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Evaluating Depression and Stress Among Young Adults Using DASS-21: Towards Personalized Intervention Strategies

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***Abstract*—Depression, anxiety, and stress are commonly studied in the elderly, often manifesting as a loss of interest in previously enjoyed activities, disrupted sleep patterns, and other emotional or behavioral changes. However, with rapid technological advancements, young adults particularly those between the ages of 20 and 40 are emerging as a highly vulnerable group. This demographic faces a unique psychological burden, as they attempt to navigate the cultural and generational gap between two vastly different worlds: an older generation that often resists or struggles to adapt to revolutionary technologies, and a younger generation having a grip on modern technology. This generational divide can create a sense of isolation and pressure for young adults especially those people living in developing countries where open conversations about mental health still remain stigmatized and difficult to initiate.**

This research aims to develop a mental health app that can evaluate depression, and stress among young adults using the DASS-21 self-assessment test and suggest a personalized intervention keeping in view the level and severity of depression and stress. For personalized interventions, upper confidence bound algorithm is used to maintain a balance between exploration and exploitation. Agent's performance and effectiveness of intervention is evaluated by a post-test.

***Index Terms*—depression, stress, personalized intervention, dass-21, reinforcement learning, UCB**

I. Introduction

ARTIFICIAL Intelligence (AI) is an umbrella term use to describe technological advancements. Everyone is familiar with AI, especially those who are familiar with self-adaptive, self-learning systems. Reinforcement learning (rl), a type of machine learning, comes under the umbrella of AI. RL is the soul of self-adaptive and self-learning systems, where the system learns patterns and adjusts itself according to requirements. Implications of AI in the field of health care are remarkable [1]. These implications not only involve diagnosing a disease but also recommend treatment plans. Moreover, technological advancements of AI have been reported for personalized medication adherence for elderly people [2], for the analysis of the living cell mechanism [3], for therapeutic treatment interventions of Alzheimer's Disease [1], Multiple Sclerosis [4], Autism Spectrum Disorder (ASD) [5], and other mental disorders.

Mental health is a fundamental concept and is closely related to the overall well-being of mankind [6]. Sartorius has defined mental health in three different manners: i) as the absence of any illness or disease; ii) a state of an organism helps to perform all functions at their best; and iii) a balanced state of an organism to maintain a healthy relationship with others and with its surroundings [7]. All these definitions are directly dependent on the fundamental needs of an individual. The degree to which these fundamental needs are met determines the mental health condition. The fundamental needs of any individual include food, shelter, family support, social circle, unnecessary stress, survival, security, freedom from pain, and environmental hazards [8]. Reflecting on these aspects highlights the complexity involved in determining which definition applies in varying contexts.

Mental health, like mental illness, is also affected by biological, social, psychological and environmental factors. Mental health, similar to mental illness, is shaped by a combination of biological, psychological, social, and environmental influences. The ability of a person to function is deeply influenced by their family, close friends, colleagues, and peers and, in the broader context, influenced by society and culture [9] [10]. Social relationships, in both contexts, play a significant role in psychological well-being. Positive social interactions can help reduce symptoms of depression and stress, while isolation or negative social conditions can increase vulnerability to mental health issues.

Depression is a complex, multifaceted disorder. It comes under the category of mood disorders and is considered one of the primary contributors to disability across the world [11]. A depressed person feels tired most of the time, struggles with sleep, irritability, sadness, and headaches. Depression should be taken seriously before it turns into a clinical depression or major depressive disorder (MDD) [13]. Major depressive disorder can lead to neurological disorders i.e., multiple sclerosis (MS) or Alzheimer's disease (AD).

Stress is another state of mind that every human being faces most of the time. Stress is a mental pressure that arises as a response to some external stimuli (tough situation, threat, challenge etc). Positive stress is helpful and plays an important role in handling different situations. Almost everyone experiences stress at some point, but what makes it worse is the way every human handles it. The stress response is different for different people and plays a crucial role in maintaining our overall health and well-being. Stress affects all body systems including the musculoskeletal, respiratory, cardiovascular, endocrine, gastrointestinal, nervous, and reproductive systems [12].

A lot of pharmacological and non-pharmacological treatments are available for depression and stress. This research aims to address the level of depression and stress among young adults living in a developing country like Pakistan and its treatment using technology-based personalized interventions. The level of depression and stress has been measured using dass-21 self assessment test. Dass-21 self assessment test measures depression, anxiety and stress into normal, mild, moderate and severe level. After the severity of results the user will be assigned an intervention through the RL agent, the correctness of choice of intervention depends on post-test results.

The rest of the paper is organised in the following manner: Section II contains literature review, section III is the research background , Section IV Proposed methodology, section V is Results and Discussion and section VI conclusions and future work.

A. Research Objectives

A lot of work has been done about mental health of older adults and adolescents. Very few worked in mental health evaluation among young adults. In the ongoing socio-economic environment and lifestyle, almost every individual is facing mental health problems. Keeping these factors in mind, proposed research aims to provide a mental health app to measure and manage depression and stress among young adults. The objectives of this research include:

- Construction of mental health app for people aged 20-40.
- Use of DASS-21 test to measure level of three main mental problems: Depression, Anxiety, Stress.
- Use of RL agent to suggest an intervention that best suits the needs and demands of a person.
- Evaluation of intervention decision by an agent through post-test.

II. Literature Review

A. DASS-21

To understand the effectiveness of the 21-item Depression Anxiety Stress Scales (DASS-21) for individuals with mild traumatic brain injury (mTBI), the study in [14] performed a psychometric evaluation. Through Rasch analysis, the researchers examined the scale's underlying structure, consistency, ability to differentiate among individuals, and item fairness. Findings suggest that the DASS-21 is a psychometrically robust instrument for gauging distress and stress in adults receiving care for mTBI. For specific depression assessment, the study advises using a shortened six item subscale for depression. [15] investigated the practical utility of the DASS-21 in elderly populations across various nations, examining sample demographics, application goals, and recruitment sites. Researchers screened 855 studies from EMBASE, PubMed, and SciELO, ultimately analyzing 22 involving 14,339 participants (predominantly women aged 60-91) from 13 countries. The review concluded that the DASS-21 is a valuable instrument for tracking depression, anxiety, and stress in diverse elderly groups globally.

This study [16] evaluates the DASS-42 and DASS-21 for assessing depression, anxiety, and stress in hematologic cancer patients. Analyzing data from 452 patients, the research shows both scales have strong psychometric properties, with the bifactor model fitting better. The results support using these scales for reliable assessment in Turkish hematologic cancer patients, aiding clinical evaluations and interventions. Evaluating the DASS-21's psychometrics in Spanish and Chinese primary school teachers, [17] underscores the significance of educators' psychological health. The study revealed cross-cultural measurement invariance issues, with the DASS-21 best fitting a one-factor model for Chinese teachers and a three-factor model for Spanish teachers. Notably, it demonstrated concurrent validity with emotional exhaustion in both samples.

B. Personalized Interventions

The systematic review [18] investigates the cutting-edge developments in Next-Generation Cognitive Behavioral Therapy (NG-CBT) for depression, with a particular emphasis on how digital tools, teletherapy, and individualized treatment approaches are being integrated. The findings indicate that NG-CBT interventions significantly enhance treatment accessibility and patient engagement. Specifically, personalized digital tools contribute to improved treatment adherence and can be cost-effective alternatives to traditional therapy.

The article [19] thoroughly examines current tools and technologies leveraging artificial intelligence (AI) in the management of anxiety and depression. It highlights the growing integration of AI applications, such as chatbots, mobile health applications, wearables, virtual reality, and large language models (LLMs), into mental health. These tools facilitate accessible, personalized, and immediate support for individuals experiencing anxiety and depression. Researchers suggest that AI interventions are good for underserved populations,

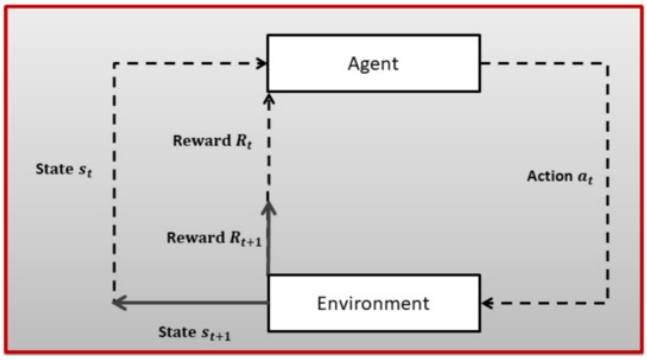


Fig. 1: Working of an RL agent presenting agent-environment interaction. a_t = action performed for state S_t, S_t = current state after performing an action at, Rt=reward received after at, $S_(t+1)$ = next state, $r_(t+1)$= reward received at a state $S_(t+1)$ [24].

but should not replace human professionals. [20] reviews the rise of anxiety among college students, by the COVID-19 pandemic, identifying risk factors across societal, institutional, familial, and individual levels. While traditional therapies are useful, they face accessibility and stigma issues. The review highlights digital interventions (apps, chatbots, VR) as scalable, cost-effective, and less stigmatizing solutions, particularly for tech-savvy students. Successful implementation requires collaborative efforts from governments, colleges, families, and students.

III. Research Background

A. Reinforcement Learning

Reinforcement learning (RL), a branch of machine learning, is goal-directed learning from interaction. Reinforcement learning involves improving performance through trial-and-error experience [21]. A method with a software agent that interacts with an unknown environment, selects actions dynamically and discovers which action yields more reward [22]. Reinforcement learning focuses on teaching algorithms to make choices by providing positive feedback for preferred actions and negative feedback for unwanted ones [23]. Similarly to how behavior is influenced by rewards and consequences in psychology, this method allows systems to gradually develop the best strategies through a process of trial and error [24] as shown in Fig 1. The reward system is crucial for guiding the agent's actions toward achieving the final goal. It serves as a feedback mechanism, clearly indicating whether a chosen action has led to a positive or negative outcome. By understanding this, the agent can adjust its strategies effectively, ensuring progress and success in reaching its objectives.

1) Upper Confidence Bound (UCB): Upper Confidence Bounds (UCB) are statistical techniques applied in decision-making under uncertainty, especially when there is a need to balance exploration of new choices with exploitation of known favorable ones. This method is commonly used in multi-armed bandit problems, where it aids in selecting actions by considering both their estimated rewards and the uncertainty around those estimates.
The UCB method works by computing an upper confidence limit for the expected reward of each option. This involves combining the estimated reward with an additional term that captures the level of uncertainty or variability in that estimate. The option with the highest resulting upper bound is chosen for the next decision step [25].
Exploration: Exploration enables the agent to gather more information about the available actions, by exploring all possible states in a given environment.
Exploitation: Exploitation allows the agent to select the action it currently believes will yield the highest reward, aiming to maximize short-term gains based on existing knowledge.

2) UCB Action Selection: UCB is favorable for uncertain conditions to balance exploration and exploitation. Mathematically, a UCB agent selects an action using the following equation:

$$A_t = argmax_a(Q_t(a) + c(\sqrt{ln(t)/N_t(a)})$$

Here t presents timesteps, Q_t is expected reward (Exploitation) at time t and last term is exploration reward.

The main objective of using the UCB here is to maximize the cumulative reward across multiple trials. UCB algorithms seek to minimize regret (the difference between the actual rewards earned and the estimated rewards. Unlike other RL algorithms, it does not require extensive training data to learn. It's exploration-exploitation property helps in minimizing regret by choosing optimal intervention available.

B. Personalized Interventions

Personalized interventions are care strategies that adapt to the specific circumstances of each individual, especially in mental health settings. Rather than relying on broad, generalized solutions, personalized interventions emphasize tailored strategies that align with the unique needs, contexts, and characteristics of an individual, a group, or a system. By aligning the intervention closely with the individual's needs, the aim is to improve the effectiveness and engagement of the treatment process, ultimately leading to better therapeutic outcomes [1].
When implementing personalized interventions, it is essential to choose them carefully, guided by the individual's specific needs and preferences. This strategy encourages shared decision-making between the individual and the healthcare provider. Research suggests that personalized interventions are especially beneficial for complex mental health conditions such as depression and anxiety, as these disorders often present differently in different individuals [26].
The emergence of AI and digital technology has revolutionized the field of healthcare especially mental health by offering tailored treatment regimes. Machine learning made significant advancements in this field, but reinforcement learning helped

to turn traditional treatment methods into personalized and adaptive treatment interventions [1].

C. Self Assessment Test

Different self-assessment tools are available online to measure depression and anxiety. Patient Health Questionnaire (PHQ-9) consists of 9 self-reporting items, one of the free online available tests used to measure depression [27]. Back Depression Inventory (BDI), Back Anxiety Inventory (BAI) consists of 21 self-reporting items, each with 4 options. BDI is used for depression and BAI is used for anxiety [28]. Depression, Anxiety, Stress Scales (DASS) is most commonly used self-assessment test for three different but interrelated variables [29]. DASS comes in two versions, DASS-42 is long item scale and DASS-21 is short item scale with 21 reporting items, each having 4 options. The DASS-21 is widely recognized for its brevity and reliability. It is available in more than 40 languages, making it a popular choice in both research and clinical contexts worldwide [30]. DASS-21 has three subscales and contains seven items for each subscale (i.e. depression, anxiety and stress). Each item has four options, and each option shows level of severity from 0-3. Level 0 shows do not apply to me at all, 1 shows sometimes applied to me, 2 shows applied a good part of the time and 3 shows strongly applied to me.

IV. Proposed Methodology

This research aims to measure level of depression, anxiety and stress in young adults. The main steps involved in the proposed research are mentioned in Fig 2. This research aims to develop a web app to evaluate and manage depression and stress among young adults. The system has been made using Python Flask and consists of three main steps:

- Pre-Test
- RL Agent for Treatment Intervention
- Post-Test

DASS-21 appears as a pre-test as the user logged in using few demographics (name, age, gender, occupation). To track the outcomes user data is stored. The interface of pre-test can be seen in Fig 3a. Dass-42 covers every minor and major detail in a behavior over a specific period like a week or two. So, the selection of items for dass-21 was critical. We made sure to include those items in dass-21 that a user (a young adult) can associate himself/herself with.

The interface of a pre-test contains a few guidelines for the. Selection of an option for each item is mandatory. Pre-test will not be submitted until all the items are responded by selecting the severity option. In case of missing item, alert message will appear on the screen reminding the user to respond to each item. After submitting the pre-test as shown in Fig 3b, results will appear on the screen. Results contains both scores and severity of each subscale (depression, anxiety, stress). Results of a random user can be seen in Fig 4. (*Note:* The user in Fig 4 selected options on purpose to obtain mild to moderate results for each subscale). It is to be mentioned here that the primary focus is to manage depression and stress, keeping anxiety apart. The reason is that managing depression and stress simultaneously with a single intervention is quiet challenging. Once the agent is trained to manage these two subscales, it will be easy to manage the interventions for the third one.

Keeping anxiety apart does not mean that anxiety is not worth cured or managed. Anxiety is as important as depression and stress. The reason behind selection of DASS-21 in this research is to provide a single platform to manage all three subscales of DASS. As discussed in section III-C each subscale contains four levels of severity ranges from 0-3. These levels represent normal, mild, moderate and severe levels of each subscale. The range for each level is different for different subscales and is quite challenging to treat at the same time.

A. Interventions Selection

After completion of the first step (pre-test), the next step is the management of depression and stress. The management or intervention selection is done through RL agent. Interventions are assigned as actions of the agent, and reward is collected through post-test results. If post-test results are better than pre-test results, then the action performed by the agent is correct. The agent receives a positive reward. If the post-test results are equal to the pre-test, then there is a capacity to evaluate another action or to try another intervention. And, in the third case, if post-test results are less than the pre-test results, the agent gets a negative reward. Hence, the user was unable to manage the problem with the selected intervention. The agent will select another intervention to obtain better results.

Selected interventions to manage depression include:

- Mindfulness meditation
- Behavioral activation
- Cognitive restructuring
- Benson relaxation technique
- Empty chair technique

Interventions used to manage stress include:

- Box breathing exercise
- Time management techniques
- Physical exercise
- Guided imagery
- Improving sleep cycle

To overcome the unavailability of training data, threshold values are fixed to help agent maintain a balance between exploration and exploitation. These threshold values play an important role in selecting intervention. Agent selects an intervention that could treat both depression and stress of user at the same time. The decision made by an agent depends on subscale with high severity. This decision is then evaluated with a post-test at the end of the session as discussed before.

V. Discussion

This section presents the results, advantage and limitation of the work and possible directions for future work.

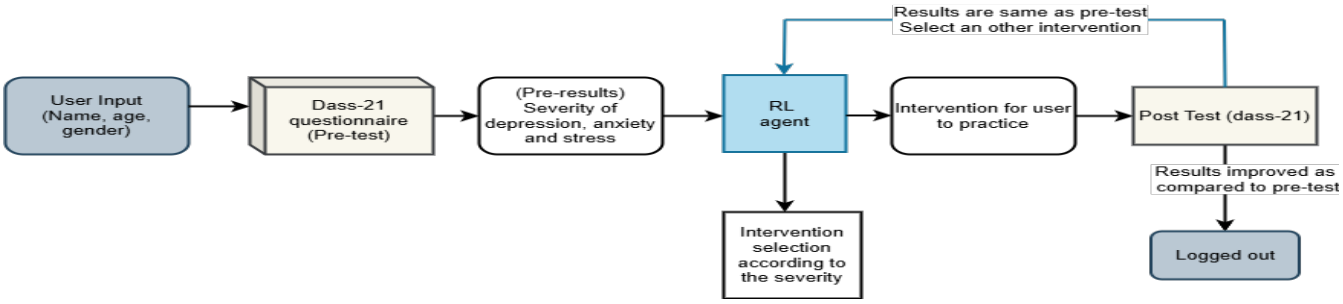
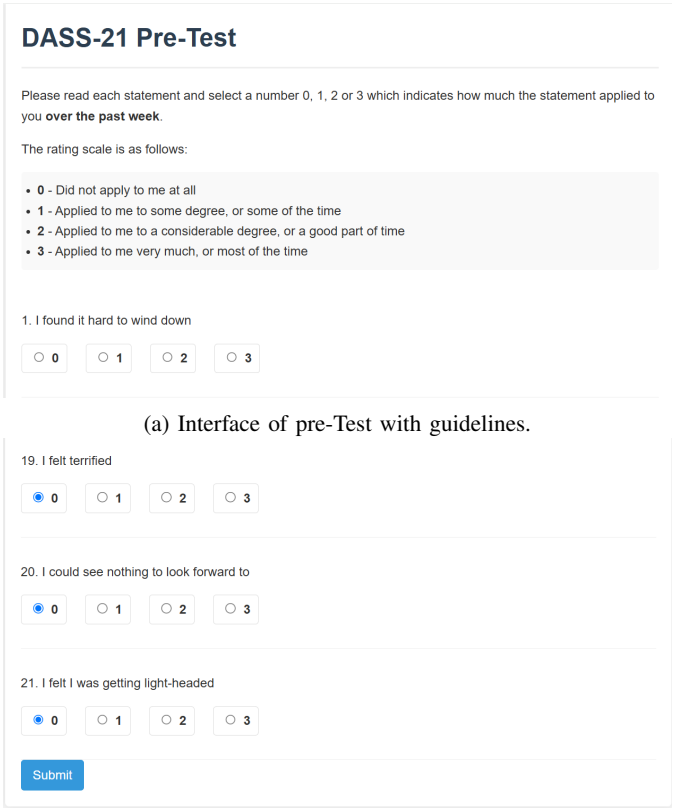


Fig. 2: Workflow diagram



(a) Interface of pre-Test with guidelines.

(b) Submission of DASS-21 test.

Fig. 3: Some visuals of DASS-21 items with levels of severity ranges from 0-3.

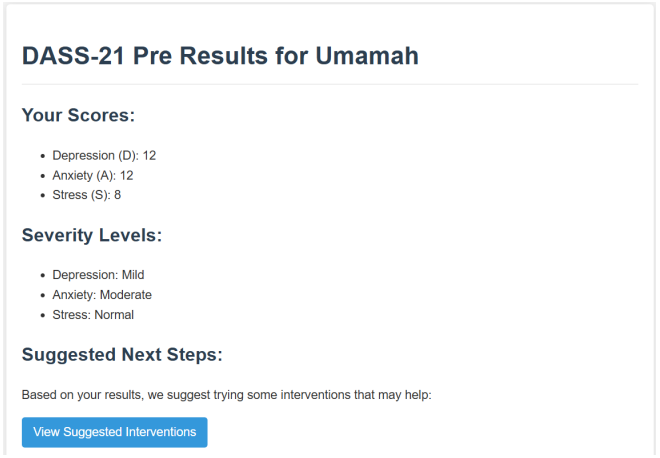


Fig. 4: Level and severity for each subgroup evaluated by selecting options given with each item.

A. Results

Use of reinforcement learning to generate adaptivity in AI-based digitial interventons is not new. Reinforcement learning has the potenial to do a lot for personalized interventions related to mental health problems. Use of DASS-21 to measure level of depression, anxiety and stress among young adults and suggest intervention according to their needs is promising. University students show a lot of interest in the proposed web app based digital intervention. The UCB algorithm used in this case does not have any prior data to train upon. But it maintained a good balance to train itself on the threshold values. Few university students volunteered for the proposed web app. Initially, the results of post-test remained same after practicing the suggested intervention for a week. The performance of the agent gets better after obtaining the same results and suggesting another intervention. To obtain satisfactory results, UCB requires more data for training. Another Problem faced by users is the understanding of reporting items. Few items are hard to interpret, and takes time to understand the context of the query being asked.

B. Conclusions and Future Work

The idea of a personalized interventions to treat depression and stress among young adults looks promising. It is important for the cultures where discussing one's mental health is difficult. The model used here requires a lot of prior knowledge to perform better. The proposed research focuses on management of depression and stress. But there is a need to manage anxiety along with depression and stress. Our future work includes intervention for all three subscales depression, anxiety and stress along with an additional feature of DASS-21 version in the native language.

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