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Psikiyatrik Hastalığı Olan Ergenlere Uygulanan Derecelendirilmiş Ölçeklerden Elde Edilen Scalogram Görüntüleri Kullanılarak Bilgisayar Destekli Hastalık Teşhis Tahmini

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ÖZ

Ergenlik dönemi hem ergenler hem de aileleri için zor bir dönemdir. Ergenler üzgün ve karamsardır. Ayrıca ergenler zaman zaman öfke patlamaları yaşayabilirler. Ergenler her şeyden önce anlaşıldıklarını ve kendilerine değer verildiğini hissetmeye ihtiyaç duyarlar. Aksi takdirde, ergenler bu duygularını tatmin etmek için başka bir ortama ihtiyaç duyarlar. Ergenlik, yaşamın zor bir dönemidir ve birey ve aile için psikolojik olarak zorlayıcı bir dönemdir. Ergenlik dönemindeki psikiyatrik hastalıklar tedavi edilmezse, ergenler kalıcı ruhsal bozukluklara maruz kalabilir. Bu bozukluklar kişinin psikolojik rahatsızlığını artırarak devam edebilir. Gençlik, bir ülkenin her alanda gelişmesinde önemli bir faktördür. Bu nedenle ergenlik dönemi uygun şekilde yönetilmeli ve psikiyatrik bir hastalık ortaya çıktığında hızlı bir tanı/tedavi süreci uygulanmalıdır. Ruhsal hastalıkların teşhisi de uzman gözlemine dayanır ve iyi bir uzmanlık gerektirir. Tabii ki bu sistemler karar destek sistemleridir ve son karar uzmanlara bırakılır. Bu çalışmada, ergenlik döneminin zorlu yaşam evrelerinde akıl hastalıklarının otomatik tedavisi için makine öğrenimini araştırmak üzere kullanıyoruz. Literatürde sıkça kullanılan, Random Forest ve Support Vector Machines algoritmaları ile çalışılmıştır. Bu algoritamalarda, işlenmeden kullanılan veri setine göre Scalogram görüntülerinde daha yüksek sınıflandırma başarısı elde edilmiştir. Random Forest: %91, Support Vector Machines: %88.

Computer-Aided Disease Diagnosis Prediction Using Scalogram Images Obtained From Graded Scales Applied To Adolescents With Psychiatric Illness

Research Article

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ABSTRACT

Adolescence is a difficult period for both adolescents and their families. Adolescents are sad and pessimistic. Adolescents may also experience outbursts of anger from time to time. Adolescents need above all to feel understood and valued. Otherwise, adolescents need another environment to

Keywords:
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satisfy these feelings. Adolescence is a difficult period of life and a psychologically challenging time for the individual and the family. If psychiatric illnesses during adolescence are left untreated, adolescents may suffer from permanent mental disorders. These disorders may continue by increasing the psychological disturbance of the person. Youth is an important factor in the development of a country in every field. For this reason, adolescence should be managed appropriately and a rapid diagnosis/treatment process should be applied when a psychiatric illness occurs. Diagnosis of mental illnesses is also based on expert observation and requires good expertise. Of course, these systems are decision support systems and the final decision is left to the experts. In this study, we use machine learning to investigate the automatic treatment of mental illnesses in the challenging life stages of adolescence. Random Forest and Support Vector Machines algorithms, which are frequently used in the literature, are used. In these algorithms, higher classification success was obtained in scalogram images compared to the unprocessed data set. Random Forest: 91%, Support Vector Machines: 88%.

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1.Introduction

Psychiatric disorders in children and adolescents cause difficulties and impairments in many areas of life such as social, emotional, academic and financial areas. Adolescence in particular is a challenging period in which children undergo multifaceted and major changes and make the transition from childhood to adulthood. Adolescence is a sensitive and important period in which, in addition to physical changes, ideas about adult life begin to form, adolescents try to find their identity and self, acquire various social skills, begin to establish close relationships with the opposite sex, make plans about their careers and undergo intense emotional changes. Therefore, as normal development continues during this period, early recognition and treatment of psychiatric disorders is very important. Scientific data such as the fact that the first symptoms of various psychiatric disorders begin in childhood or adolescence and that delayed diagnosis and treatment of some psychiatric disorders leads to poor prognosis show the importance of psychiatric evaluations during this period. Early interventions can ensure that the child completes normal development in biopsychosocial areas and prevent future medical and psychiatric disorders (Çuhadaroğlu et al., 2008; Akçan et al., 2012).

It is very important to work in cooperation with the family and school to address the problems recognized during adolescence. Mental health professionals conduct a comprehensive assessment and gather information about the family's reasons for seeking treatment. Sometimes they use different scales and tests during treatment. Sometimes, family concerns lead to a referral. Based on an assessment of the seriousness and timing of the problem, a caseworker determines a solution to address the youth or family's concern. They also consider the impact of the issue on youth functioning (Agnafors et al., 2020).

A wide range of psychiatric disorders can be seen during adolescence. Attention deficit hyperactivity disorders (ADHD), anxiety disorders, depressive disorders, mood disorders, obsessive-compulsive

disorders, conduct disorders, risky behaviors (behavioral sexual risk, teen pregnancy, etc.), substance abuse and eating disorders are among the common psychiatric disorders (Gizli Çoban et al., 2022).

1.1. Attention Deficit and Hyperactivity Disorder

Attention deficit hyperactivity disorder (ADHD) is a disorder that negatively affects the educational life and social relationships of preschool and school-age children. ADHD is a neurodevelopmental disorder that begins in childhood and can have a lifelong impact, is chronic, and is very common in childhood. ADHD has symptoms that vary according to the age and developmental level of the child. The main symptoms include attention problems, hyperactivity, impulsivity and inability to postpone requests, which are not appropriate for the child's age and developmental level.

It has a multifactorial etiology. In addition to genetic factors, environmental factors such as the mother's alcohol use during pregnancy, malnutrition and food poisoning, exposure to chemical poisons, difficulties during childbirth, exposure to infections and chemical poisons, and iron deficiency also play a role in the etiology of ADHD.

Observation of symptoms and elaboration of patient history, detailed examination of complaints, gathering information from the immediate environment, physiological and neurological examination, as well as rating scales and cognitive tests are used in diagnosis. ADHD is diagnosed by a child psychiatrist after a detailed evaluation and according to the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders (DSM-5 (Diagnostic and Statistical Manual of Mental Disorders)) .

1.2. Oppositional Defiant Disorder

Oppositional defiant disorder is known as a disorder in which children and adolescents constantly have problems with their environment and have problems in obeying the rules. Behaviors such as defiance against parents and defiance against teachers may occur. Symptoms can be listed as follows (Ghosh et al., 2017);

- Frequent moodiness,
- Fights with elders,
- Difficulty in following rules and rejection of rules,
- A state of intense aggression,
- Touchy, resentful behavior,
- He is often vindictive and wants revenge.

1.3. Behavior Disorders

Conduct disorder is a mental problem that can negatively affect the child or adolescent himself/herself, his/her family and the society in which he/she lives. There are two types of the disorder: childhood-onset and adolescent-onset (DSM 5). Childhood-onset conduct disorder usually occurs before the age

of 10. Physical violence, disturbance in peer relationships and problems at school can be considered as symptoms. In adolescence-onset conduct disorder, although there are no symptoms before the age of 10, it is stated that this disorder emerges between the ages of 12-15. Symptoms of conduct disorder (Gupta et al., 2017);

- Physical and verbal aggression,
- Tendency to argue/fight constantly,
- Don't treat animals cruelly,
- Destructiveness,
- Outbursts of anger.
- Anxiety Disorder

1.4. Depression

Depression is unfortunately one of the most common psychological problems of the modern age. It is a problem that draws attention with symptoms such as feeling sad, depressed, hopeless, worthless, withdrawal from social life and withdrawal. Clinical features of depression (Bansal et al., 2009):

- A persistent state of unhappiness,
- Not wanting to do anything, being in a bad mood and reluctant,
- Irritability
- Crying spells, irritability,
- Sleep and eating disorders,
- Excessive weight gain or weight loss,
- Slowness of movements, withdrawal,
- Thinking about death, talking about dying, suicidal tendencies

1.5. Obsessive Compulsive Disorder

Obsessive-compulsive disorder (OCD) is a chronic mental disorder characterized by obsessions and/or compulsions. Obsessions are recurrent thoughts, impulses or images that arise spontaneously, cause distress, and are usually known to be absurd. Compulsions, on the other hand, are motor or mental actions that are usually performed with certain rules in response to an obsession. When the symptoms of this disorder, which can be seen in children and adolescents, are observed by families, treatment should be sought. It is very important to get professional support. Symptoms of obsessive-compulsive disorder (Nazeer et al., 2020);

- Fear of contamination
- Obsession with order and symmetry
- Do not think that you or your loved ones will be harmed
- Continuous hand washing
- Excessive obsession with cleanliness

- Fear of germs
- Constant desire to take a shower
- Counting in certain patterns
- Repeating a prayer, word or phrase internally

1.6. Tic Disorder

Tic Disorders are sudden, fast, involuntary, non-rhythmic movements or sounds. They can be partially suppressed. In most cases, tics and twitches can be harmless and temporary. If they last less than 1 year, they are called transient tic disorders; if they last longer than 1 year, they are called chronic tic disorders. Tic disorders can usually be managed with treatment (Ueda and Black., 2021).

1.7. Adjustment Disorders

Adjustment disorders are defined as the development of emotional and behavioral symptoms that occur within 3 months of the onset of stressors as a reaction to demonstrable stressors and that cause a significant impairment in social, occupational or educational functioning. Exposure to a stressor results in greater and more pronounced distress than expected. If the stressor becomes persistent, the disorder may become chronic (Ferrer and Kirchner, 2021).

Adjustment disorders;

- Short depressive reaction,
- Prolonged depressive response,
- Mixed type with a combination of depression and depressive reactions,
- The type in which behavioral disorders are prominent,
- Combination of emotional disturbance and conduct disorder,
- Type in which other emotional disorders are evident,
- There are seven subtypes, including the type in which other symptoms are prominent.

The type in which other symptoms are prominent can also be exemplified by regressive behaviors such as bedwetting, baby talk and thumb sucking in children.

Depressive symptoms are the most common symptom group in children and adults with adjustment disorder.

Other symptoms are;

- Insomnia,
- Social withdrawal,
- Suicide symptoms,
- Anxiety,
- Reckless driving,
- Aggressive behavior,
- Failure to fulfill legal responsibilities or breaking the law,

- Alcohol and substance abuse.

1.8. Mild Intellectual Disability

Individual with intellectual disability refers to an individual who differs below two standard deviations below the average in terms of intellectual functions, has deficiencies or limitations in conceptual, social and practical adaptation skills, these characteristics occur in the developmental period before the age of 18 and needs special education and support education services. Intellectual disability is the most common and heterogeneous group of individuals in need of special education. It is possible to encounter these individuals in preschool and primary education years. Mostly children with mild intellectual disabilities are recognized by teachers at school. Those with moderate and severe intellectual disabilities may be recognized earlier. It refers to an individual who has a limited need for special education and supportive education services due to his/her mild deficiency in mental functions and conceptual, social and practical adaptation skills (Davison et al., 2022).

1.9. Borderline Personality Disorder Pattern

Borderline personality disorder is a mental disorder characterized by rapidly fluctuating moods, excessive impulsivity, poor self-perception and sensitivity to abandonment, which greatly affects the way of thinking and feeling and causes difficulties in daily life. Instability in moods can be detrimental to many areas of an individual's life and can negatively affect close relationships, school, work, interactions with the social environment or the individual's self-image. The individual's risky behaviors towards themselves (alcohol, substance abuse, suicide attempts, harming someone, risky sexual behaviors, illegal acts, abusive relationships) can affect the quality of life in many ways and can lead to serious problems in daily life (Guilé et al., 2018).

Borderline personality disorder is first seen in young adulthood and more commonly in early adulthood. Most borderline personality disorder, like other mental health problems, can be cured over time with the right treatment and can continue their lives in a quality enough for themselves (Tschan et al., 2017; Coskun et al., 2022).

1.10. Conversion Disorder

Conversion disorder (also known as functional neurological system disorder) is a condition in which a person experiences physical and sensory problem such as paralysis, numbness, blindness, deafness or seizures without an underlying neurological pathology. These problems are serious enough to negatively affect important life functions such as academic performance, social relationships and family life (Brazier and Venning, 1997). Children with conversion disorder do not fake or deliberately fabricate their physical or sensory problems. They are real, but the problems are not caused by underlying medical problems; rather, they are disturbances in the normal functioning of the body. Conversion disorder is usually, but not always, caused by poorly expressed distress that is relieved by the presence of symptoms (Pehlivantürk and Unal, 2002).

Conversion disorder is still a poorly understood diagnosis in children. The name "conversion disorder" refers to the transformation of emotional stress into physical symptoms. However, the same type of physical and sensory problems can occur with or without known psychosocial or traumatic stressors. For this reason, the broader term "functional neurological symptom disorder" is accepted for this condition. Diagnosis and treatment are essentially the same whether or not the problem has an identifiable emotional cause (De Cos Milas et al., 2016).

1.11. Bipolar Disorder

Bipolar Disorder is often characterized by episodes of depression and mania. Depression seen in Bipolar Disorder is generally a severe depression with a more severe course, causing more loss of functioning and more suicidal thoughts and attempts. In mania attacks, symptoms such as seeing oneself as big and strong, decreased need for sleep, being more talkative than usual, flight of ideas, inability to focus attention, easy distraction, increase in purposeful activities, excessive participation in activities that are likely to have bad consequences are observed. It usually starts insidiously and with few symptoms. It can also start acutely in adverse life events and stressful situations. Its course is chronic and continuous (Demeter et al., 2008).

In order to diagnose Bipolar Disorder, there must be an episode of mania or symptoms of mania mixed with depression. In children and adolescents, these episodes of mania and depression may alternate rapidly or may be mixed. The most common symptoms are irritability, overstimulation and restlessness. Irritability, irritability and severe behavioral problems are also common. Especially during mania, the ability to evaluate reality may be impaired. In adolescents, substance abuse and serious violations of rules may occur during these episodes. Unnecessary boasting, self-righteousness, mobility, impulsive and reactive behaviors may be observed in children (Buckley et al., 2023).

It is thought to be a largely genetically inherited mental disorder. Genetic predisposition is higher in Bipolar Disorder that emerges in childhood. Factors such as adverse life events, stressful situations, exposure to neglect and abuse, physical illnesses can cause Bipolar Disorder or trigger attacks (Geller and Luby, 1997).

1.12. Trichotillomania

Trichotillomania is a condition in which a person pulls, twists or plucks their own hair. This hair pulling is not for cosmetic reasons (such as shaping eyebrows with tweezers) and usually causes distress. It can start at a young age (under 5 years old), but when it starts this early, the child usually stops. When hair pulling starts later in life, in the pre-adolescent or adolescent years, it can be more persistent and last into adulthood (Grant, 2019).

The etiology is not known for certain, but biological, behavioral, learning and psychological factors are involved in its development.

1.13. Psychotic Disorders

Serious mental problems that interfere with a child or adolescent's ability to think clearly, react emotionally, communicate normally, have unusual perceptions (hallucinations), have delusions (a false, fixed, bizarre belief), understand reality and behave appropriately are known as psychotic disorders (Stevens et al., 2014). Psychotic symptoms are seen in children and adolescents with schizophrenia, depression, bipolar disorder and some forms of alcohol and drug addiction.

Psychotic disorders are often the result of a complex network of underlying genetic, hereditary, psychological and environmental factors. Sometimes they occur secondary to an underlying medical condition, such as a brain tumor, brain infection, blood salt imbalance (and other metabolic disorders), seizure disorder, and others (Ringbom et al., 2022). Most young people will need multiple interventions, comprehensive community programs, medications, psychotherapy, family support, vocational and rehabilitation assistance, special education programs, residential and/or inpatient treatment to manage symptoms.

Artificial intelligence applications are being studied by scientists in many fields, from autonomous systems to the creation of expert decision support systems in disease diagnosis, and high successes are being achieved. These achievements of artificial intelligence have now turned theoretical studies into practice. When the literature is examined, it is seen that the application of artificial intelligence / machine learning methods in psychiatric diseases of children and adolescents is not as much as studies for other diagnostic methods. It is very important that psychiatric diseases of young people, who are the guarantee of our future, are diagnosed and treated urgently. Fast and accurate diagnosis is important as in all diseases and needs an objective approach. Machine learning based expert decision support system offers this objective approach based on the studies in the literature. In this study, automatic diagnosis of psychiatric disorders in adolescents will be attempted using DSM 5 and various scales. Figure 1 shows the block diagram of the study.

Timely and accurate diagnosis of these illnesses is of critical importance. The effective involvement of children and adolescents who are diagnosed quickly and accurately in treatment processes is of great importance in terms of preventing negative effects on families and society. For this reason, diagnosis and treatment processes need to be free from errors made by specialised physicians. Machine learning, as a sub-branch of artificial intelligence, is used in a wide range of applications from autonomous vehicles to production processes, quality control applications to various biomedical imaging and blood value analyses. In fact, studies are currently being carried out on artificial intelligence-supported robots that assist doctors in surgical interventions. Although the future role of artificial intelligence is frequently discussed and is a matter of concern, it is clear that with the right applications and generally accepted protocols, it will improve the quality of human life. In this direction, our study aims to create a decision support system that helps the expert to diagnose psychological disorders in adolescents quickly and accurately. In this direction, 5 different tests were used to diagnose adolescents who applied to the clinic with suspicion of illness. Numerical values of these tests were applied various algorithms

to obtain scalogram images. Then, these images were preprocessed with Sobel filter and finally, Random Forest and Support Vector Machines algorithms were used for diagnostic classification.

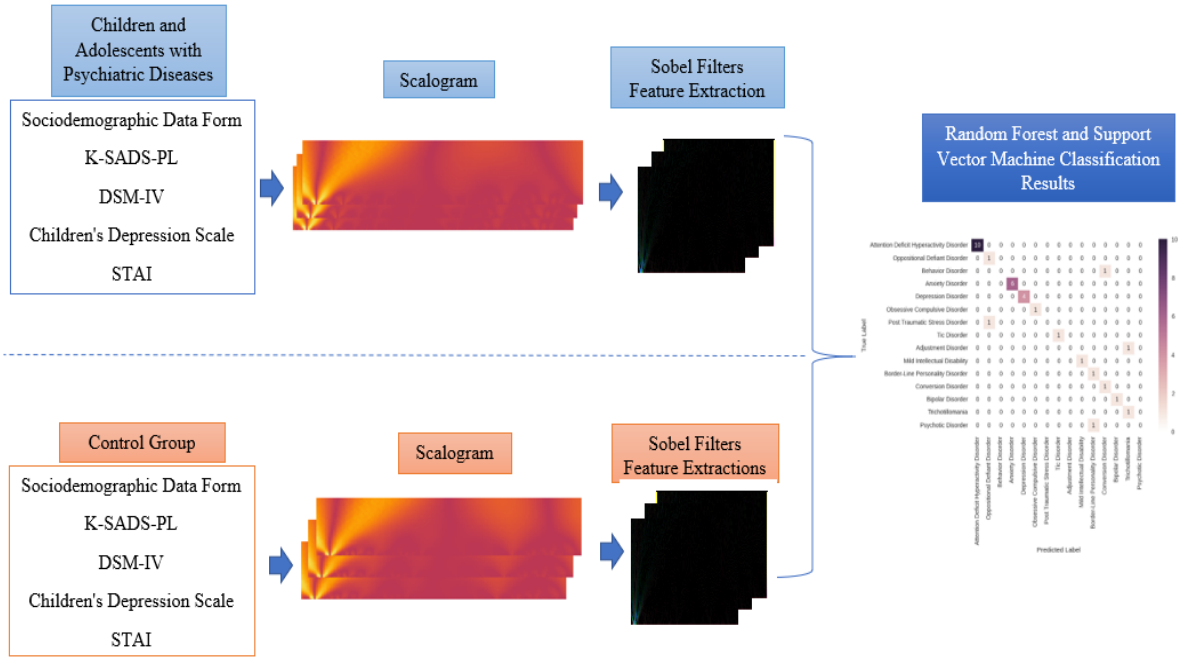

Figure 1. Block diagram

2. Dataset

The sample of this cross-sectional study consisted of adolescents between the ages of 11 and 18 with at least one psychiatric disorder according to DSM 5 who applied to Kahramanmaraş Sütçü İmam University Faculty of Medicine, Child and Adolescent Psychiatry Polyclinic. A total of 160 adolescents, 81 girls and 79 boys, were included in the study.

Inclusion criteria;

1. Being between the ages of 11-18,
2. Having at least one psychiatric diagnosis according to DSM 5
3. Absence of severe intellectual disability in both the child and the parents, which would complicate the implementation of the K-SADS-PL.
4. Information obtained from the files that completed the questionnaire forms completely.

A data set was created with the scale values obtained with the forms described below, and classification was made with machine learning methods for the diagnosis of psychiatric illness in adolescents.

2.1.1. Sociodemographic Data Form

This form was developed by the researchers and used to collect sociodemographic characteristics of adolescents and their families. The content of the data included the adolescent's name, age, gender, education level, number of siblings, place of residence, parents' age, field of education, occupation, presence or absence of mental illness, family relationship between parents, monthly income of the child, psychiatric, etc. The mother's care problems during pregnancy, treatments received, method of delivery,

history of prematurity, family type, additional medical history, medications, time of saying first words, how long she breastfed, whether the child had a known medical condition, and if any, medication history for medical illness.

2.1.2. Affective Disorders and Schizophrenia Interview Schedule for School-Age Children Now and Lifespan Version

The CGVI-SDI was developed by Kaufman et al. in 1997 and translated into Turkish by Gökler et al. in 2004. An interim study was conducted to determine lifetime and current psychopathology according to the Diagnostic and Statistical Manual of Mental Disorders-IV, DSM 5 and interview-style diagnostic criteria. The form consists of three parts. Initial information, general information such as child demographics, general health status, previous psychiatric admissions and treatments, family and age relationships, school status and other school information are structured and not considered as a starting point. The second part of the diagnostic screening includes screening questions and an assessment report documenting disease-specific psychiatric symptoms. If the screening is positive, an additional list of symptoms is requested to further narrow down the psychopathology. In interviews, the symptom structure is graded as "unavailable", "subconscious" and "threshold". The subconscious level of acquisition is not sufficient to detect errors, but is a pool for further investigation of specific errors. The parents and children in the Affective Disorders and Schizophrenia Interview Schedule for School-Age Children Now and Lifespan Version (K-SADS-PL) expanded the knowledge gained through interviews and assessments to everything they eventually saw (mother, father, child, school, etc.). With adolescents, parents are the first to be interviewed. When working with young people, they are spoken to first. The clinician uses his/her own clinical perspective to separate information from other sources. Psychotic disorders, mood disorders, anxiety disorders, disruptive behavioral disorders, substance abuse, externalizing disorders, tic disorders and eating disorders are assessed with the K-SADS-PL. The third part is a general rating scale used to determine the level of functioning of the child or young person at the time of assessment (Kaufman et al., 1997; Gökler et al., 2004).

2.1.3. DSM-5 Based Disruptive Behavior Disorders Symptom Screening Scale (DBDSS)

Developed in 1994 by Prof. Dr. Atilla Turgay, the validity and reliability of the scale was investigated by Prof. Dr. Eyüp Sabri Ercan and colleagues in 2001. The scales are completed by the child's parents or teachers and allow the child to be rated for attention deficit hyperactivity disorder, oppositional defiant disorder and conduct disorder. Nine attention deficit questions (1-9). The items include 9 items related to hyperactivity/impulsivity (items 10-18), 8 items related to oppositional defiant disorder (items 19-26) and 15 items related to conduct disorder (items 27-41) for a total of 41 items. The person filling out the form is asked to mark 0, 1, 2 or 3 of the items describing each symptom. Each item is scored as None = 0, Less = 1, A lot = 2, Very much = 3. In order to talk about attention deficit, at least 6 of the 9 items associated with this symptom must be 2 or 3. The presence of oppositional defiant disorder (ODD)

requires a score of 2 or 3 on at least 4 of the 8 items, and a diagnosis of conduct disorder (CD) requires a score of 2 or 3 on at least 3 of the 15 items. The analyses performed on the subscales of the DSM 5 Based Disruptive Behavior Disorder Screening and Rating Scale were found to be reliable and valid. Cronbach's alpha coefficients for the subscales are Attention Deficit 0.88, Hyperactivity 0.95, Oppositional Defiant Disorder 0.89, Conduct Disorder 0.85 (Turgay et al., 1997; Ercan et al., 2014).

2.1.4. Depression Scale for Children (DSC)

In 1981, Kovacs developed the Children's Depression Inventory (CDI), which was developed to measure the severity of depression in children and adolescents, revised by Oy in 1991, validity and reliability studies were conducted and translated into Turkish. The Child Depression Inventory is reported to be an excellent scale for determining the severity of depression. It is a self-assessment scale that can be applied to children aged 6-17 years. The scale is read or completed by the child. The application will take approximately 25-30 minutes. Out of 27 points, there are three options for each item. Children are asked to choose the most appropriate statements from the last two weeks. For example; 1. Sometimes I feel sad. 2. I am often sad. 3. I am always sad. Each item is worth 0, 1 or 2 points depending on the severity of the symptoms. Opposite items on the scale are reverse scored. These items are 2,5,7,8,10,11,11,13,15,16,18,21,24,25. The score is calculated in such a way that questions marked with 0 are counted as 2,2 points. The maximum score that can be obtained from the scale is 54. The higher the score, the more severe the depression. A pathologic cut-off score of 19 is recommended (9, 10). Oy reported the test-retest reliability of the Depression Scale in Children as 0.70 and the internal consistency as 0.80 (Kovacs, 1981; Oy, 1991).

2.1.5. State–Trait Anxiety Inventory (STAI)

Developed in 1970 by Spielberger and colleagues, it is a self-assessment scale. The scale has two sub-dimensions, the Trait Anxiety Scale and the State Anxiety Scale, each consisting of 20 items. The State Anxiety Scale determines the anxiety level of an individual at a specific time and situation, while the Trait Anxiety Scale determines the general anxiety level of the individual regardless of the situation. It is an easy-to-use, self-completion scale (Spielberger, 1970; Öner and Le Compte, 1985). Both scales can be used at the same time. In this case, the State Anxiety Scale should be completed first and then the Trait Anxiety Scale. The scale can be completed individually or as a group and takes approximately 20 minutes to answer without any time limit. The State Anxiety Inventory includes 1=none, 2=somewhat, 3=very much, 4=completely options according to the severity of the feelings, thoughts and behaviors expressed by the item. In the anxiety trait scale, you should choose the appropriate option from 1=never, 2=sometimes, 3=often, 4=almost always. Representations and even inverted representations should be considered when scoring. The evaluation of inversions converts 1 to 4, 4 to 1 and so on. Total scores on both scales range from 20 to 80. A high score indicates a high level of anxiety and a low score indicates a low level of anxiety. The State-Trait Inventory of Private Fear has two types

of statements. Direct statements express negative emotions and reverse statements express positive emotions. The inverse statements for the State Anxiety Inventory are 1, 2, 5, 8, 10, 11, 15, 16, 19 and 20. The inverse statements for the Trait Anxiety Inventory are items 1, 6, 7, 10, 13, 16 and 19. After determining the total scores of the direct and inverse statements separately, they are subtracted from the total score of the inverse statements. The total score assigned to the direct statement is taken. A predetermined constant value is added to this number. This constant value is 50 for the State Anxiety Inventory and 35 for the Trait Anxiety Inventory. The average score recorded in the application varies between 36 and 41. A score between 0-30 indicates low anxiety, 31-49 indicates moderate anxiety, and 50 and above indicates high anxiety (Caci et al., 2003).

An example of the data set is given in Figure 2.

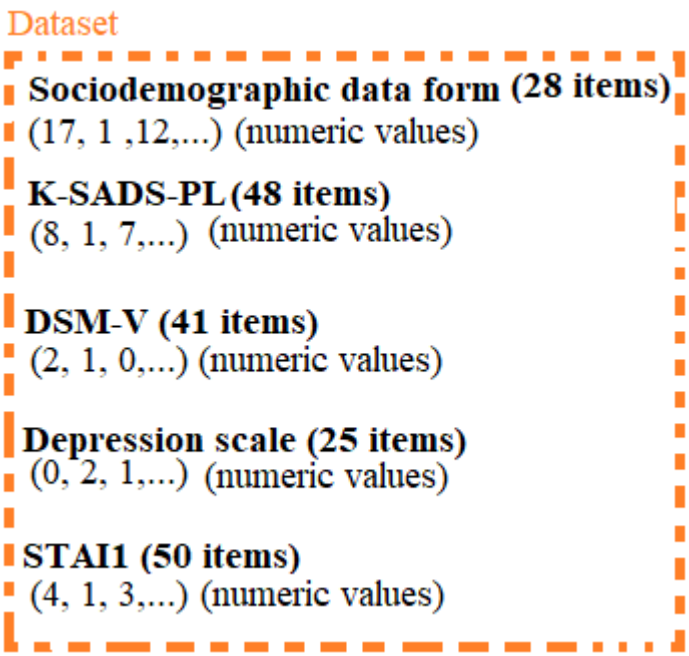

Figure 2. Dataset example

3. Method

In the study, a database was created from the graded scales applied to children and adolescents. This database was converted into images using the Scalogram method. In order to process Scalogram images with computer-aided software, the second step of the study is to extract various features from the images. In the last step, the features extracted from the images are classified using machine learning Methods . Python software and libraries were used for the computer-aided applications throughout the study.

3.1.1. Scalogram

The scalogram is the absolute value of the continuous wavelet transform coefficients of a signal. The wavelet transform is a more powerful time-frequency transform than the traditional cosine and Fourier transforms (Li and Zhou, 2016). Morlet introduced the wavelet as a family of translations and dilations

from a single function called the mother wavelet. This new signal processing was developed more efficiently by Mallat, Meyer, Daubechies and Grossman and became a popular technique in biosignal analysis. Instead of analyzing Fourier transforms at a single scale (time or frequency), wavelet transforms are analyzed on a multiscale basis. A wavelet is a windowing method with different resolutions for regions. Wavelet decomposition maps a signal onto a time scale plane using a scale instead of frequency. This is the same as the time-frequency plane in the short-time Fourier transform (STFT), with each scale of the time-scale plane representing a specific frequency range of the time-frequency plane. A wavelet- a small waveform- is a localized wave for a limited time. Comparing wavelet with Fourier transform, Fourier analysis decomposes the signal into sinusoids of different frequencies, while wavelet decomposes the signal from a mother wavelet into shifted or scaled shapes (Sejdic et al., 2008; Salles and Ribeiro, 2023).

As can be seen in Equation 1, the continuous wavelet transform (CWT) for signal f(t) is defined as the integration of f(t) with shapes shifted or scaled from a mother wavelet ψa, b(t).

$$CWT(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} f(t) * \psi\left(\frac{t-b}{a}\right) dt \quad (1)$$

$$a \in R^{+} - \{0\}, B \in R$$

In other words, as seen in Equation 2, the CWT is the sum of the signal multiplied by the shifted and scaled shapes from a mother wavelet ψ.

$$CWT(scale, position) = \int_{-\infty}^{+\infty} f(t) * \psi(\text{scale}, \text{posisiton}, \text{t}) dt \quad (2)$$

The original fundamental wavelet ψ(t) is called the mother wavelet and its variations ψa,b(t) are called daughter wavelets. The daughter wavelets are shifted or scaled shapes from a mother wavelet. 'a' is the scale factor to scale the ψ(t) function, while 'b' is a shift factor to translate the ψ(t) function. The result of the CWT is a matrix filled with wavelet coefficients fitted according to scale and position. Figure 3 shows scalogram images from graded scales administered to adolescents with different psychiatric illnesses. A 160x192 matrix is created from our input data set. Here, the number of rows comes from the number of 160 patients and the number of 192 columns comes from the total number of items of 5 different scales. With the applied scalogram algorithm, 224x224 images are obtained.

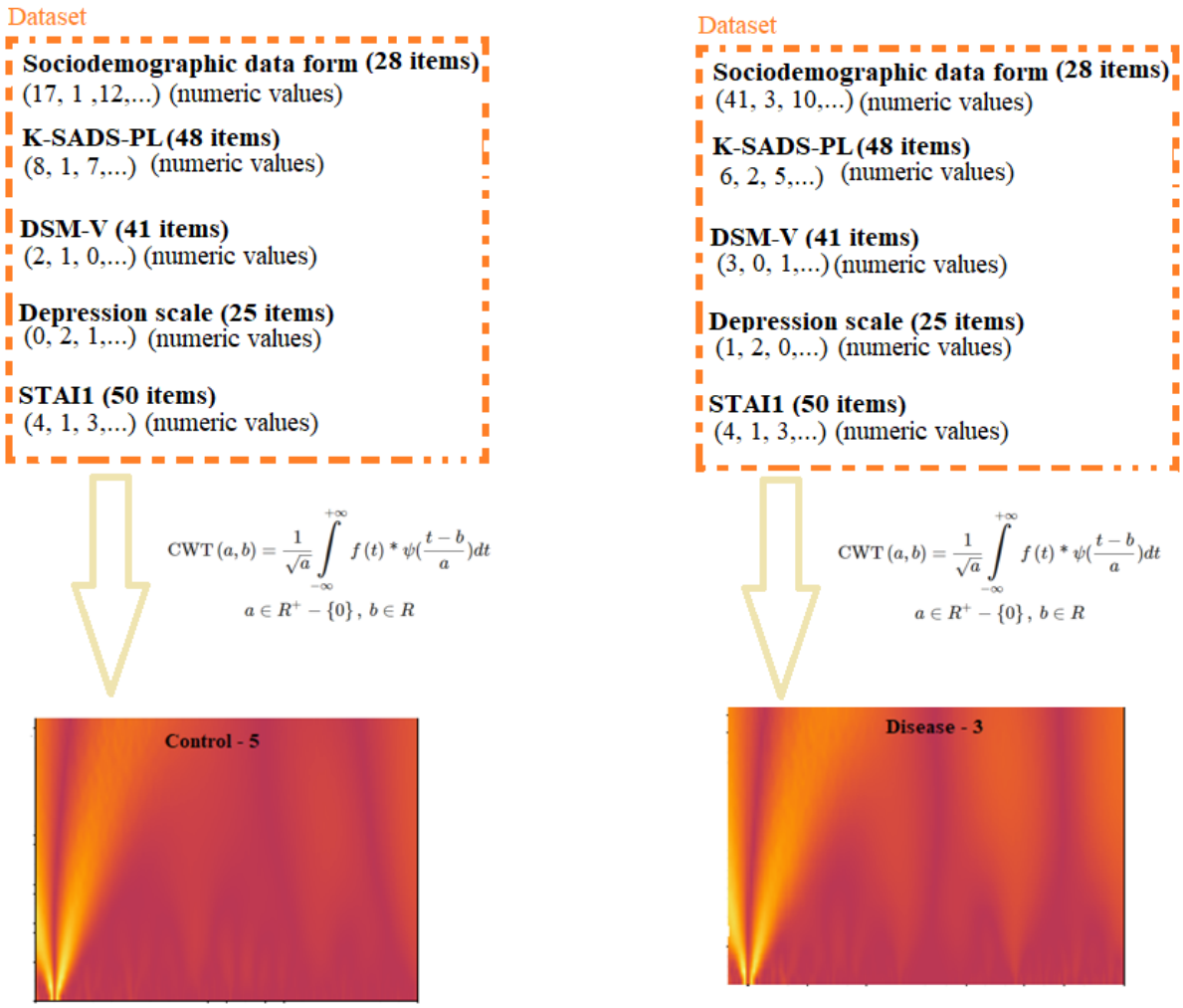

Figure 3. Scalogram images obtained from the dataset

Scalogram images obtained from signals cannot be processed in machine learning methods in this state. Machine learning methods work by extracting various features from images. Although there are different feature extraction methods in the literature, some of them have proven themselves since they are now being studied on many different images and give high performance results. One of them is the Sobel Filter, and this method was used in our study to extract features from images. The features extracted with the filter are automatically classified in Support Vector Machines and Random Forest machine learning methods, which have proven themselves in different datasets and are widely used in the literature.

3.2. Sobel Filter

In computer vision and digital image processing, the Sobel operator is a popular edge detection algorithm used to identify and highlight boundaries in an image. The Sobel operator performs a 2D spatial gradient operation on the image, primarily providing high spatial frequency fields corresponding to edges (Tian et al., 2021).

Sobel filter was applied to the scalogram images obtained in our study. As a result of applying Sobel filter to the 224x224 size images obtained with scalogram, 224x224 size processed images were obtained.

Edge detection is critical in many applications such as object detection and recognition, scene understanding and feature extraction. By understanding where an object begins and ends, computers can more efficiently identify and categorize it (Zhang Jin-Yu et al., 2009).

Essentially, the Sobel operator is a mechanism that predicts changes in the intensity levels of an image. It is like a tool that helps us see where colors in an image change suddenly or slightly, implying edges or boundaries in the image.

The Sobel filter uses two 3×3 kernels convolved with the original image- one for horizontal changes and one for vertical changes- to approximate the derivatives. If we define A as the source image and Gx and Gy as the two images containing the horizontal and vertical derivative approximations at each point, respectively, the calculations look like Equation 3. Here '*' stands for the convolution process of 2D signal processing.

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} * A \; and \; G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * A \tag{3}$$

Since the Sobel kernels can be decomposed as the product of an average and a differentiation kernel, they compute the gradient with smoothing as seen in Equation 4.

$$G_x = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} * ([+1 \quad 0 \quad -1] * A) \; and \; G_y = \begin{bmatrix} +1 \\ 0 \\ -1 \end{bmatrix} * ([1 \quad 2 \quad 1] * A) \tag{4}$$

Here the x-coordinate is defined as increasing in the "right" direction and the y-coordinate is defined as increasing in the "down" direction. At each point in the image, the resulting gradient approximations can be combined as in Equation 5 to give the gradient magnitude.

$$G = \sqrt{G_x^2 + G_y^2} \tag{5}$$

Using this information, the direction of the gradient Θ can also be calculated using the formula in Equation 6. It is 0 for a vertical edge that is lighter on the right-hand side in the equation.

$$\Theta = atan2(G_y, G_x) \tag{6}$$

The resulting images were classified using proven feature extraction (Sobel) and classification methods that are frequently used in the literature. Figure 4 shows the scalogram image of one of the data in the dataset.

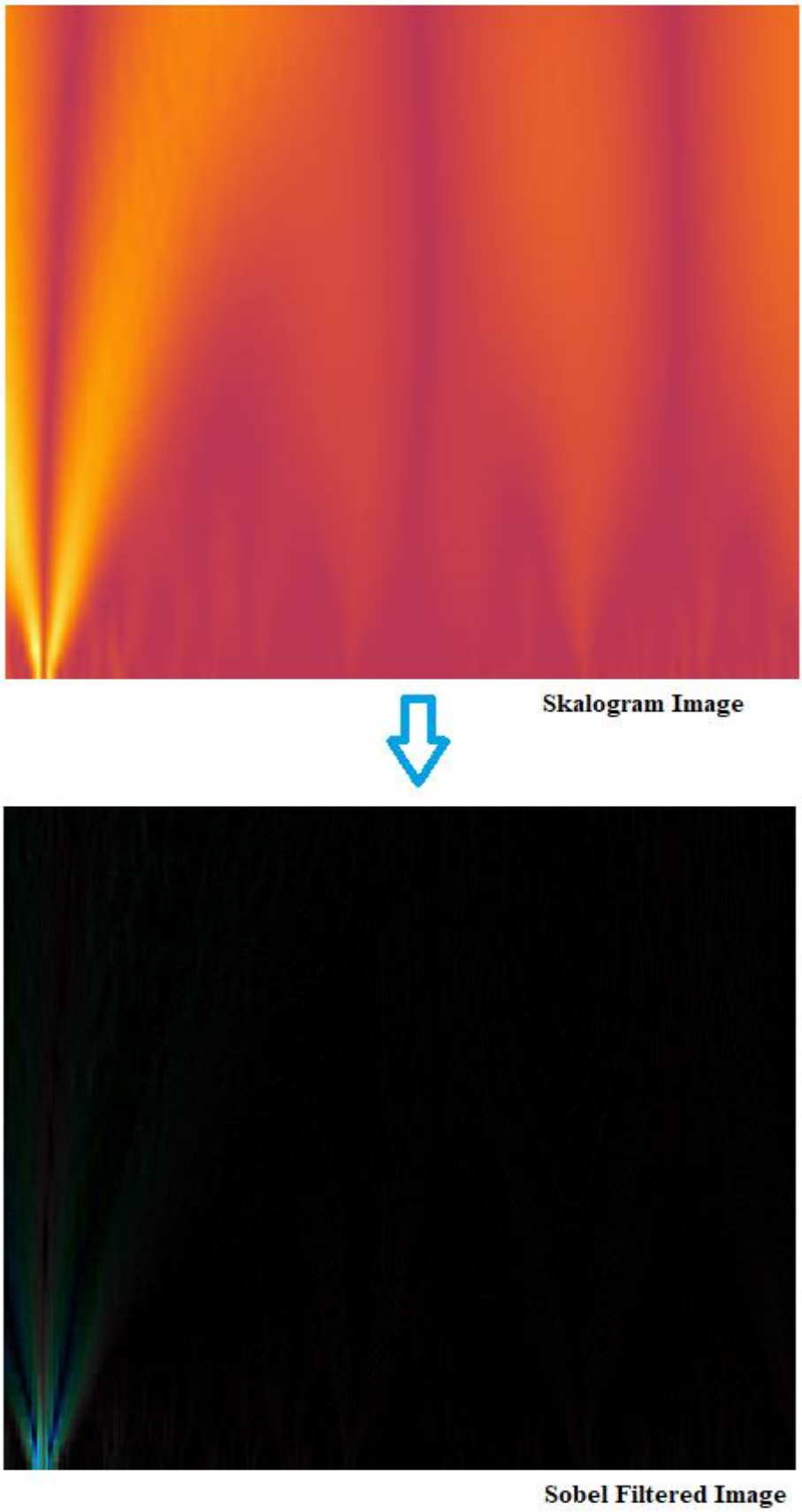

Figure 4. Sobel Filter image obtained from Scalogram images

3.3. Random Forest

Random Forest is a supervised learning algorithm. As the name suggests, it creates a forest and does so in a somewhat randomized way. The "forest" it builds is a collection of decision trees, often trained by "bagging". The general idea of bagging is that a combination of learning models increases the overall result (Sun et al., 2024).

In simple words: A random forest generates multiple decision trees and combines them to obtain a more accurate and stable prediction.

A big advantage of random forest is that it can be used for both classification and regression problems, which make up the majority of existing machine learning systems. Figure 5 shows an architectural example of a Random Forest.

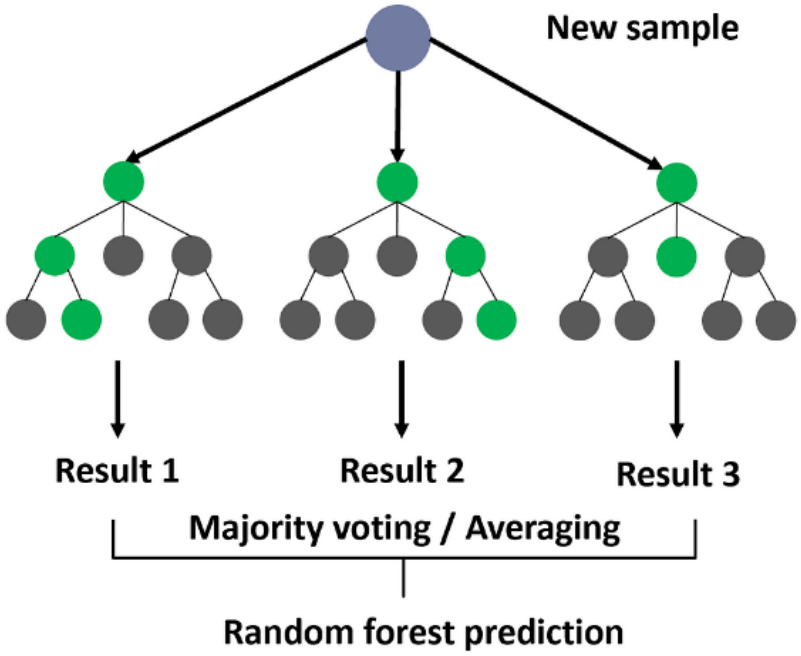

Figure 5. Random forest.

Random Forest has approximately the same hyperparameters as a decision tree or a bagging classifier. One does not have to combine the decision tree with a bagging classifier and can easily use only the Random Forest classifier. In this method, regression tasks can also be taken care of using the Random Forest regressor. Random Forest adds additional randomness to the model when growing trees. Instead of looking for the most important feature when partitioning a node, it looks for the best feature among a random subset of features. This results in a wide variety, often resulting in a better model. In a Random Forest, only a random subset of features is considered by the algorithm for splitting a node. It can even make trees more randomized by using random thresholds for each feature, instead of searching for the best possible thresholds (like a normal decision tree) (Zhao et al., 2024).

3.4. Support Vector Machine

The Support Vector Machine (SVM) is a supervised machine learning algorithm used for both classification and regression. It is best suited for classification, although we also call it regression problems. The main goal of the SVM algorithm is to find the optimal hyperplane in an N-dimensional space that can separate data points of different classes in the feature space. The hyperplane works so that the margin between the closest points of different classes is as maximum as possible. The size of the hyperplane depends on the number of features. If the number of input features is two, the hyperplane is just a line. If the number of input features is three, the hyperplane becomes a 2-dimensional plane. When the number of features exceeds three, a complex structure will be formed (Yin et al., 2023).

SVM Assume two independent variables x1, x2 and a dependent variable which is either a blue circle or a red circle as shown in Figure 6 (a). The hyperplane that separates the data points or makes a classification between the red and blue circles is a line and it can be seen that there is more than one line considering only two input features x1, x2. The best hyperplanes to represent the best separation or margin between the two classes are in Figure 6(b). Therefore, it is necessary to select the hyperplane whose distance to the nearest data point on each side is maximized. If such a hyperplane exists, it is known as the maximum margin hyperplane/hard margin. So in Figure 6(b) above, select L2. Here there is a blue ball on the border of the red ball. The blue ball on the border of the red balls is the outlier of the blue balls. The SVM algorithm has the ability to ignore the outlier and finds the best hyperplane that maximizes the margin. SVM is robust to outliers. So, what SVM does in such data points is to find the maximum margin, as in the previous data sets, and add a penalty every time a point crosses the margin. So the margins in such cases are called soft margins. When there is a soft margin in the dataset, the SVM tries to minimize (1/margin+∧(∑penalty)). Hinge Loss is a commonly used penalty. If there is no violation, there is no Hinge Loss; if there is a violation, there is Hinge Loss proportional to the violation distance (Alfaleh et al., 2023). SVM solves this by creating a new variable using a kernel as shown in Figure 6(c). A point on the line is called xi and a new variable yi is created as a function of distance from the origin o. In this case, the new variable y is created as a function of distance from the origin. A nonlinear function that creates a new variable is called a kernel and the structure shown in Figure 6(d) is obtained.

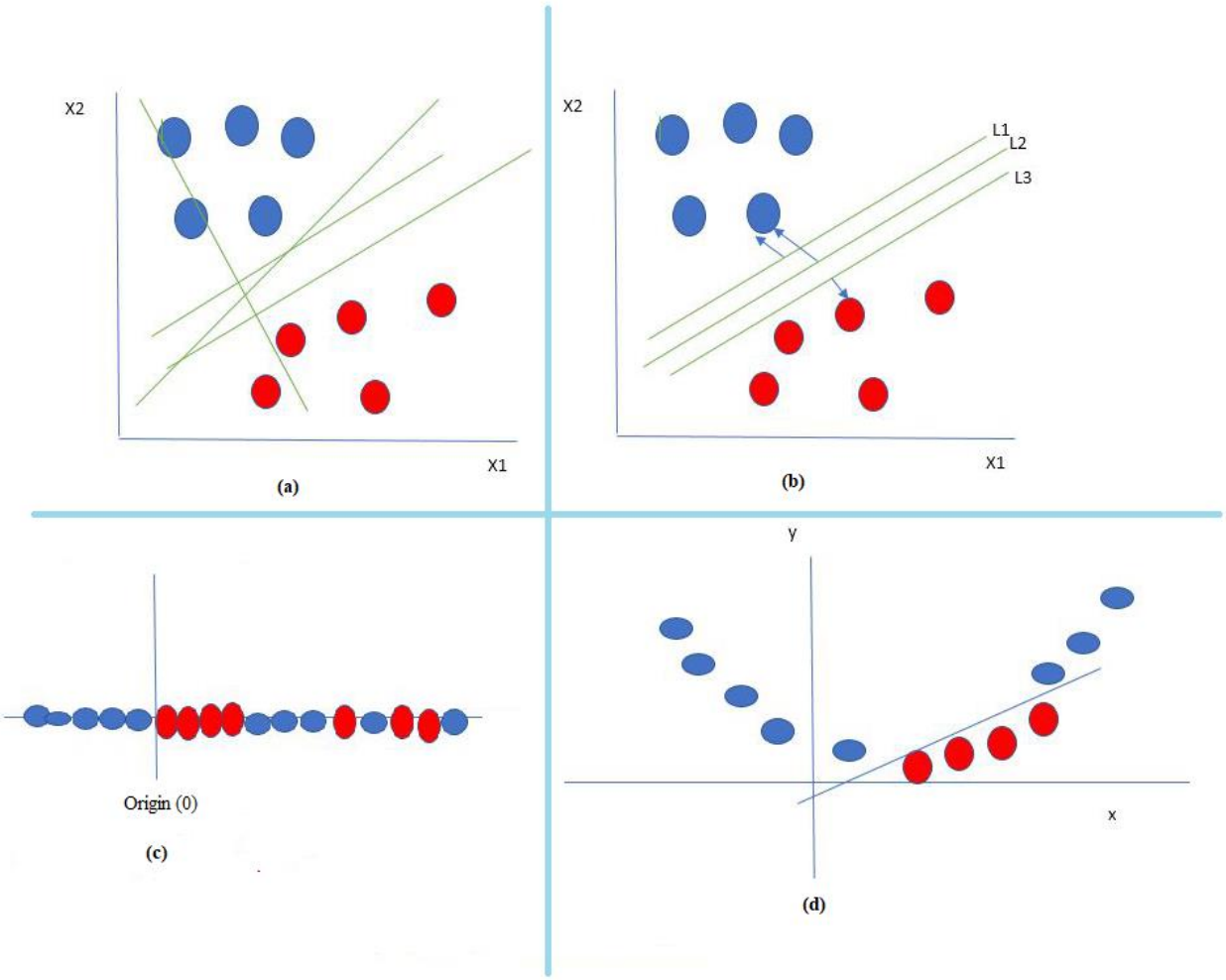

Figure 6. Support vector machine

4. Results and Discussion

The classification success of the unprocessed 1D data and the scalogram images created by processing the data are given in Table 1. As can be seen in Table 1, higher classification success was achieved in the scalogram images obtained by processing the data. In addition, the Random Forest method achieved higher success in Scalogram and unprocessed data.

Table 1. Success comparison of scalogram image and raw data sets

	Classification success with 1D raw data set	**Classification success with 2D Scalogram images**
Support Vector Machines	%75	%88
Random Forest	%86	%91

The filtered and feature extracted images are classified using Support Vector Machines and Random Forest methods. Machine learning based automatic classification results are interpreted with Confusion Matrix and Receive Operator Curve (ROC) curves. Thanks to these two methods, the classification results can be analyzed in detail.

In particular, the Confusion Matrix provides the opportunity to see the correct and incorrect label-based classification. Figure 7 shows the Confusion Matrix obtained with the Support Vector Machines method and Figure 8 shows the Confusion Matrix obtained with the Random forest method. There are 32 data without any training and 4 of them are calculated in different classes. Support Vector Machines performed up to 88% correct classification.

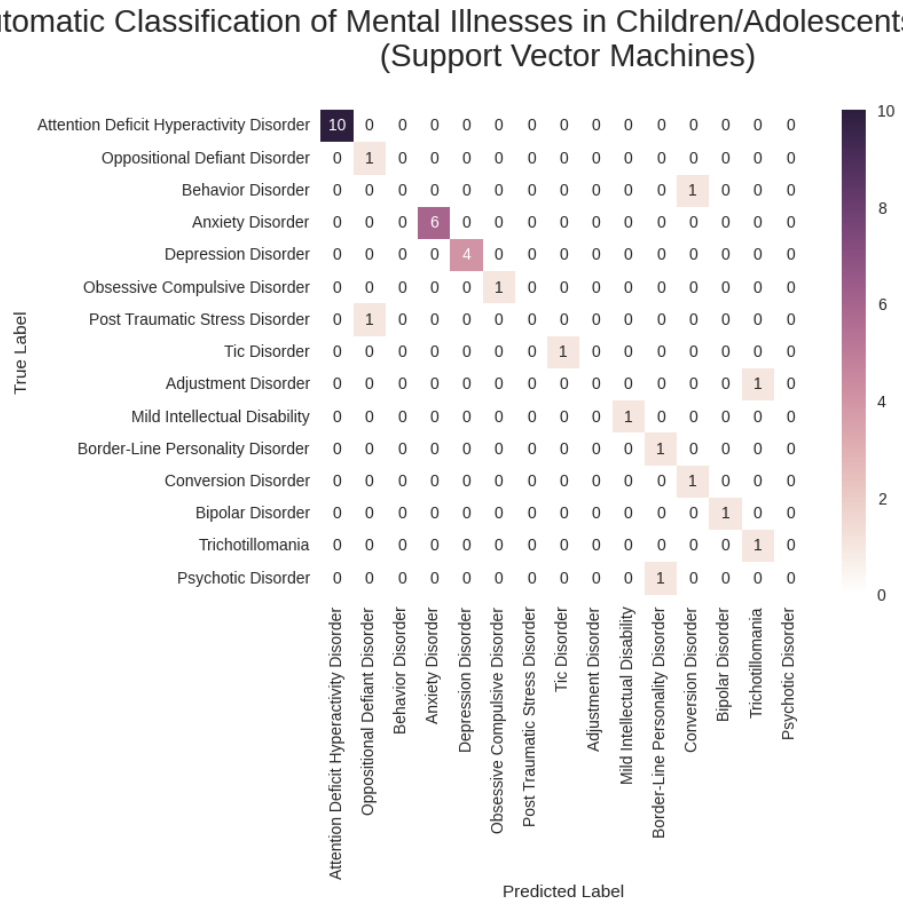

Figure 7. Support vector machines confusion matrix.

The Random Forest method achieved high classification success by misclassifying only 3 out of 32 test images. The obtained classification success was 91%.

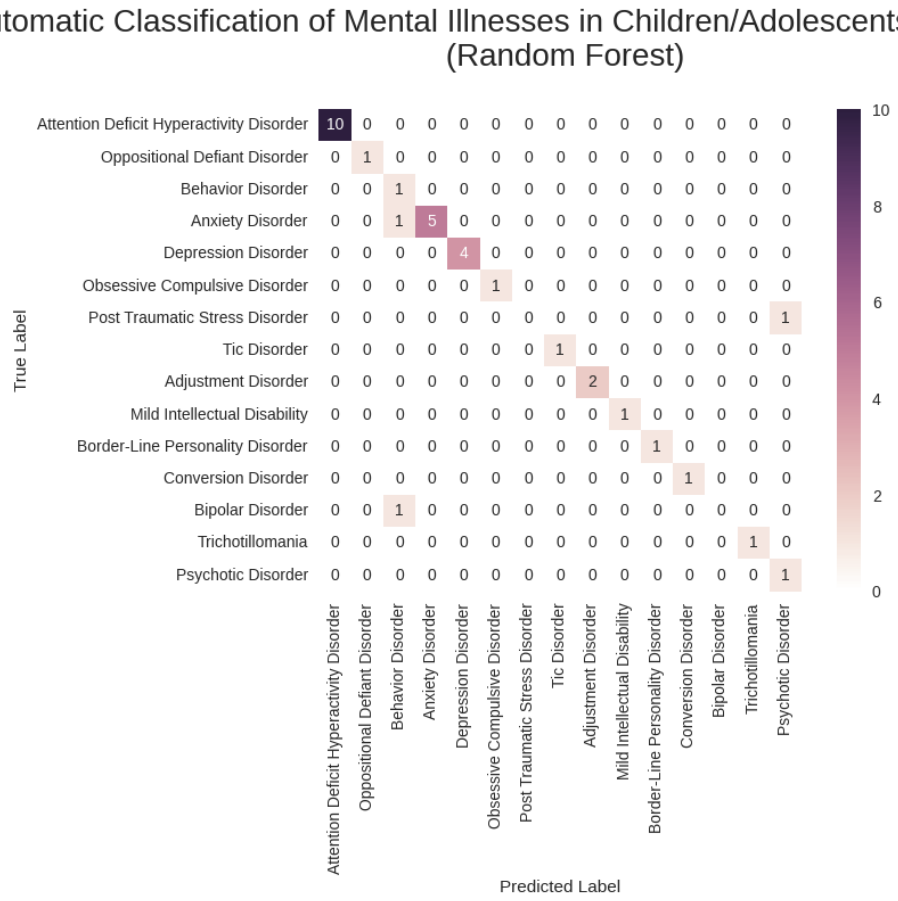

Figure 8. Random forest confusion matrix

ROC curves were also obtained from the results of the automatic classification software used in the study. Figure 9 shows the ROC curve of Random Forest methods. Both graphs were obtained from the training data set of the study. When evaluated on a disease class basis, both methods achieved high classification success. There is also a balanced distribution of success. If there were significant differences between the training on a class basis, outlier values would have been removed from the data set using different data preprocessing methods. Thus, a more accurate result would have been obtained on data that was not subjected to any training. When the two methods are evaluated among themselves, it is seen that they draw close ROC curves. Considering that both methods are frequently used in the literature and have proven themselves in the field of Medicine, it is possible to say that they are ideal methods for our study. On the other hand, we have obtained results that are a reference for the use of these methods for future studies.

The results obtained encourage us to work with data obtained from more and different locations in the future. Thus, with more data, we can perform machine training similar to the years of training of an expert physician. On the other hand, by including adolescents from different locations, we will be able to make a general evaluation as well as a comparison between regions. In all these respects, the ROC curves obtained by both methods in training and the confusion matrices obtained in the classification of

the test data proved that the study was concluded efficiently and can be a resource for experts who will work in the field.

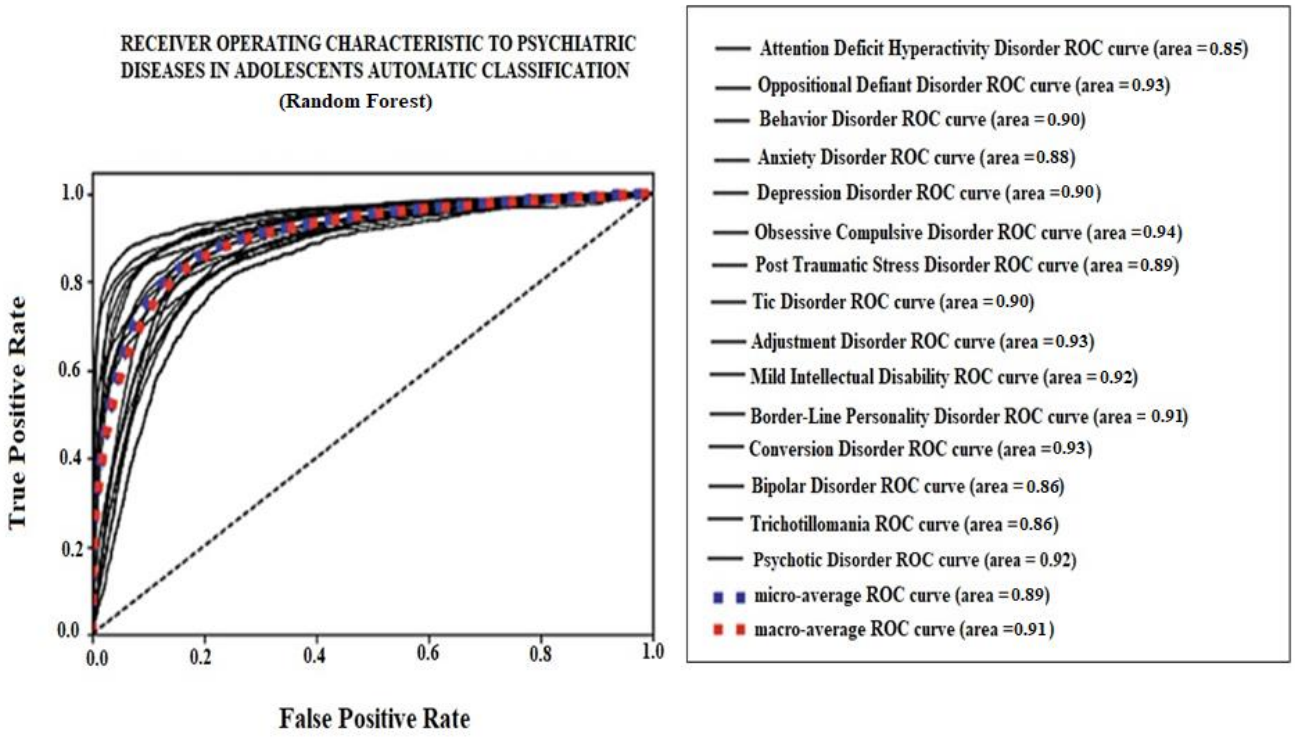

Figure 9. Random forest ROC curve.

5. Conclusion

Psychiatric illnesses in children and adolescents affect the individual, the family and society. Timely and accurate diagnosis is vital for psychiatric illnesses. Ensuring that children and adolescents who are diagnosed correctly and quickly enter the rapid treatment process is very important in terms of preventing negative consequences that will affect the family and society. Since the main thing is correct diagnosis and treatment, these processes should be free from errors caused by specialist physicians.

Machine learning, which is a sub-branch of artificial intelligence, is used in a wide range of areas, from autonomous vehicles, production processes and quality control to the creation of expert decision support systems using various blood values and biomedical images. Studies have even gone so far that artificial intelligence robots that make decisions and assist the doctor in surgery are now being studied. Although the future destination of artificial intelligence is often discussed and feared, it is obvious that it will increase the quality of life of human beings with the right use and protocols that will be accepted by everyone.

When the literature is examined, it is still a new field of study to study the diagnosis/treatment processes of psychiatric diseases using various artificial intelligence software. However, when the literature is examined, the success of artificial intelligence on biomedical images has caught up or even surpassed the expert. In our study, an artificial intelligence study that can support the expert in obtaining fast and accurate results in the diagnosis of psychiatric diseases that negatively affect children and adolescents,

which are the future of every country and the greatest resource. While conducting this study, a database was created from the answers given to the graded scales used in diagnosis. This database was not processed directly with machine learning methods, but was converted into Scalogram images from which more detailed features could be extracted.

Conflict of Interest Statement

The authors of the article declares that no conflict of interest.

Authors' Contribution Declaration

Sinan ALTUN: %70; Hatice ALTUN: %30

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