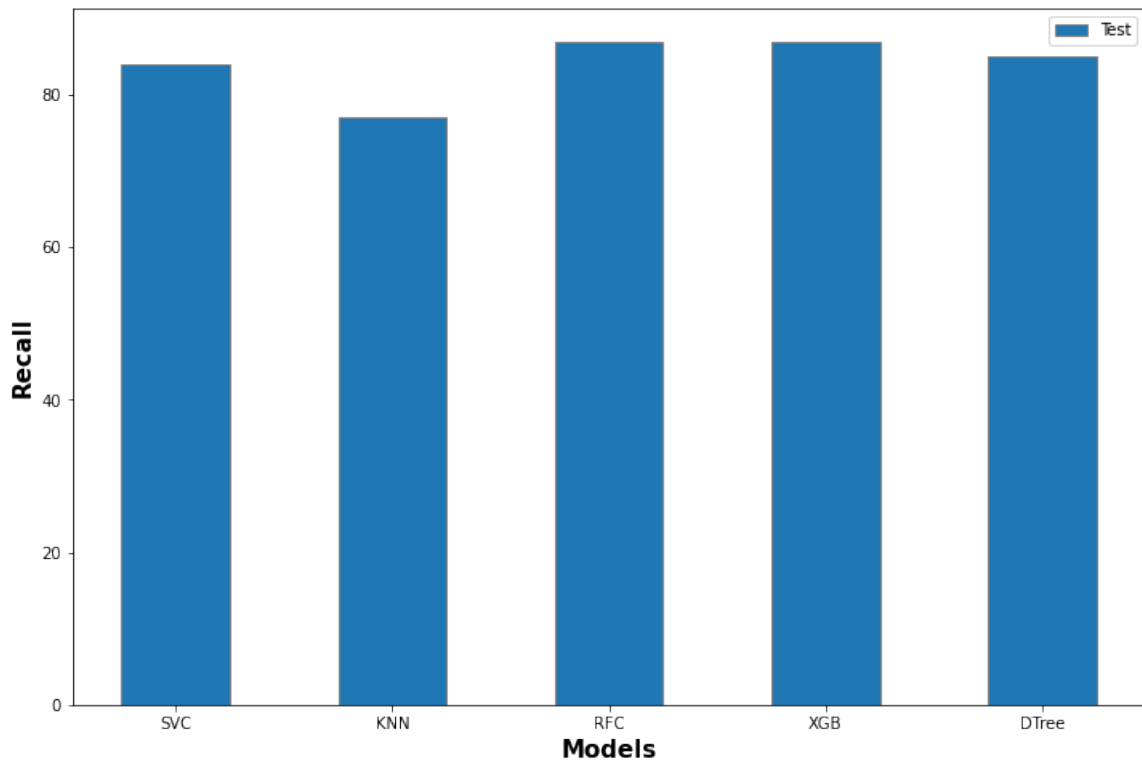


Figure 4.7: RECALL

The recall value for KNN is 77, SVC is 84, Decision Tree is 85, RFS is 87, and XGBoost is also 87. In terms of precision value, RFS and XGBoost perform the best.



### 4.3.3 F1-score

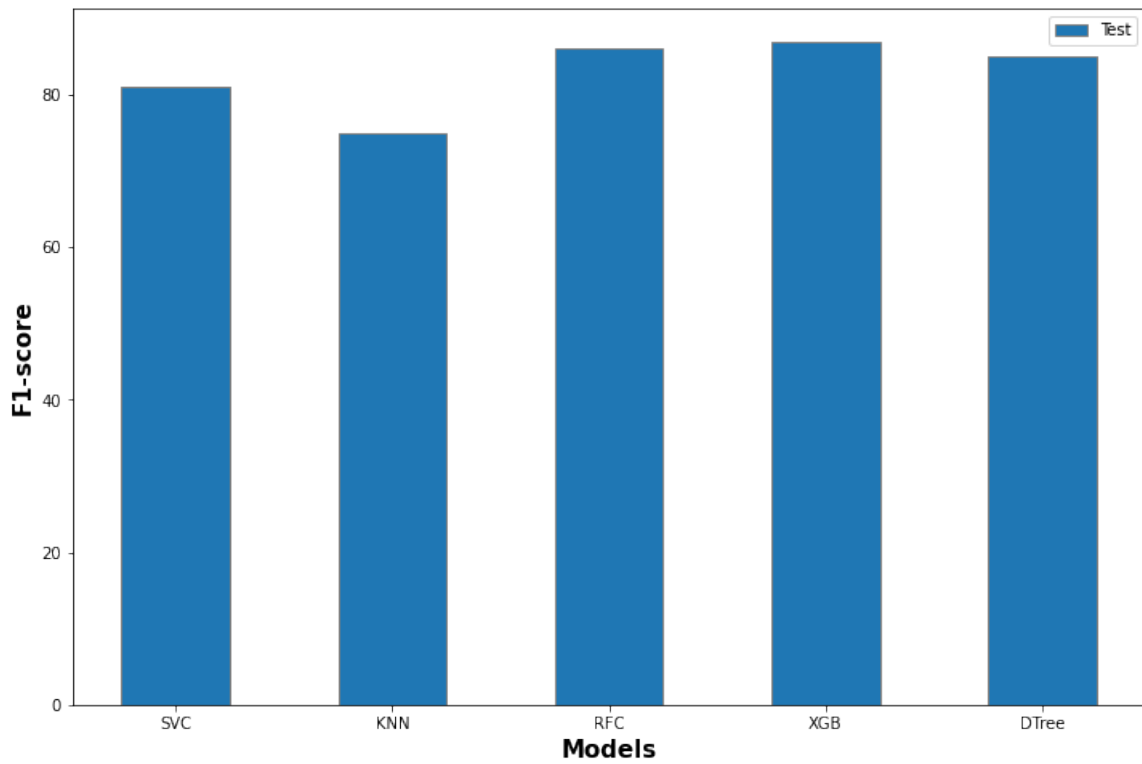


Figure 4.8: F1-SCORE

The F1-Score for KNN is 75, SVC is 81, Decision Tree is 85, RFS is 86, and XGBoost is 87. In terms of precision value, XGBoost performs the best and then RFS.

### 4.3.4 Accuracy

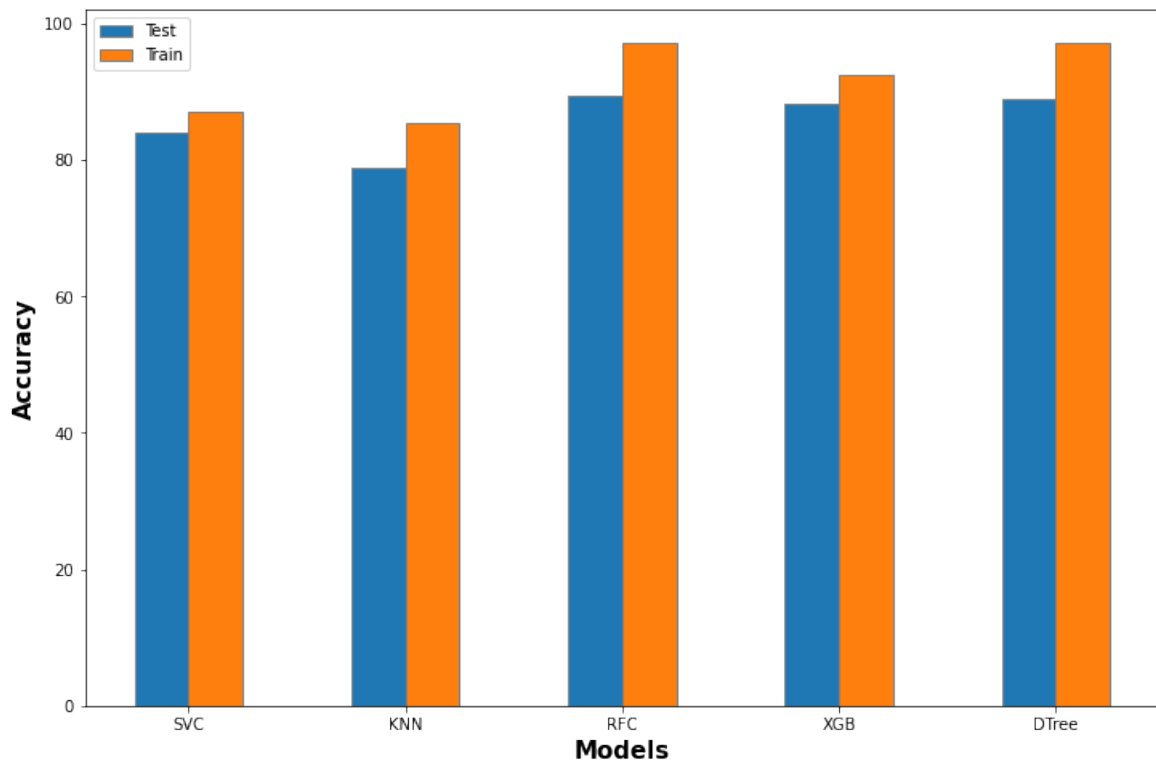


Figure 4.9: Accuracy Analysis

To sum up, It can be evaluated that the XGBoost Classifier among these is the most suitable model, it has the highest accuracy and F1 score. In comparison to other models, the precision and recall scores are also superior. Then the Random Forest model is given higher accuracy, precision, recall and f1 score.

# Chapter 5

## Conclusion and Future Work

### 5.1 Conclusion

Attachment style, anxiety, anger management, stress, and depression levels in children were used in this research's application of machine learning algorithms to determine parenting style. Due to the lack of publicly accessible datasets, the dataset was developed through online survey. Parents shape us and play a vital role in development. Every parents loves their children and wants to give them the best upbringing. Through the whole process, we will help the people to know more about themselves, one can identify what parenting styles they raised with, find own attachment style, can acknowledge the dealing way of depression, anger management, anxiety, stress. For this research, Among the 5 ML model XGBoost is more suitable for this research as it gave 89.3% accuracy, f1 score, precision and recall is 87%. Then, The RF model also performed better, it has only 1% less in F1 score than the XGBoost, which basically represents there is a strong connection between parenting style and the effects. We also come to a conclusion that in Bangladeshi scenario most of the parents follow Authoritative parenting style and the uninvolved parenting style is very few in number. For further work on this research, an app or website will be created when guideline to acquire positive parenting will be given, then as mentioned before one can know thyself more better , and if needed can ask for help, it creates a healthy parent-child relationship, the problems like depression, anxiety, lack of self-esteem etc reduces. They will get to learn how to deal with these issues. This will also make the parent's life more meaningful, they will be less affected by environmental factors, differential factors of father and mother. This will make their life less stressful, if parents are happy and aware enough.

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