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Research Article

Harnessing Machine Learning for Accurate Prediction of Mental Health Conditions based on DASS-42 scores

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ABSTRACT

The increasing global prevalence of mental health conditions, coupled with their profound impact on individual well-being, necessitates the development of efficient diagnostic tools. Traditional methods of mental health assessment, such as the Depression, Anxiety, and Stress Scales (DASS-42), rely on manual interpretation of questionnaire scores, which may be limited in detecting complex patterns. This study proposes harnessing the power of machine learning (ML) to improve the accuracy and efficiency of mental health condition predictions based on DASS-42 scores. By leveraging various ML algorithms, including Random Forest, Decision Trees, and Nearest Neighbour, we aim to predict mental health outcomes such as depression, anxiety, and stress with greater precision. The DASS-42 dataset used in this study contains responses from individuals across diverse demographic backgrounds. Feature engineering is applied to extract meaningful attributes, while the models are trained and evaluated on labelled data indicating the presence or absence of mental health conditions. Cross-validation and hyperparameter tuning are employed to optimize the performance of the models, and metrics such as accuracy, precision, recall, and F1 score are used to assess their predictive capabilities. Initial results demonstrate that machine learning models, particularly ensemble methods like random forests, outperform traditional statistical methods in predicting mental health outcomes. The incorporation of ML not only improves diagnostic accuracy but also has the potential to streamline mental health screening processes in clinical and non-clinical settings. This research highlights the significant role that machine learning can play in enhancing the identification and management of mental health conditions, thereby contributing to more effective interventions and personalized treatment plans. Future work will focus on refining models by integrating additional psychological and physiological data to further increase predictive power.

Keywords: Anxiety, Depression, Machine learning, Nearest Neighbourhood, Decision Tree, Random Forest, Stress, Gaussian Naïve Bayes classifier.

Introduction

Among those who are diagnosed with a "substance use disorder" (SUD), depression is one of the most prevalent co-morbid disorders [1]. There is mounting evidence from clinical and epidemiologic research throughout the world that shows a correlation between SUD and depression, and vice versa [2]. Therefore, out of all the population, 27% are diagnosed with substance use disorder and life time major depressive episode, 41% of those diagnosed with lifetime substance used disorder also diagnosed with lifetime major depressive episode [3]. Told estimations regarding patients that looking for the treatment of substance use issues are more likely to experience multiple depressive illnesses. These were some of the findings and the following conclusions drawn; Among the clients who received treatment for substance use disorders, forty four percent of them had serious depressive disorder [4]. Due to the fact that symptoms of depression may be mimicked by both current drug consumption and withdrawal from drugs, accurate evaluation of SUD patients is frequently obstructed by fluctuating and covering side effects [5, 6]. Time is another issue with psychiatric diagnostic processes. Most substance abuse treatment centres prioritize their "core business" when faced with funding cuts [7]. Patients with SUD and co-morbid depressive illness are at expanded

hazard of backslide and less likely to have a positive treatment result if the condition is not identified early on [8]. This shows that there is a need of appropriate screening instruments for depression to facilitate addressing of the depression in the SUD clients.

One of the most frequently utilized questionnaires requesting the patient's subjective assessment of their state of depression and anxiety is the tool called the Depression Anxiety Stress-Scale developed by Lovibond & Lovibond [9]. Depression, Anxiety, and Stress Scale (DASS-21) questionnaire is a well-developed tool, which can be used for rating three aspects of mental health in adults whether they are patients or not, and offers a clear hierarchy for the rating of all the three variables [10–12]. While being originally designed as an instrument for measuring the subjective seriousness of side effects connected with melancholy, nervousness, and stress, the DASS does not offer a direct solution to the algorithmic identification of patients belonging to the categories distinguished by systems such as the DSM or the ICD [13].

There was a reduction from the initial 42-item Lovibond DASS to a 21-item version [15]. The DASS-21 has been approved for clinical and non-clinical adult participants [16–20] and though the tool has not been specifically validated for pregnant women it has been demonstrated to be a substantial and solid instrument for measuring levels of stress, anxiety and depressive symptoms. At admission, the majority of substance abuse treatment centers in the Netherlands administer the DASS-21 to adults aged 24 and above to gauge the seriousness of their burdensome, restless, and stress side effects. Within the framework of Routine Outcome Monitoring (ROM), the patient's condition is measured and documented using the questionnaire at a specific point in time during treatment, beginning with intake [21]. If a person's DASS-total score is 60 or above in Dutch ROM, it is suggested that they have further mental evaluation. Considering how widely utilized the DASS-21 is in clinical practice, its potential use as a screening device for depression would be very beneficial. Using the DASS as a potential screening tool for PTSD in SUD patients was previously investigated by Kok et al. [22]. The DASS was determined by these authors to be a reliable tool for screening PTSD in substance use disorder patients when administered at admission and again four weeks later. Nevertheless, as far as we are aware, there has been zero investigation into the feasibility of using the DASS-21 to evaluate for burdensome problems in individuals with SUD. The overall point of this undertaking is to lay out the precision of the DASS-42 screening tool in combination with conventional machine learning models for anticipating the levels of pressure, tension, and misery in different populations that are categorized by age, gender, geographical location, and other parameters. The research is structured as follows: In part II, the background work is presented, under part III the methods used are described, part IV contains discussion and finally the model is described in part V.

Background

The novel coronavirus disease emerged to become a worldwide pandemic after its flare-up in December 2019. It is similar to that of the catastrophic physical health implications and comprehending the effect of the infection on the mental domain was paramount. As far as COVID-19's effects on mental health are concerned, the World Health Organization (WHO) reports that the virus has mostly contributed to rising public stress and anxiety levels. The elderly, those with certain medical disorders, and those working in the health field have been the ones most impacted by these issues [23]. Mental health issues among healthcare staff were exacerbated by providing cancer treatments during a pandemic. With regards to pressure, restlessness, tension, and despondency, the short-term consequences of the pandemic on healthcare personnel varied. Factors including age, sex, and occupation dictated the severity, which might vary from moderate to suicidal [24].

Self-administered with the DASS-21 questionnaires, the researches in this study pointed toward deciding the levels of sadness, tension, and stress in five disease healthcare and administration professionals in 2020 in BiH. Altogether, target population comprised 224 staff members of which 175 agreed to take tests for research purposes. This number reflects the current state of preventative measures and the operations of cancer centres. There was a 78.1% response rate. Women made up the vast majority (78.3%) of the 175 participants in the research. Among the individuals who took part, 47.4% were under the age of 35, 41.7% were in the 36 to 54 age bunch, and 10.9% were past the age of 55. Among the participants, 64.6% were married and 58.9% had completed some kind of post-secondary education. The following occupations were represented: medical radiation technicians (11.4%), more than half were attendants (48.6%), 29.1% were clinical doctors, and 10.3%were engaged in administration. There were 35 healthcare personnel who had risk factors for SARS-CoV-2-related serious illness. It was experienced by 44% of the participants. There was a normal body mass index (58.3% of the individuals). During the epidemic, 87 healthcare personnel began using immune-boosting nutritional supplements. The 21-item survey consisted of three self-report measures developed to

measure DASS, which in turn evaluated important symptoms of uneasiness, stress, and misery. Every one of the seven aspects is assigned a Likert scale score between zero and three. There are four possible outcomes: 0 (not at all applicable), 1 (to a certain extent or sometimes), 2 (to a large extent or for the most of the time), and 3 (very much or for the majority of the time). Therefore, the scoring of stress, anxiety, both and depression made from this method enabled us to quantify the studied levels of relevant categories. To obtain the total DASS-21 score, all the scores of the separate subscales are doubled as the DASS-21 is a brief from of the first 42-thing test. Finally, the ratings that emerge that are as stated in the handbook are firstly categorized as typical, gentle, moderate, serious, or incredibly extreme. According to the examination done, it is apparent that there exist significant contrasts in the degrees of trouble, nervousness, and stress between patients who have other conditions increasing their vulnerability to severe COVID-19 outcomes [25]. The stress levels of the individuals from various cities were also found to be significantly varied. Supplement use was significantly related to degree of education. Depression was prevalent among those who had significant levels of anxiousness and stress.

Even one year after the Ebola response began, the commonness of PTSD and nervousness sadness side effects persisted in the 2014 Ebola epidemic [26]. A comparable image is painted by the worldwide HIV epidemic. Consequently, the country's mental health system may face a significant difficulty in dealing with the post-pandemic risk of PTSD. People with addiction or dependence issues may see a decline in mental health due to the pandemic, as the healthcare system is primarily concerned with emergency services. (The Great Lockdown: Worst Economic Downturn Since the Great Depression - IMF Blog, 2020) The Great Lockdown was a worldwide economic catastrophe that had devastating consequences and was expected to trigger a recession. As a result of layoffs and payouts in several industries across the United States and Europe, the unemployment rate reached a record 14% in the United States and would go on to reach 20% in the years after the epidemic. A man committed himself in Madhya Pradesh after being quarantined suspect leaps to death at quarantine facility in Greater Noida, magisterial probe ordered | India News, 2020), and this situation contributed to a rise in the suicide rate among economically needy people.

Accordingly, research carried out in China discovered that their level of depressive symptoms was a mix of moderate to severe, with 5% of the participants, while 28% had slight depressive signs. 8% moderate to extreme degrees of tension, and 8. 1% moderate to extreme pressure [27]. 28 states that nations such as Japan, Singapore, and Iran have been similarly affected as far as its impact on mental health is concerned. Individuals may turn to these drastic actions when they are overwhelmed by emotions such as despair and sadness after a loved one's death, fear and terror about the future, or financial difficulties. Suicides have been documented in the states of Maharashtra, Uttar Pradesh, Assam, and Kerala. A lady from Phagwara committed suicide due to her anxiety of contracting the virus (In India: A lady conceded in an UP clinic ends it all evaluating Coronavirus, tests negative (Suspect Coronavirus patient who committed herself in UP centre tests negative - India News, 2020; The Tribune India, 2020) [29]. "Suicides because of lockdown: "Self-destruction driving reason for north of 300 lockdown passings in India, says study", an Indian paper title in May 2020 revealed more than 300 'non-COVID19 passings' in India because of misery brought about by the lockdown. Since the plague began obstruction with individuals' lives, regular instances of medical services faculty, traveller labourers, and individuals in segregation and quarantine focuses ending it all have been accounted for in information and media. Alcohol Ban during lockdown is a Different Tragedy to the People of Kerala: Non-Availability causing the Issue, 2020. Despite the fact that several news stories, websites, and researchers have documented fatalities during the pandemic that are unrelated to lockdown, Third UP youth suicide reported in 2020 due to coronavirus lockdown; man commits himself in Lakhimpur Kheri, Uttar Pradesh, unable to care for family; tippler in Hyderabad, India, takes his own life after being unable to buy alcohol during lockdown (The New Indian Express, 2020) [30].

Anxieties about potential health problems brought on new mental health issues in healthy persons, made things worse for those who already had mental health issues, and made caregivers of those who were afflicted feel worse. Fear of illness or death, feelings of powerlessness, and blaming others for their illness were common reactions regardless of exposure, and they might lead to a collapse in mental health [31]. Feelings of unease and terror caused by an illness might manifest as prejudice and bigotry. Despite the common belief that anxiety and depression are separate mental health issues, it is not uncommon for both to co-occur [32], and there is a strong correlation between the scores on instruments that assess anxiety and mood disorders [33]. A number of theorists have formulated theories to help account for the interaction of uneasiness and despondency, which, as indicated over, two significant findings are. It is as a result reported that, anxiety and depression as hypothesized by Clark and Watson's three-sided model of affective disorders [33] are related but are different from each other. Positive affect (e.g., joy, self-assurance, and excitement) and physiological hyper arousal are distinguishing features of the two states, however both are

defined by side effects of high bad effect (e.g., irritation, discomfort). Depressive disorders are characterized by low degrees of positive effect, as indicated by Clark and Watson, whereas anxious disorders are characterized by physiological hyper arousal.

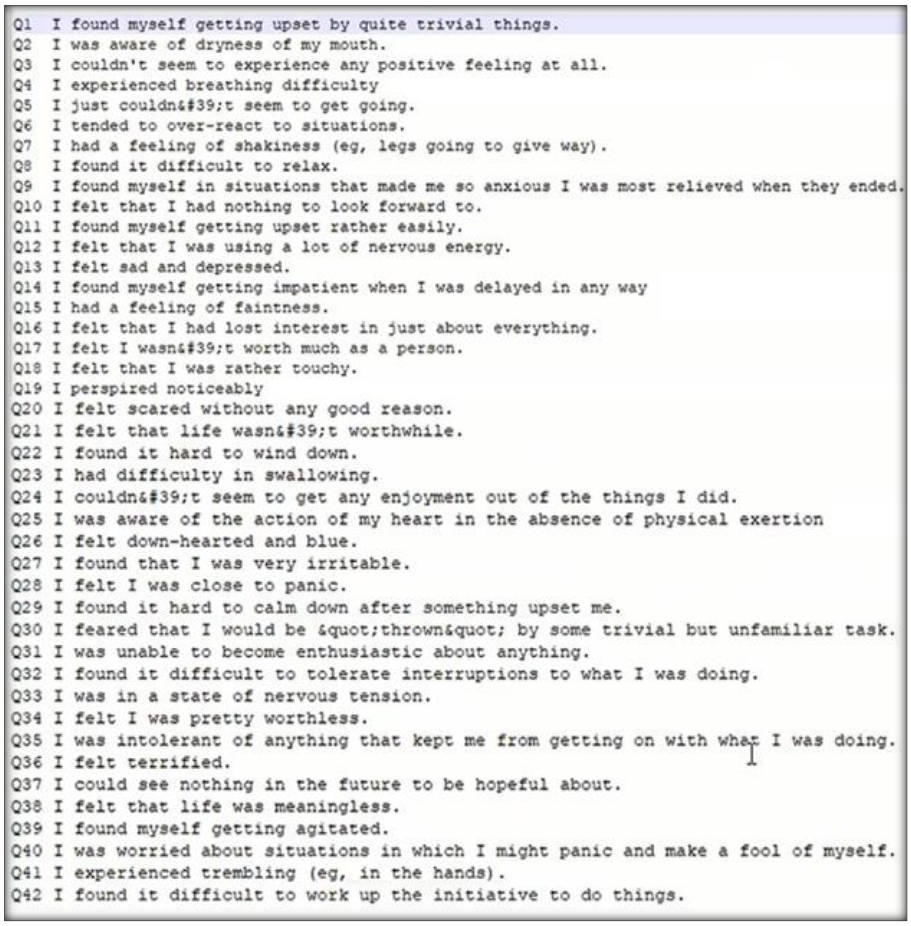
Numerous research has provided credence to this tripartite perspective; for example, Watson et al. [34] conducted a factor analysis and identified three distinct variables: overall distress, anhedonia vs. positive affect, and physical anxiety. Attempts to differentiate between anxiety and depression using conventional metrics have been unsuccessful. There is substantial content overlap and strong correlation between the widely used Hamilton depression and anxiety [35] measures, as well as between the two. The aftereffects of the characteristic form of the State-Quality Uneasiness Stock [40] seem to be just as responsive to depressive symptoms as they are too anxious ones, according to the research in [39]. Lastly, while the Beck Anxiety Inventory may have less overlap with depression measures than other anxiety measures [35], as stated by the authors in [43], this instrument is not ideal for measuring general anxiety. It was developed by Spielberg; however, the main reason is that the approaches of this instrument are confined to panic attack symptoms, rather than other aspects of anxiety, such as worrying, restlessness, and muscle tension.

For the purpose of differentiating between anxiety and depression, bodily arousal symptoms from generalized anxiety symptoms (such as tension or agitation), and so on, the Depression Anxiety Stress Scales [35] may be more useful. Three scales may be consistently formed from the DASS items: (a) Depression (DASS-D), (b) Anxiety (DASS-A), and (c) Stress (DASS-S). This has been supported by factor analytic research using both nonclinical [45] and clinical samples [46] materials. Things on the Downturn scale evaluate sensations of gloom and other dysphoric temperament symptoms, such as worthlessness and melancholy. Questions on bodily arousal, panic episodes, and dread (such as shaking or dizziness) are the main focus of the Anxiety scale, similar to the BAI. Lastly, unlike the BAI, the Stress scale captures feelings like tension, irritation, and an overreaction to stressful situations.

The DASS is a hearty and dependable instrument for assessing side effects of nervousness, wretchedness, and strain -stress, as shown in the research in [47], which backs up earlier results. Particularly, the DASS-D seems to evaluate features that are more intended for misery which is low certain effect, while the DASS-A reflects facets that are peculiar to anxiety which is physical hyper arousal and the DASS-S reflects facets that are common to tension and despondency including strain or bad temper. This view is furthermore maintained by the results showing that the hard and fast DASS-S scores were significantly increased in both the anxious and depressive subjects though the total DASS-D scores were essentially expanded exclusively in the discouraged patients. From the analysis of raw scores obtained for DASS-A, one can deduce that the slightly heightened second variable in depressed participants does not support this view either; moreover, these participants reported somewhat higher scores only next to the panic disorder group. The tripartite model predicted that the groups suffering from anxiety disorders would have higher DASS-A scores than the depressed group.

Method

The existing research on using DASS-21 as an evaluating device for burdensome problems in SUD patients is quite limited, notwithstanding the way that it is a consolidated structure of DASS-42. Hence DASS-42 instrument was used to analyse depression, stress and anxiety level of nearly 40,000 participants with data collected by the Australian academy over a period of 2 years. The data is freely available online and easily accessible by anyone for educational use. A set of 42 questions used during the survey is represented in fig 1.



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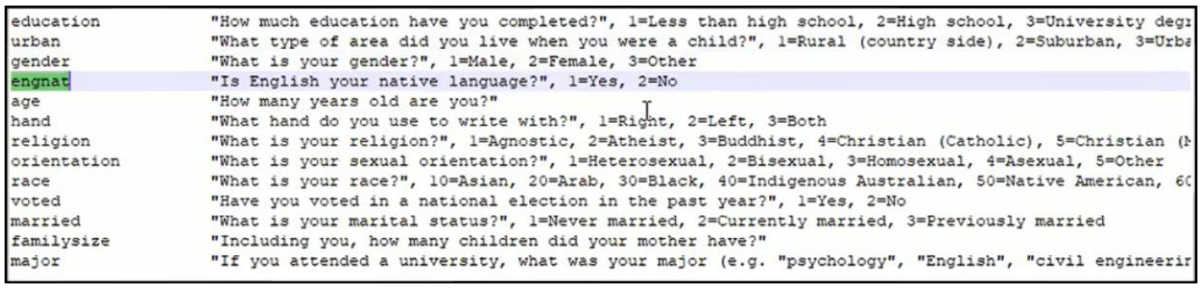
Q1  I found myself getting upset by quite trivial things.
Q2  I was aware of dryness of my mouth.
Q3  I couldn't seem to experience any positive feeling at all.
Q4  I experienced breathing difficulty
Q5  I just couldn&#39;t seem to get going.
Q6  I tended to over-react to situations.
Q7  I had a feeling of shakiness (eg, legs going to give way).
Q8  I found it difficult to relax.
Q9  I found myself in situations that made me so anxious I was most relieved when they ended.
Q10 I felt that I had nothing to look forward to.
Q11 I found myself getting upset rather easily.
Q12 I felt that I was using a lot of nervous energy.
Q13 I felt sad and depressed.
Q14 I found myself getting impatient when I was delayed in any way
Q15 I had a feeling of faintness.
Q16 I felt that I had lost interest in just about everything.
Q17 I felt I wasn&#39;t worth much as a person.
Q18 I felt that I was rather touchy.
Q19 I perspired noticeably
Q20 I felt scared without any good reason.
Q21 I felt that life wasn&#39;t worthwhile.
Q22 I found it hard to wind down.
Q23 I had difficulty in swallowing.
Q24 I couldn&#39;t seem to get any enjoyment out of the things I did.
Q25 I was aware of the action of my heart in the absence of physical exertion
Q26 I felt down-hearted and blue.
Q27 I found that I was very irritable.
Q28 I felt I was close to panic.
Q29 I found it hard to calm down after something upset me.
Q30 I feared that I would be &quot;thrown&quot; by some trivial but unfamiliar task.
Q31 I was unable to become enthusiastic about anything.
Q32 I found it difficult to tolerate interruptions to what I was doing.
Q33 I was in a state of nervous tension.
Q34 I felt I was pretty worthless.
Q35 I was intolerant of anything that kept me from getting on with what I was doing.
Q36 I felt terrified.
Q37 I could see nothing in the future to be hopeful about.
Q38 I felt that life was meaningless.
Q39 I found myself getting agitated.
Q40 I was worried about situations in which I might panic and make a fool of myself.
Q41 I experienced trembling (eg, in the hands).
Q42 I found it difficult to work up the initiative to do things.
```

Fig 1 List of Questions used for the survey

Discussion

The data obtained from the respondents, based on the 42 questionnaires also included some additional information which the respondents were made to share. It included information such as level of education, Country, area of residence (urban, rural), gender, age, religion, race, sexual orientation, marital status etc. This additional information proved very useful in understanding the degrees of misery, uneasiness and stress among the populace in light of their education, Country, gender, age, religion, race, sexual orientation and marital status. Fig 2 represents the set of additional information that the respondents were made to furnish during the survey.



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education       "How much education have you completed?", 1=Less than high school, 2=High school, 3=University degr
urban           "What type of area did you live when you were a child?", 1=Rural (country side), 2=Suburban, 3=Urba
gender          "What is your gender?", 1=Male, 2=Female, 3=Other
engnat          "Is English your native language?", 1=Yes, 2=No
age             "How many years old are you?"
hand            "What hand do you use to write with?", 1=Right, 2=Left, 3=Both
religion        "What is your religion?", 1=Agnostic, 2=Atheist, 3=Buddhist, 4=Christian (Catholic), 5=Christian (P
orientation     "What is your sexual orientation?", 1=Heterosexual, 2=Bisexual, 3=Homosexual, 4=Asexual, 5=Other
race            "What is your race?", 10=Asian, 20=Arab, 30=Black, 40=Indigenous Australian, 50=Native American, 60
voted           "Have you voted in a national election in the past year?", 1=Yes, 2=No
married         "What is your marital status?", 1=Never married, 2=Currently married, 3=Previously married
familysize      "Including you, how many children did your mother have?"
major           "If you attended a university, what was your major (e.g. "psychology", "English", "civil engineerir
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Fig 2 Additional information gathered from the respondents

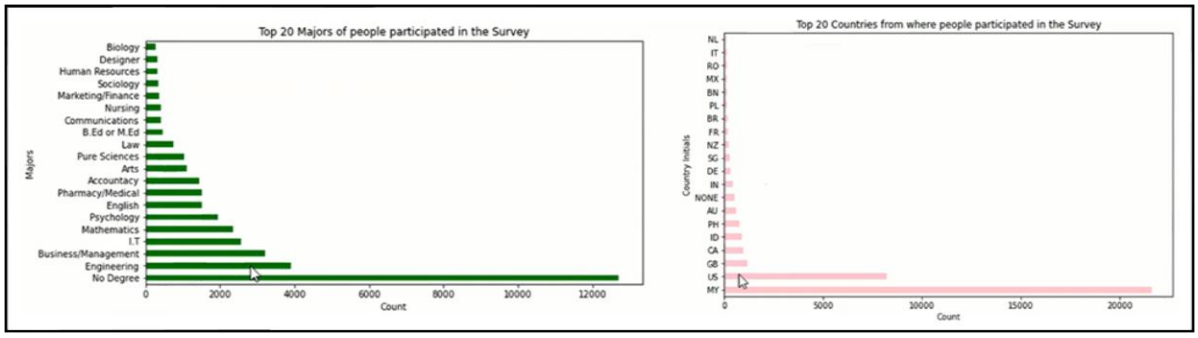

Fig 3 (a) Top 20 majors of participants (b) Top 20 countries to which participants belonged

Fig 3 (a) shows the distribution of top 20 majors (level of degree obtained) while fig 3(b) represents country wise (Top 20) distribution of population who participated in the survey. Fig 3 (a) shows that nearly 1/3rd i.e. 33 % of the respondents did not hold any higher degree of education and also nearly 55 % of the population belonged to Malaysia (Fig 3(b))

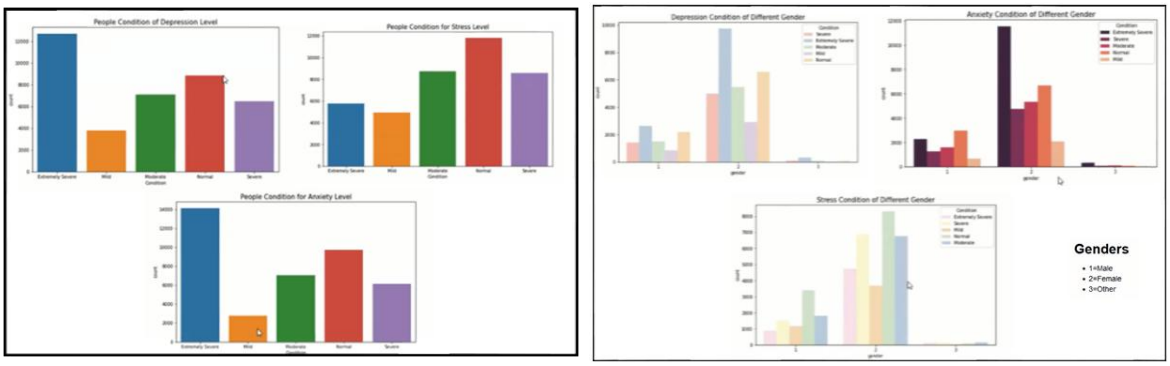

Figure 4 (a) Levels of individuals' stress, anxiety, and depression (b) Participants' levels of depression, anxiety, and stress broken down by gender

Fig 4(a) shows the distribution of depression, stress and anxiety level for the entire range of respondents. The depressive symptoms were "extremely severe" in almost one-third of the subjects. Almost 35% of people exhibited "extremely severe" anxiety, while 15% demonstrated "extremely severe" stress.

Fig 4(b) shows gender wise distribution of depression, stress and anxiety level for the entire range of respondents. 24 % of the females had “extremely severe” levels of depression while nearly 8% males showed “extremely severe” levels of depression. 28% females and nearly 6% males showed “extremely severe” levels of anxiety. 12.5% females while 1.3% males showed higher levels of stress.

Concerning the mental health issues, it determines that, stress, anxiety, and depression results shows that female respondents seem to be more affected than male respondents.

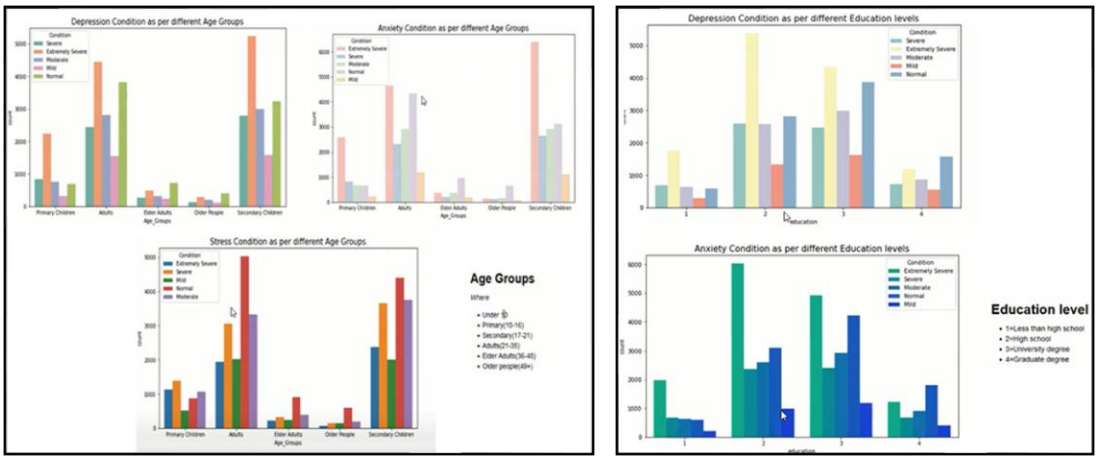

Fig 5 (a) Age wise; Depression, anxiety and stress level of participants (b) Depression, and anxiety level of participant’s; education wise

Fig 5(a) shows age wise distribution of depression, stress and anxiety level for the entire range of respondents. Secondary children in the age group of 17-21 had "incredibly extreme" levels of melancholy and tension. Stress level was also highest among secondary children's when compared with the entire respondents.

Figure 5(b) displays the distribution of anxiety and depression levels according to education level. Population with education level up to high school showed highest level of depression. Also, the level of anxiety was the highest in this group.

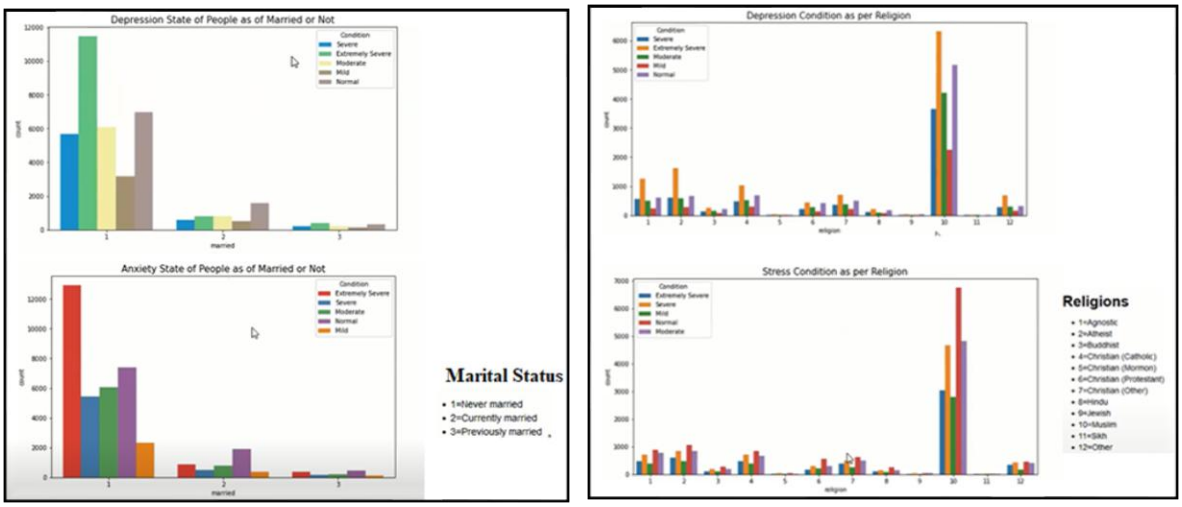

Fig 6 (a) Depression, and anxiety level of participants based on marital status (b) Depression, and stress level of participant's; religion wise

Fig 6(a) shows distribution of depression, and anxiety level based on the marital status. The individuals who never got married had "extremely severe" degrees of sadness and distress.

The distribution of depression and stress levels according to religion is shown in Figure 6(b). Members of the religious group had the greatest rates of stress and depression (10)

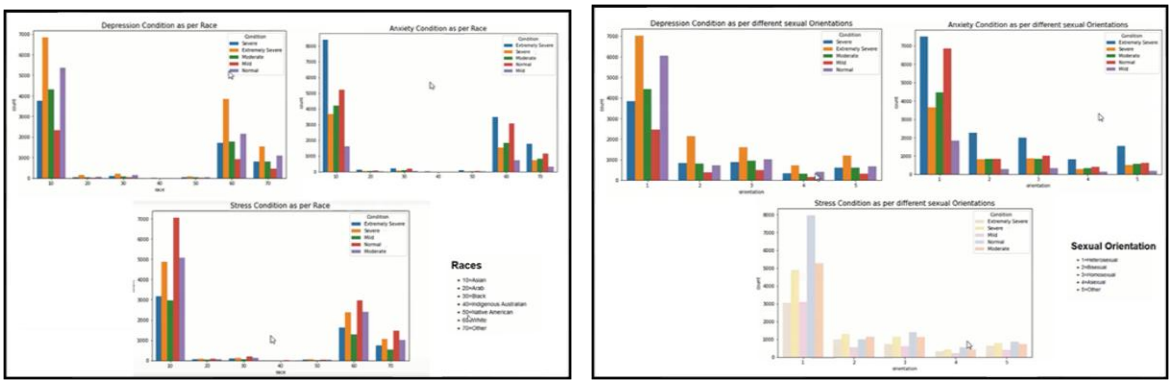

Figure 7 (a) Participants' levels of depression, anxiety, and stress as a function of race (b) The relationship between participants' sexual orientation and their levels of depression, anxiety, and stress

Figure 7(a) as mentioned earlier shows the racial diverse stress, anxiety, and depression level. The "Asian" population exhibited "extremely severe" levels of melancholy, anxiety, and tension.

Fig. 7(b) displays the relationship between sexual orientation and the prevalence of depression, anxiety, and stress. Stress, anxiety, and sadness were found to be "extremely severe" in the "Heterosexual" community.

Creating the Model

Predicting the levels of discouragement, uneasiness, and stress in understudy include the utilization of AI models namely random forest, Decision-tree, Gaussian Naïve Bayes classifier, Nearest-neighbours [29]. The results for various models are represented in fig 8, 10 and 12.

i. For Depression

Result_Depression

	Model	Accuracy(%)	F1_Score(%)	Precision(%)	Recall(%)
0	Random-Forest	92.4	92.2	92.4	92.4
1	Decision-Tree	79.3	79.4	79.5	79.3
2	GaussianNB	87.2	87.7	89.4	87.2
3	Nearest-Neighbors	87.0	86.2	87.0	87.0

Fig 8 Model Prediction for Depression

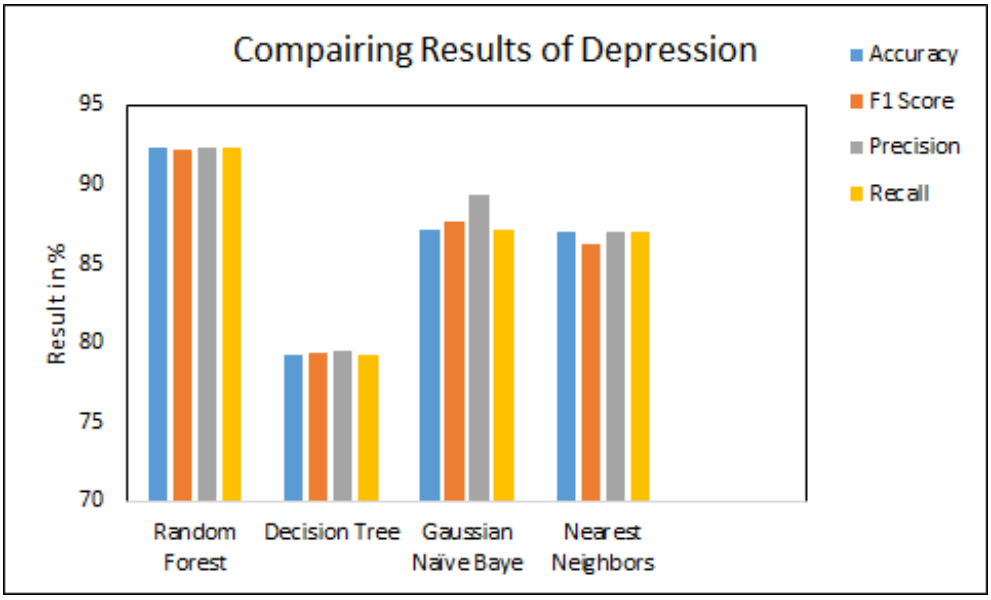

Fig 9 Comparing results of Depression

Fig 8. is a tabular representation of various machine learning techniques (Random Forest, Decision tree, Gaussian Naïve baye's, and Nearest neighbour) used to create the model for prediction of "Depression". Accuracy, F1-Score, precision and recall of various models are compared and it is found that highest values of Accuracy, F1- score, precision and recall is achieved with random forest model (92.4%).

ii. For Anxiety

Result_Anxiety

	Model	Accuracy(%)	F1_Score(%)	Precision(%)	Recall(%)
0	Random-Forest	85.0	82.6	84.1	85.0
1	Decision-Tree	73.5	73.4	73.3	73.5
2	GaussianNB	81.1	81.9	83.8	81.1
3	Nearest-Neighbors	79.3	76.3	76.6	79.3

Fig 10 Model Prediction for Anxiety

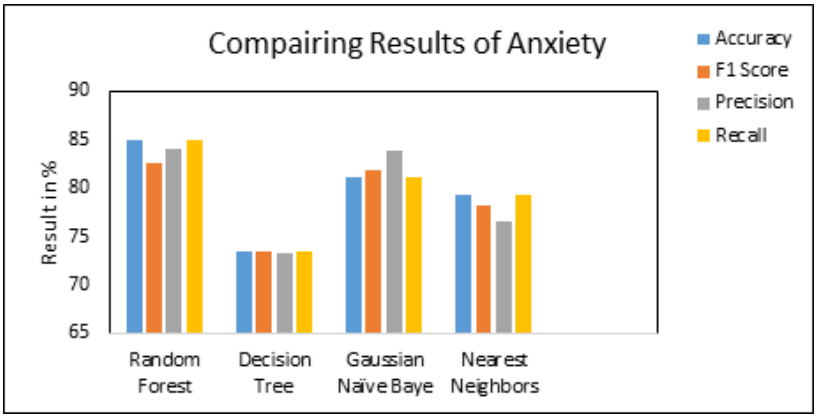

Fig 11 Comparing results of Anxiety

Accuracy, F1-Score, precision and recall achieved with RF model was the highest (85%), while with Decision Tree the measures were nearly 73%.

iii. For Stress

Result_Stress

	Model	Accuracy(%)	F1_Score(%)	Precision(%)	Recall(%)
0	Random-Forest	88.7	88.4	88.7	88.7
1	Decision-Tree	74.8	74.9	75.1	74.8
2	GaussianNB	84.8	85.3	86.7	84.8
3	Nearest-Neighbors	84.1	83.8	83.8	84.1

Fig 12 Model Prediction for Stress

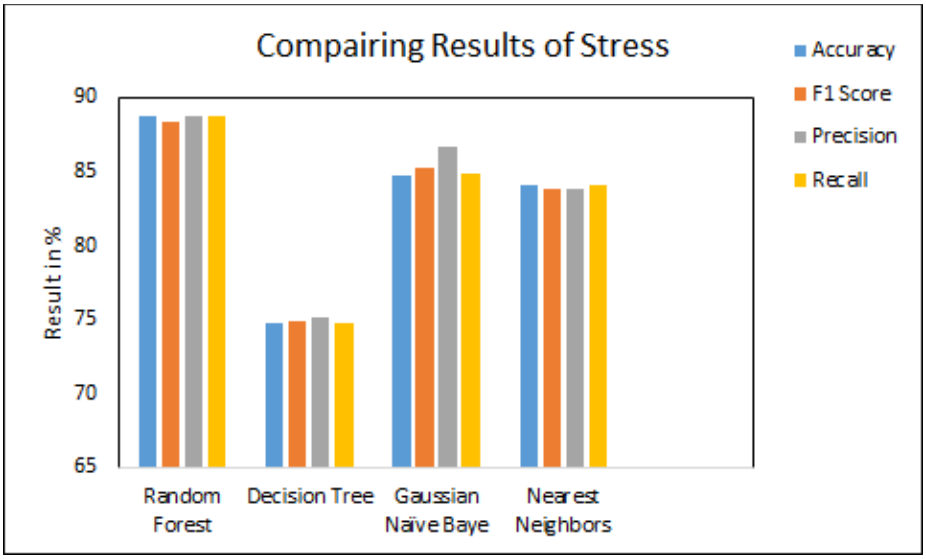

Fig 13 Comparing results of Anxiety

Conclusion

DASS-42 instrument was used to analyse depression, stress and anxiety level of nearly 40,000 participants with data collected by the Australian academy over a period of 2 years. 33 % of the respondents did not hold any higher degree of education and also nearly 55 % of the population belonged to Malaysia. 33% of the participants showed “extremely severe” levels of depression. A quarter of the participants reported "extremely severe" stress, and almost a third reported "extremely severe" anxiety. When compared to male respondents, female respondents had significantly

greater rates of anxiety, stress, and depression. Students in secondary schools, who had extremely severe anxiety and sadness were in the age bracket of 17-21 years. It was, further, found that the never-married group provided the highest level of extreme scores for anxiety and sadness. Concerning the frequency and intensity of mental reactions, there were intense melancholies, anxieties, tensions observed in the "Asian". Additionally, the Charleston-type "Extremely severe" waves of depression, anxiety and stress were deep-rooted in the population which was "Hetero sexual".

The random forest, Decision-tree, Gaussian Naïve Bayes classifier and Nearest-neighbours models were developed to forecast the depression, anxiety and stress. Accuracy, F1-Score, precision and recall achieved with RF model was the highest for prediction of depression, anxiety and stress.

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