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Gaining Insights into Patient Satisfaction through Interpretable Machine Learning

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Abstract - In an attempt to quantify patient experiences, CMS developed a nationwide standardized survey instrument - Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey for assessing hospital care. Self-reported questionnaire offers feedbacks on the provider's success in meeting patients' expectations and serves as an effective means to evaluate the tangible hospital services. Beyond that, patient-related characteristics and clinical information substantially contribute to the variations in patients' behavioral intentions . For example, satisfaction level varies among patients with different diseases and usually remains at a low level for patients of poor health status. In fact, the healthcare experiences of a patient can be viewed as a personalized journey connecting a myriad of touch points that a patient interacts with, across multiple service units, and throughout the entire length of stay.

The proposed framework transforms heterogeneous data into human understandable features and integrates feature transformation, variable selection, and coefficient learning into the optimization process. Therefore, it can achieve desirable model performance while maintaining excellent model interpretability, which paves the way for successful real-world applications.

Key Words: **patient-centered care, mixed-integer programming model, real-world applications.**

1. INTRODUCTION

P ATIENT satisfaction is one of the critical indicators in evaluating healthcare quality . In the era of patient centered care, an individual's unique health needs, personalized treatment and desired health outcomes are the main drivers behind health policy decisions. Patient satisfaction, as a direct feedback and quality measurement of patient experiences, have influenced the care delivery in the past decade, and the way how health systems are managed and reimbursed.

The Centers for Medicare & Medicaid Services (CMS) have initialed the Hospital Value-Based Purchasing Program which partially links hospital reimbursement from CMS to a set of quality measures including patient satisfaction; hence poor performance on these measures can substantially increase the financial risk of hospitals. Besides the financial impact, patient satisfaction is strongly associated with greater compliance and increased treatment adherence ,thereby leading to improved health outcomes. Assessing the influencing factors that drive patient satisfaction is a crucial step in developing corrective actions and necessary interventions. As with other service sectors, factors influencing patient satisfaction consist of tangible aspects like hospital services and intangible aspects like patient demographics and socioeconomic status. In an attempt to quantify patient experiences, CMS developed a nationwide standardized survey instrument - Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey for assessing hospital care.

2.EXISTING SYSTEM

Most existing studies have focused on variables of a single source, while failing to relate a broader scale of indirect factors that may also affect patient satisfaction Second, according to a previous investigation very limited number of approaches is involved in patient satisfaction studies. Commonly used approaches include mean and percentage calculation, correlation and regression analysis, pairwise comparison, principal component analysis, and other traditional statistical methods.

The first trajectory is to develop novel intrinsically interpretable models and to improve the existing ones for enhanced performance on specific tasks.

For instance, Lethem propose a generative model called Bayesian Rule Lists that utilizes a sequence of if-then-else decision statements to achieve accurate performance on stroke prediction.

Disadvantage:

Our ATC simulator task during the selection process engendered high stress and required complex cognitive functioning for ATCO candidates, similar to how the spatial frequency power of HRV or RSA measured at rest predicted subsequent military training performance in several environments of stressful and cognitive and emotional complex training.

Unlike our stress-resilience traits, the mental state of response inhibition is assessed prior to the execution of the job-specific simulator task in a stressful ATCO candidate selection situation.

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3. PROPOSED SYSTEM

Then, we introduce a mixed-integer programming model that seamlessly performs feature transformation, variable selection, and coefficient learning by solving an optimization program.

Last, the proposed method is compared against other state-of-the-art machine learning methods in terms of model performance and interpretability. The proposed framework of this paper belongs to the first research trajectory. We focus on building an intrinsically interpretable model for tackling the patient satisfaction problem.

Through meaningful feature engineering and explicit data modeling, our method is expected to produce interpretable results while maintaining good performance as the complex black-box models.

Advantage:

Tools for stress resilience evaluation that are both time and cost efficient yet capable of self bias are available.

MRI, fMRI, fear exercise, genes, transcriptional regulation, etc. are high-cost metrics that may provide a deep and found to be highly into the biochemical processes contributing to one's resilience, but their evaluation is invasive and very demanding in terms of logistics and time.

Features based on objectively definable peripheral metabolic reactions that are very loosely linked to more fundamental concepts particular moods, such as stress resistance.

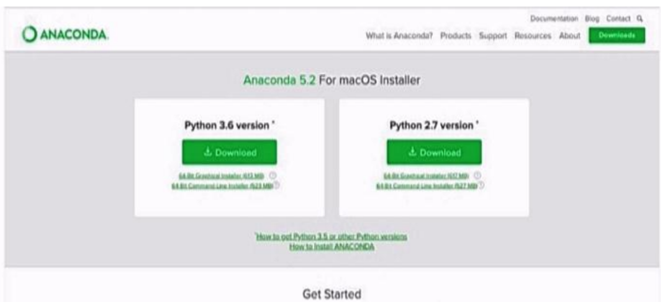


Fig 3.1 Anaconda Framework

4. SYSTEM DESIGN

In order to get from a particular issue to a solution, the first step in the process is to design. Manager To begin the process of moving from the issue domain to the solution management, the problem must be defined. As a link between the development of requirements and the finished response, layout plays an important role here. The design method goal is to provide a model or description of a system that may be used in the construction approach for that system. Known as a "gadget layout", this is the most recent variant. Systemic problem solving is one way to put this approach to work. The layout of a gadget is the most creative and challenging part of the whole process of making a device.

In spite of its complexity, this method makes coding for the recommended machine easier. or the suggested machine, this is a method of providing it Also included are instructions for Putting the device into use. There are a few parts to the system that must be taken into consideration. As a result of the research conducted in this section, new forms for presenting the findings will be devised. In the making of the machine. In this particular case, the emphasis is on translating the performance specifications into a layout description.

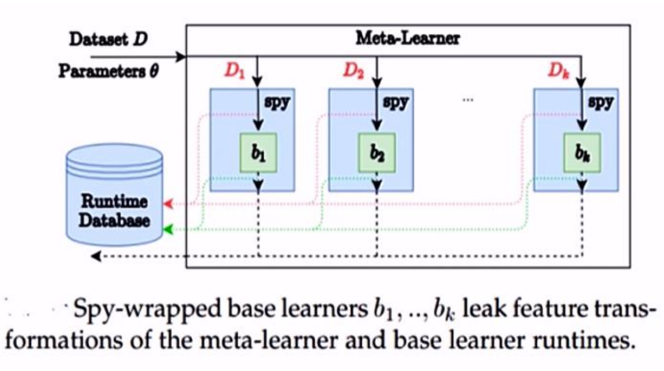


Fig 4:Architecture Design

4.1 Use Case Diagram

The use-case analysis in the Unified Modeling Language is what's discussed and constructed in the use-case diagram, which is a behavioural diagram (UML). Its objective is to provide a graphical illustration of the operation of the machine in terms involved, the objectives they want to achieve (which are shown as use instances), and any dependencies that those use instances may have. The visual representation of the use case's principal function is to show its purpose.

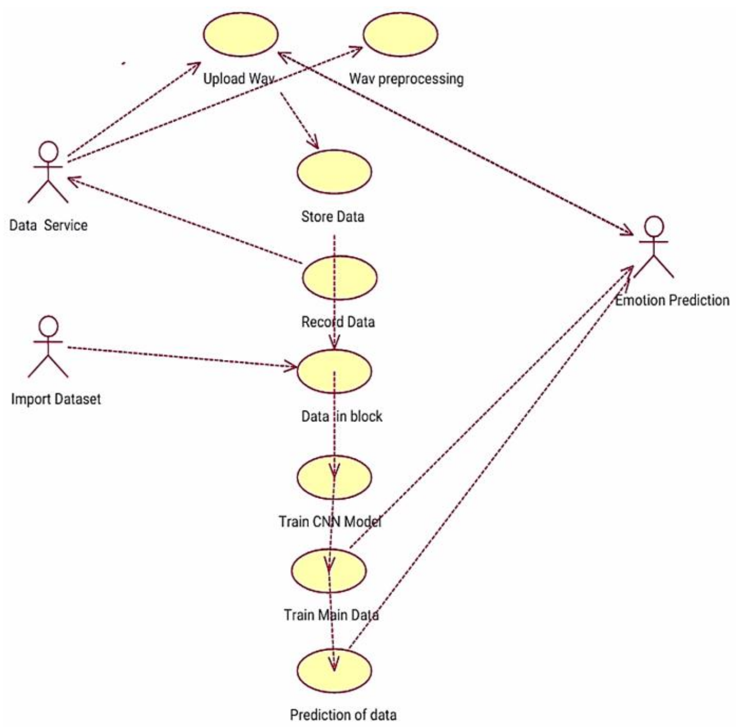


Fig 4.1:Use case diagram

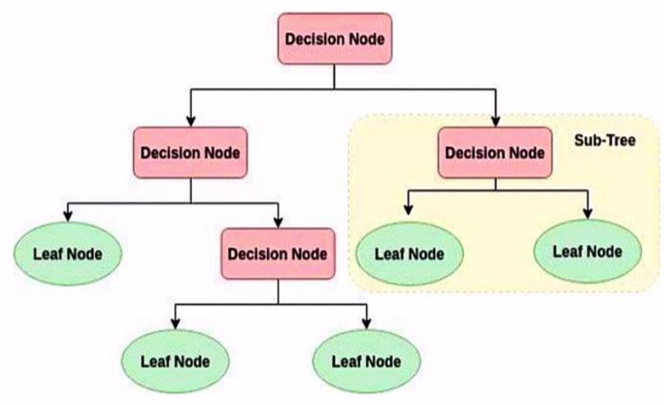
5. IMPLEMENTATION

There are two psychophysiological biomarkers of stress persistence: the aural startle response (ASR) and or the physiological allosteric responses (PAR). Analysis of electrocardiography , electromyography, electro dermal activity and breathing were part of a multimodal approach. But use a binary classification task, we examine the information about the future of the feature map generated by our computational technique of assessing physiological aspects of stress resilience and comparing high- and low-performing ATC simulators. Our new technique gives a classification accuracy of 78.16 percent.

Using earlier research, these findings are assessed and compared to those of other studies, as well as future research possibilities.

Decision Tree:

A kind of Supervised Machine Learning, Choice Trees separate samples along a specific boundary. To understand the tree, humans need to look at its chosen hubs and leaves in more detail. We make our decisions based on what's on display. In addition, the information is divided at the choice hubs.



6.SYSTEM DESIGN

1.Unit Testing - In this testing checking out utility exams the gadget. the entire utility is fashioned of distinct modules. Unit testing focuses on each sub- module unbiased of 1 any other, to find mistakes.

2.Integration Testing - Integration testing is intended to test the device as a whole. Its goal is to thoroughly test the device while all of its modules and sub modules are fully integrated had been keyed into the equipment. it is been visible the equipment is functioning flawlessly, to the first-rate of the consumer.

3.System Testing -System testing can be defined in a variety of ways, but the most basic definition is that validation is successful when the system performs in a way that can be fairly predicted by the user. Validation testing ensures that the system satisfies all of the system's practical, behavioral, and overall performance requirements. The task was tested with all its modules and ensured that there have been no errors.

4.Black Box Testing - Black box trying out is a technique to checking out wherein the tests are derived from this system or element specification. The system is a "black container "whose behavior can handiest be decided with the aid of reading its inputs and the associated outputs.

5.White Box Testing - White container testing makes use of the machine's internal perspective to set up test cases based on its internal structure. To pick out all paths through the software, you'll need programming skills.

TC No	Positive scenario	Required Input	Expected output	Actual output	Test Result
1	Upload datasets	Upload video	Should successfully upload	uploaded	Pass
2	Pre-processing	Process dataset	Remove unwanted datasets	Unwanted datasets are removed	Pass
3	Train image	Image processing	Identify object	Object detected	Pass
4	Classification	Objects are classify	Identify the object and classify which type of object it is	Object classified	Pass
5	Performance analysis	Find Accuracy	Display Accuracy information	Accuracy information displayed	Pass

Table 6.1:Test Cases

Test-Case	Test-Purpose	Test condition	Expected-outcome	Actual-result	Pass-or-Fail
Install python	Installing python3.7	Installation Done	Installation Done	Installation Done	Pass
Install python	Installing python3.7	Installation Done	Installation Done	Installation Done	Fail
Load Data	Load datasets In CSV format.	If the data is not in the CSV format, shows a Error message.	Load datasets.	The data is loaded Successfully in CSV format.	Pass
Pre Process data	CSV data	If values are missing,or improper data	Preprocessig is done	As Expected.	Pass
Tokenization	CSV data	Datasets Tokenization	Tokenization Is Done	As Expected.	Pass

Table 6.2:Testing Details

7.CONCLUSION

The findings presented show that our integrated method might be utilised to measure objective characteristics for stress resilience and to determine the constraints of the maximum range in relevant occupational settings, such as ATC, spaceflight directors, etc. As a result of working with such a small group of people, we can see both the advantages and disadvantages of this research. Resilience-related biological changes in a group of people are more difficult to detect than the general population or cohorts that include PTSD patients and hcs. This lends weight to our research since we discovered useful information for machine learning-based prediction of task performance under stress in a group of physiological parameters unconnected to the task that had diminished variability.

8.FUTURE ENHANCEMENTS

Research on ATCO choosing aims to supplement preexisting criteria for selection with proven concrete physiological responses of stress responses that are indicative of future task performance and comprehensive on-the-job functioning amid duress, as well as this publication.

Although the results and methods of this study may be generalised, we recommend further research on a larger sample of ATCOs from a varied range of cultural backgrounds, as well as further work geared at ensuring the stability and comprehensibility of the established machine learning techniques.

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