**Motivation**

Hispanics population in the US are disproportionately affected by COVID-19. There are, on average, more Hispanics diagnosed with COVID-19 than any other racial population and they economically suffer more. The situation is not any better when it comes to mental health disorders. A survey by the Pew Research Center found that 28% of Hispanics experiencing “high” psychological distress, more than any other race in the country. The severe mental impact of the outbreak on the Hispanics can be corroborated by the CDC data too. According to the CDC, the Hispanic population is experiencing higher levels of symptoms of mental health disorders compared to other populations. On average, the percentage of Hispanic population reporting symptoms of depressive disorder is 2.8% higher than the average population (Figure 1), 6% and 8% higher than White and Asian communities, respectively.

**Decision Support System**

To deal with the disproportionate mental health effects faced by the Hispanic population in the US, we have developed a Decision Support System (or DSS) which can be used by non-profit agencies working towards improving mental health, such as, [Give an Hour](https://giveanhour.org/) to prepare for future mental health conditions and make time-appropriate decision to obtain long-term gain. The DSS consists of two tools: (1) predictive tool and (2) Markov Decision Process (MDP) tool. The predictive tool forecasts the severity of depressive and anxiety disorder of our target user group at each state for the next period by considering the historical values of several potential different indicators. Results of the predictive tool will help local agencies to better prepare for the upcoming issues stemming from the potential anxiety and depressive disorder across the states in the US. The MDP tool assists the local agencies in making better-informed actions based on the severity level of anxiety and depressive disorders for the user group across the states. Both tools are provided in executable format; the decision makers can run the tools from the command line and the tools will provide applicable results. We provide a succinct summary of the two tools in the following two section.

**Predictive tool**

We have developed a linear-regression based predictive model to predict the level of response variable, percentage of Hispanic population showing symptoms of anxiety and depressive disorders, at each state in the US for the next 2 weeks. We have used the following indicators as the independent variables: (i) COVID-19 related deaths among Hispanics, (ii) percentage of Hispanics without health insurance, and (iii) total unemployment claims among Hispanics. In our preliminary analysis, we have found 'US State' to be an insignificant predictor. That is why we decided to consider developing predictive models for each state separately. We have found that the response variable is highly correlated with the number of deaths due to COVID-19. for this variable were more than 85% for California and North Carolina. Overall, the value for the total model were more 70% for most of the states. The executable creates visualizations in html format for R-squared, RMSE, and the predicted response for next period.

**MDP**

We have developed an MDP model with a preliminary set of states, actions, transition probability matrix (TPM), and rewards. We consider three states for our MDP model: Red (alarming), Yellow (severe), and Blue (moderate). Two thresholds values,, on the response variable selected by the decision maker (DM) will determine the MDP state for each state in the US. . The executable provides a list of actions for all three conditions.

Based on a preliminary literature review, we have defined the following actions to define the action space: (i) hire a celebrity (HC), (ii) increase budget in social media advertising by 1% (SMA), (iii) increase paid positions in telemedicine by 1% (TM), (iv) create one art therapy (AT), (v) increase social awareness activity by 1% (SAA), (vi) increase number of support groups by 1% (SG). Notice that all these actions are to be implemented to improve the mental health issues faced by our user group. We have not found any specific mental health solution which is customized for Hispanics only.

We consider a “cost-ordering” approach to develop the TPM for the MDP model. The intuition behind this as follows. Each action is assumed to have a cost associated with them. For example, it is safe to assume that hiring a celebrity costs more than increasing the budget for SMA by 1%. Between two actions, the action with the highest cost should have the highest probability of turning a Red state to a Blue state, while it should have the lowest probability of turning a Blue state to a Red state. Following this intuitive approach, we have developed an algorithm named “TPE (Transition probability elicitation) algorithm” in Python. The algorithm will ask the DM about the costs of each action. Based on the inputs, the algorithm will sort the actions in terms of their cost and create the transition probability matrix accordingly.

At this point, we need to acknowledge several shortcomings of the present version of the MDP tool. The TPE algorithm follows an intuitive approach to create the TPM, which can be incorrect in practice. To remedy this, we suggest implementing Bayesian update of the TPM based on the actions taken by the DM over time. But this approach requires a collaboration with the DM, which is not feasible at this stage of the challenge.We have also noticed that it is hard to estimate the reward for each action-state pair without collaborating with the DM. It can be even be hard for the DM to provide an estimate for each state-action pair. We suggest implementing Inverse Reinforcement Learning to elicit the inherent state-action rewards, which, again, requires a collaboration with the DM.

Nonetheless, we have an executable file for the MDP tool, which can be implemented and used by local agencies right now. While a short-term collaboration between our team and the agencies can really improve the usability of this tool drastically.

All codes, datasets, and executables files are available at this [GitHub link](https://github.com/THASNA31/TeamUMUT_Code_for_Spot_Challeneg_Mental_Health).