Using Machine Learning Methods to Predict Autism Syndrome

Hosam Alhakami, Fatimah Alajlani, Alshymaa Alghamdi, Abdullah Baz, Tahani Alsubait

hhhakam@uqu.edu.sa, s44180592@st.uqu.edu.sa, s44180219@st.uqu.edu.sa, aobaz01@uqu.edu.sa, tmsubait
@uqu.edu.sa

Umm Al-Qura University, College of Computer and Information Systems, Makkah, Saudi Arabia

Summary

Autism Spectrum Disorder (ASD) is the most common developmental disability affecting people globally. Around 100,000 people had been affected globally from the 1980s to 2016. ASDs are characterized by poor social skills, poor intelligence, poor verbal and nonverbal communication skills. In some situations, these effects can be far-reaching making parents overly stressed. The financial risks brought by ASDs are a major source of stress for parents. Also, parents get stress resulting from stigmatization from people in society who has little or no information about ASDs. This results in psychological stress among parents who persistently do not look for other support. It becomes worse if parents lack any support systems to give them encouragement. However, parents can get support from focus groups and homebased psychological help with their mental health practitioners. This study has shown the far-reaching consequences of parental stress as it inflicts relationships and child and family care. Moreover, it suggested an adaptive learning system to help parents choose the best learning environment for their autistic children and multiple algorithms were chosen from machine learning to compare between them, and the best algorithm that can predict autism was identified.

Key words:

Data Analytics, Autism Spectrum Disorder, Machine Learning

1. Introduction

Autism Spectrum Disorder (ASD) is the most common developmental disability affecting people globally. Around 100,000 people had been affected globally from the 1980s to 2016 [1]. There is no accessible data, however, in the Kingdom of Saudi Arabia (KSA) regarding the number of ASD, to the best of our knowledge. However, it is estimated that more than 167,000 out of over 28 million people in Saudi Arabia have ASD [2]. The support and medical services for children with ASD are also insufficient making most parents seek help in other more developed countries like the United States and UK. ASDs include Autism. It is characterized by deficits in verbal and non-verbal communication, low intelligence and poor social skills [1]. Because of the severity of these effects, especially among children, parents encounter greater parenting challenges that often result in physical and psychological stress. Upbringing is a major challenge among these parents as their children have major developmental challenges. Parents are always genuinely worried about the financial hardships brought about by their children's condition as

they need a lot of money for treatment and disease intervention. Also, parents worry about the inappropriate and unpredictable behavior their children might display and the emotional concerns it can bring to their children. The severity of autism syndrome is another major course of worry for parents who care for their children. Despite these concerns, research has indicated that support plays a significant role in alleviating these worries among parents. Next section covers the most important research conducted in this area.

This paper is structured as follows: Section 2 is an overview of ASD and related literature. Section 3 describes the utilized dataset. Section 4 visualizes the provided dataset and describe methods to make use of it. Section 5 introduces the final findings. The last section concludes the work.

2. Literature Review

Parents with children suffering from autism are faced with major challenges in the upbringing of their children. These challenges are driven by their children's developmental difficulties [3]. Children with Autism demonstrate major struggles with social skills causing them to lack meaningful social interactions compared to other children [4]. Moreover, the children develop very narrow interests that ultimately dominate their entire life. Studies have shown the frequency with which parents with ASD children report stress and anxiety, greater depression levels, and other health-related problems [4]. Moreover, parents with ASD children have high-stress levels and low well-being levels compared to the parents of children that grow typically and the parents of those children growing with developmental disabilities like the Down syndrome [5]. According to [6], Autism may cause intellectual disability among children. As a result, such children may bring about much childcare-related problems causing their parents to develop higher levels of stress [7]. Usually, parents genuinely get stressed when their children lack intelligence, especially at a stage when they are supposed to show higher levels of intelligence during development. Parents may thus, find it difficult to adjust to their new revelations as most of these diagnoses are received after the age of 4 [5]. At that period, the scope and nature of their developmental problems often eludes precise characterizations [4]. Several studies studied the genesis of parental stress in relation to their ASD

children. According to [8], parental stress can stem from the behavioral and social problems of the child, bullying experience, alienation, being less independent compared to their peers, and inability to plan and organize their own things. This might be contributed by the child's emotional issues, anxiety, and depression, which also result in parental stress [9]. The disorder's character makes it difficult to understand the child and parent's problems. Therefore, the difficulties arising from child rising can bring significant effects to the family [10]. Also, the realization that there is no cure for the infection adds more stress to the parent [3]. Moreover, raising ASD children means creating "extra time to meet the needs of the child" [11]. A number of studies have also indicated the significance of support services in helping parents struggling with stress. The authors of [10] revealed the significance of family support parents benefited from helping them cope with high levels of stress and enhance their resilience. Access to mental health support proved significant in a number of studies [12].

2.1 Adaptive E-learning Systems

Adaptive E-learning systems are a special type of E-learning system, that adapts itself to the learner, as the term suggests. In general, these systems have a degree of personalization in response to the user's characteristics, for example, it may suggest different learning material based on the learner's interest; a learner model may be built which incorporates the learner's characteristics and these characteristics are used as a basis to support the adaptation. The field is relatively new in terms of the technology that is being used to develop solutions. It is also relatively complex which makes the progress slow. Adaptive E-learning systems are, however, preferable to traditional E-learning systems, as they can cater to the needs of students with different characteristics and needs. A one-size-fits-all approach will tend to leave some students dissatisfied and frustrated, which in turn can have a negative impact on the quality and effectiveness of learning. Adaptive E-learning systems can personalize the presentation of the learning not only the content; this can also be done by considering the individual student's learning style, so making the system much more useful. Clearly, the scope of the practical application of adaptive learning systems is enormous. The current research focuses on one area of application in particular and that is the development of adaptive learning systems for people with autism. These types of systems are very beneficial to them, as they facilitate the way of education, making them interact well with the system. These systems depend on the shapes and colors that help this group to learn easily. Realistic scenarios are presented so that they can teach in a fun and easy way [13]. The system is divided according to three factors depending on the type of injured: allocation, interaction, and participation. The assignment factor differs depending on the student's

speed in learning and the power of his observation of things. This is considered different from one student to another because this category differs from each other in speed. As for the interaction factor, the electronic system gives the student an experimental opportunity to learn, and then the student's interaction with the system is measured. The participation factor helps the student to participate in real-life scenarios, to see how the student will encounter these problems. These systems apply to this category of infected people significantly. People with autism help increase their confidence and develop their skills significantly.

2.2 Parenting Stress

Parents experience high levels of stress which makes it difficult for them to care for the child and manage their behavior. It gets worse when the parent has more than one child with ASD; it means multiple stresses and challenges to the parent [8], as it increases the level of depression and anxiety to more than three times among parents with ASD children compared to parents with normal children [14]. There is ongoing negative stigma, especially when people relate to the character of children with ASD to poor parenting. Parents thus, feel harshly judged since ASD is a silent disability. Moreover, there is a lot of bullying, victimization, and marginalization of ASD children which adds to their parent's stress [3]. The likelihood of children with ASD to be invited for birthdays is very low. If it happens, they sit and eat separately from then others given their poor social skills. Children become victims of bullying and victimization given their difficulties in interpreting verbal and nonverbal communication and poor social skills [15]. As a result, they stay home with their parents.

2.3 Marital Relationships

Differences in parenting among parents are another challenge that contributes to parental stress. There is a significant difference in parent's reactions to their children's diagnostic results. Better still; parents have differences in disciplining, caring for their child, and managing the child's behavior [16]. Parents with children with ASD experience marital problems and issues as they struggle to manage their relationship and at the same time manage their ASD child. Mothers are the most affected in marriages and relationships which explain their higher levels of psychological stress such as anxiety, depression, and stress although there is no significant difference in the levels of stress across gender [9]. As mothers try to balance everything and remain objective in caring for their child as well as trying to normalize issues in her relationship, they easily break down with stress as they cannot hold up any more of it. However, mothers openly talk about their feelings of anxiety, depression, and emotional drainage [7]. In most cases, they lose appetite and experience weight loss. However, it has emerged that parents that are able to

manage their family communications and come up with a unified parenting approach can easily take in more and avoid stress by applying proven problem-solving mechanisms [7].

2.4 Financial Burden

The financial burden inflicted by ASD on a family is enormous. In the context of Saudi Arabia, fathers are hard hit by the financial burden as they are regarded as the breadwinners of the family. However, it is still difficult to determine whether there are any gender differences in respect to this particular aspect as it affects the mother and the father of the child. Many scholars have studied the effect of financial burdens on the family but only sampled out mothers and did very little sampling of fathers in the studies [11]. Mothers literally leave their jobs and come to stay home caring for their ASD children, manage healthcare appointments, and other school stuff relating to their child while fathers continue working. As a result, it pushes the financial burden to the father. Caring a child with ASD costs approximately $17,000-$21,000 annually, indicating the height of the financial burden it brings to the family [17]. Overall, healthcare interventions for children with ASD costs at least 8 times higher than the interventions for children without ASD [18]. To make it worse, insurance companies rarely cover ASD related services making families settle for loans to treat their children [18].

2.5 Social Capital

Social capital refers to the social network that gives support that one gains from people close to them and who share common interests and beliefs [12]. Marital relationships make a significant contribution to social capital as it forms part of the group of people individuals are close to and who can give support during such trying moments. These include marital partners, community members, friends, and members of the family. Parents who have a strong social capital have demonstrated the ability to enjoy better health and are well prepared to cope and accept their child's ASD diagnostic results [6]. Some parents and family members are very supportive while others are embarrassed to be seen with their ASD children. Sometimes, family members may criticize the parents as they don't understand the challenges and nature of what it takes to care for ASD children [7]. Some parents may decide to distance themselves from the child's grandparents and the entire extended family based on the kind for support they receive from them. The lack of social capital is stressful as it leaves parents with nowhere to go for social support when they need it most.

2.6 Self-Efficacy and Coping

Stress can be bad as it may result in stress-related health issues among parents such as guilt, confusion, anger,

isolation, denial, and depression [19]. Therefore, there is a need for problem-based coping mechanisms for parents to cope with stressful situations as they care for their children. Parents cannot effectively manage childcare with stress-related health issues over their head. Studies have revealed that most parents with ASD children use emotional and avoidance mechanisms to cope with stress [20]. More importantly, fathers use avoidance to cope with stressors that the child's challenging behavior brings their way as well as other judgmental issues from other people on the parent and the child [21]. The most common coping mechanisms include focusing on work [22] and refusal to attend to the focus groups which have over time enhanced the father's ability to cope by relieving stress, hostility, obsession, and insensitivity [10]. Mothers are more emotional beings, and they use emotional coping mechanisms. These mechanisms include low self-efficacy, a feeling of incompetence, and minimal ability for self-help [23]. Mothers often demonstrate high levels of depression, anxiety, and stress compared to fathers [23]. As a result, their ability to care for the child's needs and those of the rest of the family is greatly incapacitated. The only difference between mothers and fathers is that mothers have a higher likelihood of participating in local parent support groups that help them get new connections in friends and parents that have an understanding of the difficulties associated with caring for children with ASD [22].

2.7 Family-Centered Treatment

Given the level of stress parents go through, the need for special services is necessary to help them to cope with the daily challenges they face. However, the level of support given will depend on how severe the autism behavioral difficulties are, or the child's cognitive functioning, the perception of the parent on the child's stability and severity, and stability or lack of function in a child [17]. Family treatment for parents has been found to be the most significant with mental health specialists working with special groups coming to help parents with their difficulties in coping.

3. Dataset

The dataset selected for this research is entitled "Autistic Spectrum Disorder Screening Data for Toddlers", which is an open source dataset available from The UCI Machine Learning. It was donated to the repository on July 22, 2018, by Dr.Fadi Fayez Thabtah. It has 1054 observations of 18 variables taken from AQ-10-child test. The attribute Type is being categorical and binary in nature [24]. The preliminary dataset contains ten binary variables that represent sorting questions (A1_Score to A10_Score), as well as class variables of jaundice, autism, family_mem_with_ASD, sex, who completed the test,

Qchat-10-Score, and class/ASD. The remaining features in the datasets are collected from the "submit" screen in the ASD Tests screening app. It should be noted that the class variably was assigned automatically based on the score obtained by the user while undergoing the screening process using the ASD Tests app [24]. The data shown in table 1 describes the variables. The table also includes the actual questions associated with the A1_Score to A10_Score variants. The questions ask a simple binary answer, either 1 or 0.

Table 1: Description of the variables of dataset

Feature	Type	Description
A1: Question 1 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A2: Question 2 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A3: Question 3 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A4: Question 4 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A5: Question 5 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A6: A6: Question 6 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A7: Question 7 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A8: Question 8 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A9: Question 9 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
A:10 Question 10 Answer	Binary (0, 1)	The answer code of the question based on the screening method used
Age	Number	Toddlers (months)
Score by Q-chat-10	Number	1-10 (Less than or equal 3 no ASD traits; >3 ASD traits)
Sex	Character	Male or Female
Ethnicity	String	List of common ethnicities in text format
Born with jaundice	Boolean (yes or no)	Whether the case was born with jaundice
Family member with ASD	history Boolean (yes or no)	Whether any immediate family member has a PDD
Who is completing the test	String	Parent, self, caregiver, medical staff, clinician.
Why are you taken the screening	String	Use input textbox
Class variable	String	ASD traits or No ASD traits (automatically assigned by the ASDTests app). (Yes / No)

4. Methodology

4.1 Data Visualization

Visualize positive ASD toddlers based on the top 15 countries even though the reach of the app affects this distribution, it does quite well in describing the report as shown in fig 1. Developed countries like UK, US, Australia, Canada indeed are the most affected ones. But we see the female population distinguishable compared to males, which is quite contrary.

1) Family member with ASD/Ethnicity: The chart in fig 2 represents the relationship between country and ethnicities We can observe that in Toddlers, white and European children have a very high chance of being ASD positive if present in their genes. Blacks and Asians follow, though, in smaller proportions. We cannot firmly conclude anything, but we can remain confident of a positive ASD genetic association as supported by studies.

2) Jaundice born child based on gender: The chart in fig 3 shows that autism is 2-3 times higher (in young children) than non-ASD positive jaundice, while according to reports it is about 10 times. A child born with jaundice has a poor association with ASD. Also, according to reports, ASD is more common among boys (about 4-5 times) than among girls. In young children, the number of boys is almost 4 times the number of girls, which is very close to the actual proportion.
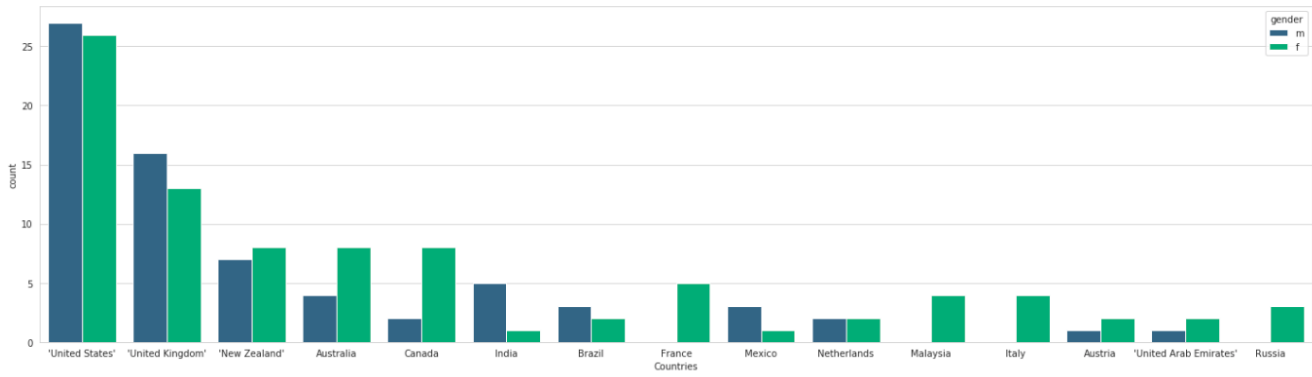
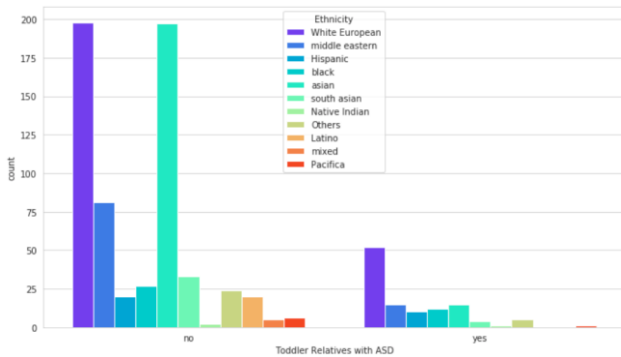Fig. 1 Positive ASD Toddlers country wise distribution.

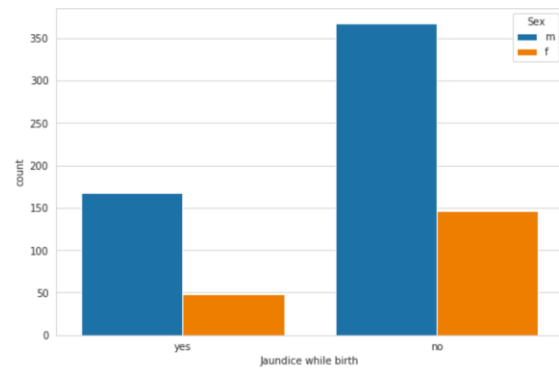Fig. 2 Positive ASD Toddler relatives with Autism distribution for different ethnicities.

Fig. 3 ASD positive Toddlers born with jaundice based on gender.

4.2 Preprocessing

This section explains the data that was used and how the data was previously processed. Supervised learning will use the data, but will focus on two types of data sets, including: the training package and the test group. The training data set includes examples of disaggregated data. The test dataset contains new data where instances were not in the training data set. To the workbook where he learns the data in his own way, then a set of test data will be provided to the workbook for division, testing, and prediction. The instances will then be named in the test data set. The result of the required predictions is calculated at a certain point [25]. Since this paper focuses on predicting autism. The research focuses on predicting autism. The dataset will provide the data in the form of a test that contains the characteristics of autism that the child has such as age, gender, and other details. There are a lot of several stages to conducting this research such as data pre-processing, filtering, feature extraction, forecasting, and accuracy testing. To prepare the dataset for training, column features were chosen that represent the Age Mons, age, ethnicity, and country of residence, Jaundice, Class/ASD, Traits, Family_mem_with_ASD, some data were also excluded from the data set and result columns AQ - 10 to check. In this model, we processed categorical data such as gender and categorical data such as age. Finally, the dataset is divided into a training group, this type is used to help our models learn relationships in data they were interested in; and a test group, the model did not appear during training. Finally, Form test for estimation and calculation its performance on the data as it did not appear during training [26].

4.3 Model Building

The strategy used to prepare this model began to discern some valuable capabilities that contain the rationale, and we need to use a little methodology for the model; this encourages us to refrain from reformulating a similar code on many occasions, and after that, many models use the default settings provided by Scikit-learn. The calculation technique used to analyze models over a region is the region that is subject to the characteristics of a university work. We will build three models using logistic regression, Forrest Random classifier, K-NN classifier on dataset for toddlers and compare between the models to find the best prediction algorithm.

1) Logistic Regression: Logistic regression analysis is a statistical method for evaluating the relationship between different predictive variables (whether categorical or continuous) and the result is binary [27]. In this model for better parameters, Grid Search was applied to training data. Results showed that this model predicts 0.58%.

2) Random Forrest Classifier: For our Random forest model choose Random Forest Classifier with n estimators parameters=500. First, the training data is used after it shows us the result of the training data. Then, the test data is used to predict by this algorithm.

3) KNN Classifier: KNN is to discover removes between the question and all models in the information, pick models for the predefined number (K) nearest to the inquiry, and afterward vote on the most widely recognized name (on account of characterization) or normal appraisals (in miles). Our involvement in the KNN model. incorporate improving the estimation of k inside a given arrangement of qualities by means of the elbow technique. A default estimation of 13 neighbors (k = 13), with 50 off base inclusion. The informational collection of various k esteems from 1 to 50 was concentrated against the normal blunder rate. The "k" factors are dissected against the elbow mistake technique as appeared in fig 4. The ideal worth k for the model inside a given range is 1 where the mistake rate is 0.12.

The performance of the models was calculated using the test data set, after which the best prediction results are presented in Table 2.
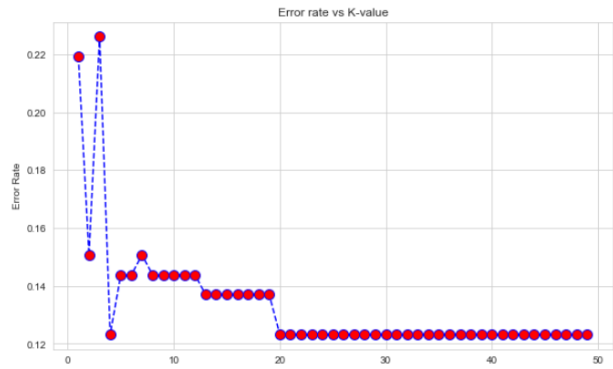

Fig. 4 Error rate vs K-value.

Table 2: The best classifier models

Model	Macro avg
Logistic Regression	0.68
Random Forrest Classifier	0.71
K-NN Classifier	0.71

5. Results

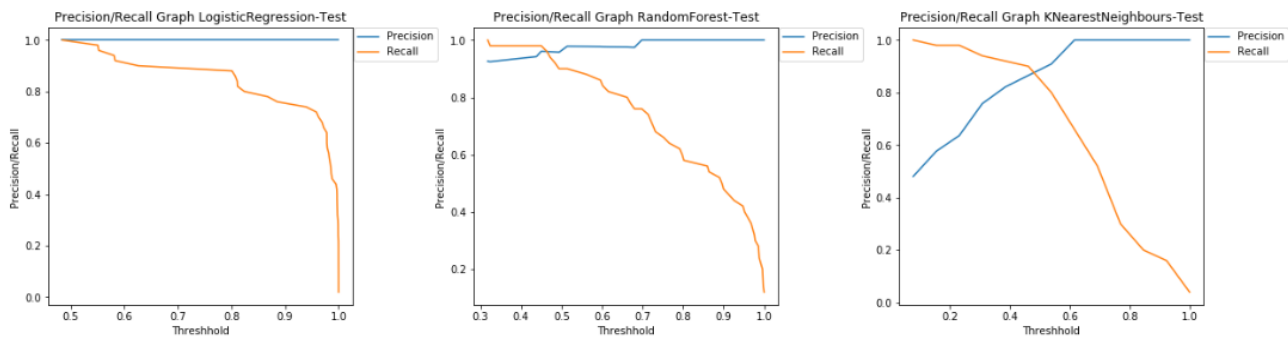This section provides the results for our analysis as shown in fig 5 below.

Fig. 5 Best performance classifier.

Table 2 shows that the two models KNN classifier and Random Forrest Classifier perform almost the same. However, both are outperforming the Logistic Regression model. When applying Random Forrest Classifier and KNN classifier models on the provided dataset with regards to related factors such as toddler's age, gender, ethnicity,

jaundice while birth and any relative having ASD traits, both models can predict either the toddler has ASD or not with the precision of 71%.

6. Conclusion

In this paper, our work was motivated by the high level of parents passes the stress level with children with ASD daily. Because of their intellectual capabilities, low social skills, and poor communication skills among children with autism spectrum disorder, their parents always feel stigmatized when their children become vulnerable to abuse and bullying. Some financial difficulties, strained family relationships, and lack of social support are some of the issues this paper has uncovered to fuel stress among parents. However, parents with strong social support and good coping mechanisms were always stronger. Family-focused therapy is the best form of treatment for parents because it helps them relieve stress by connecting them with parents who have the same problems. Education is important for autistic children, so an adaptive learning system has been proposed to help parents find a suitable education system that works to benefit and educate autistic children. Also, for predicting autism, a readymade dataset was used to implement many machine learning algorithms. The goal is to make a measurement of the accuracy of the algorithms in predicting and choosing the best among them.

References

[1] F. M. Alnemary, H. M. Aldhalaan, G. Simon-Cereijido, and F. M. Alnemary, "Services for children with autism in the kingdom of saudi arabia," Autism, vol. 21, no. 5, pp. 592–602, 2017.

[2] D. Saab, M. Chaaya, and R. Boustany, "National prevalence and correlates of autism: A lebanese cross-sectional study," Autism Open Access, vol. 8, no. 223, p. 2, 2018.

[3] T. S. Tomeny, "Parenting stress as an indirect pathway to mental health concerns among mothers of children with autism spectrum disorder," Autism, vol. 21, no. 7, pp. 907–911, 2017.

[4] Alhazmi, R. Petersen, and K. A. Donald, "Quality of life among parents of south african children with autism spectrum disorder," Acta neuropsychiatrica, vol. 30, no. 4, pp. 226–231, 2018.

[5] N. Porter and K. A. Loveland, "An integrative review of parenting stress in mothers of children with autism in japan," International Journal of Disability, Development and Education, vol. 66, no. 3, pp. 249–272, 2019.

[6] K. Ilias, K. Cornish, A. S. Kummar, M. S.-A. Park, and K. J. Golden, "Parenting stress and resilience in parents of children with autism spectrum disorder (asd) in southeast asia: A systematic review," Frontiers in psychology, vol. 9, p. 280, 2018.

[7] M. Argumedes, M. J. Lanovaz, and S. Lariv´ee, "Brief report: Impact of challenging behavior on parenting stress in mothers and fathers of children with autism spectrum disorders," Journal of autism and developmental disorders, vol. 48, no. 7, pp. 2585–2589, 2018.

[8] E. Pisula and A. Porebowicz-D¨orsmann, "Family functioning, parenting stress and quality of life in mothers and fathers of polish children with high functioning autism or asperger syndrome," PloS one, vol. 12, no. 10, 2017.

[9] L. Perez Repetto, E. Jasmin, E. Fombonne, E. Gisel, and M. Couture, "Longitudinal study of sensory features in children with autism spectrum disorder," Autism research and treatment, vol. 2017, 2017.

[10] S. Das, B. Das, K. Nath, A. Dutta, P. Bora, and M. Hazarika, "Impact of stress, coping, social support, and resilience of families having children with autism: A north east india-based study," Asian journal of psychiatry, vol. 28, pp. 133–139, 2017.

[11] Picardi, A. Gigantesco, E. Tarolla, V. Stoppioni, R. Cerbo, M. Cremonte, G. Alessandri, I. Lega, and F. Nardocci, "Parental burden and its correlates in families of children with autism spectrum disorder: A multicentre study with two comparison groups," Clinical practice and epidemiology in mental health: CP & EMH, vol. 14, p. 143, 2018.

[12] D. Shepherd, J. Landon, S. Taylor, and S. Goedeke, "Coping and carerelated stress in parents of a child with autism spectrum disorder," Anxiety, Stress, & Coping, vol. 31, no. 3, pp. 277–290, 2018.

[13] M. J. C. Samonte, J. J. K. Cape, M. N. O. Kalaw, and B. S. F. Valentino, "Interact: Interactive e-learning for children with autism," Journal of Telecommunication, Electronic and Computer Engineering (JTEC), vol. 10, no. 1-17, pp. 101–104, 2018.

[14] Padden and J. E. James, "Stress among parents of children with and without autism spectrum disorder: a comparison involving physiological indicators and parent self-reports," Journal of developmental and Physical disabilities, vol. 29, no. 4, pp. 567–586, 2017.

[15] Hayat, A. H. Meny, N. Salahuddin, F. M. Alnemary, K.-R. Ahuja, and M. W. Azeem, "Assessment of knowledge about childhood autism spectrum disorder among healthcare workers in makkah-saudi arabia," Pakistan journal of medical sciences, vol. 35, no. 4, p. 951, 2019.

[16] S. Alkhalifah and H. Aldhalaan, "Telehealth services for children with autism spectrum disorders in rural areas of the kingdom of saudi arabia: Overview and recommendations," JMIR pediatrics and parenting, vol. 1, no. 2, p. e11402, 2018.

[17] N. S. Da Paz and J. L. Wallander, "Interventions that target improvements in mental health for parents of children with autism spectrum disorders: A narrative review," Clinical psychology review, vol. 51, pp. 1–14, 2017.

[18] Zaidman-Zait, P. Mirenda, E. Duku, T. Vaillancourt, I. M. Smith, P. Szatmari, S. Bryson, E. Fombonne, J. Volden, C. Waddell et al., "Impact of personal and social resources on parenting stress in mothers of children with autism spectrum disorder," Autism, vol. 21, no. 2, pp. 155–166, 2017.

[19] S. R. Kiami and S. Goodgold, "Support needs and coping strategies as predictors of stress level among mothers of children with autism spectrum disorder," Autism research and treatment, vol. 2017, 2017.

[20] L. Salas, V. Y. Rodr´ıguez, C. T. Urbieta, and E. Cuadrado, "The role of coping strategies and self-efficacy as predictors of life satisfaction in a sample of parents of children with autism spectrum disorder," Psicothema, vol. 29, no. 1, pp. 55–60, 2017.

[21] W. H. Chong and S. M. Kua, "Parenting self-efficacy beliefs in parents of children with autism: Perspectives from singapore." American Journal of Orthopsychiatry, vol. 87, no. 3, p. 365, 2017.

[22] Y. Zhou, H. Yin, M. Wang, and J. Wang, "The effect of family-focused psychoeducational therapy for autism spectrum disorder children's parents on parenting self-efficacy and emotion," Archives of psychiatric nursing, vol. 33, no. 1, pp. 17–22, 2019.

[23] S. E. Goldberg, "Connectedness in mothers of children with autism spectrum disorder: Associations with maternal stress, self-efficacy, and empathy," Ph.D. dissertation, Mills College, 2018.

[24] F. Thabtah, "Machine learning in autistic spectrum disorder behavioral research: A review and ways forward," Informatics for Health and Social Care, vol. 44, no. 3, pp. 278–297, 2019.

[25] Arya, "Predicting autism over large-scale child dataset," 2015.

[26] F. Thabtah, "Autism spectrum disorder screening: machine learning adaptation and dsm-5 fulfillment," in Proceedings of the 1st International Conference on Medical and health Informatics 2017, 2017, pp. 1–6.

[27] P. Ranganathan, C. Pramesh, and R. Aggarwal, "Common pitfalls in statistical analysis: logistic regression," Perspectives in clinical research, vol. 8, no. 3, p. 148, 2017.

Hosam Alhakami received his B.Sc. degree in Computer Science from King Abdulaziz University, Saudi Arabia in 2004. From 2004 to 2007, he worked in software development industry, where he implemented several systems and solutions for a national academic institution. Following that, he started his postgraduate studies in UK, where he received his MSc degree in Internet Software Systems from Birmingham University, Birmingham, UK in 2009. Then he successfully acquired his PhD in Software Engineering from De Montfort University in 2015. His research interests include algorithms, semantic web and optimization techniques. He focuses on enhancing real-world matching systems using machine learning and data analytics in a context of supporting decision-making.

Fatimah Alajlani received her B.Sc. degree from Umm Al-Qura University in 2018. Currently, she is a Master of Science candidate at Umm Al-Qura University, College of Computer and Information Systems, Computer Science Department.

Alshymaa Alghamdi received her B.Sc. degree from AlBaha University in 2018. Currently, she is a Master of Science candidate at Umm Al-Qura University, College of Computer and Information Systems, Computer Science Department.

Abdullah Baz received the B.Sc. degree in electrical and computer engineering from UQU, in 2002, the M.Sc. degree in electrical and computer engineering from KAU, in 2007, and the M.Sc. degree in communication and signal processing and the Ph.D. degree in computer system design from Newcastle University, in 2009 and 2014, respectively. He was a Vice-Dean, and then the Dean of the Deanship of Scientific Research with UQU, from 2014 to 2020. He is currently an Assistant Professor with the Computer Engineering Department, a Vice-Dean of DFMEA, the General Director of the Decision Support Center, and the Consultant of the University Vice Chancellor with UQU. His research interests include VLSI design, EDA/CAD tools, coding and modulation schemes, image and vision computing, computer system and architecture, and digital signal processing. Since 2015, he has been served as a Review Committee Member of the IEEE International Symposium on Circuits and Systems (ISCAS) and a member of the Technical Committee of the IEEE VLSI Systems and Applications. In 2017, IEEE has elevated him to the grade of IEEE Senior Member. He served as a Reviewer in a number of journals, including the IEEE Internet of Things, the IET Computer Vision, the Artificial Intelligence Review, and the IET Circuits, Devices and Systems.

Tahani Alsubait is a faculty member of College of Computer and Information Systems. She earned her PhD in AI and instruction from the University of Manchester. She hold a Bachelor's in Computer Science from King Saud University and a Master's from King Abdulaziz University. Her research interests include knowledge representation and reasoning, data analytics and HCI.