

Predicting the Attention Rate of Patients by Monitoring their Emotions

Project Proposal

Version 1.0

April 17th, 2021

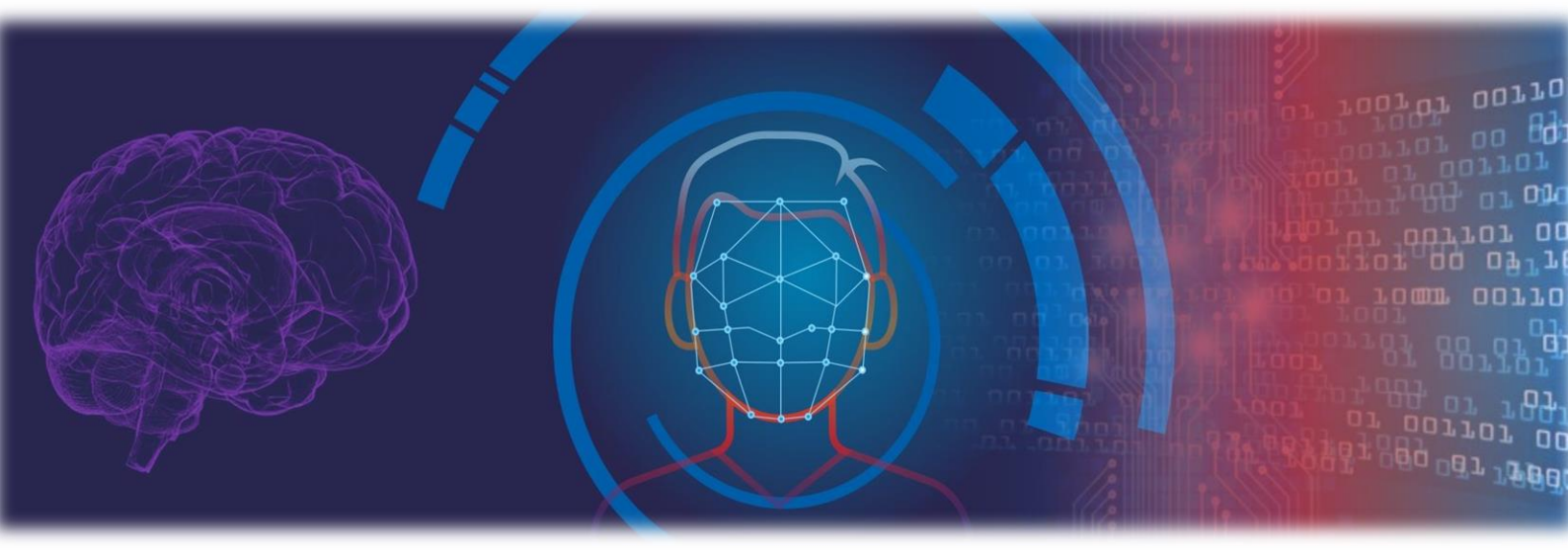
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Preface

This report was written for my genuine challenge for Fontys University of Applied Sciences, in which a model for predicting the attention rate of patients by their emotions in real time was build which aimed for aiding doctors in classifying which patients required immediate attention and which would not. It included a Jupyter notebook in which the exploratory data analysis and the model building was carried, an infographic, deployment, and a result document. The project was carried out from March 2021 to June 2021.

In this project a deep research was carried out to understand the most common behavioral emotions illustrated by different patients. The decision to choose a Convolutional Neural Network for implementation was basically because it is widely known for recognizing image patterns and learning from images to predict your outcome which in our case is emotions. The model building involved a lot of experimenting with the parameters and the depths of the convolutional and hidden layers. Moreover, callback functions were used to save the widely information from epochs for visualizations. A bit of enhanced research yielded dad that pre trained models provided by PyTorch library we're also great for image recognition hands hence the use of pre trained VGG 16 was implied on our data set from stop. After comparing the performance of both the models built the custom CNN model yielded better performance with an accuracy of 63%. Lastly by using computer vision techniques the recognition of emotions was carried out in real time by using default computer camera.

I would like to thank my machine learning teacher Avetyan, Rafayel R, my data analysis teacher Jurjus, Herman H.H. and social impact teacher Veneman, Woody for providing me with enriching and helpful feedback which helped me build this project with more value.

This document's current version is the first.

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1. Introduction

Artificial Intelligence isn't an intruder in our lives, but a multi-talented assistant that can improve our lifestyle if used in the right way. As we proceed more into time, we might not be aware, but we are already involved and interacting with different Artificial Intelligence technologies such as when you ask your Siri to play your favorite song, using your voice to search up the definition of a word on Google or your smart lights which turn on only when you're physically present in the room etc. All these technologies were created in order to improve the lives of humans and provide ease.

In our project, with the aim of creating something valuable that would serve people, a model would be build which would help many doctors in understanding and monitoring the different emotional behaviors of various patients and henceforth classifying them into which require immediate response and who might be doing okay otherwise. This would help improve time management and eventually offer a quick and premium patient experience for every patient.

The knot tying Artificial Intelligence and healthcare allows physicians and hospital staff to provide a more data-driven decision by using various algorithms, identifying similar patterns, and visualizing automated insights. One such implementation was of IBM Watson's ability to identify correct treatments for over 1,000 cancer patients.

2. Project Overview

This section explains the brief description, formed researched questions, and the chosen approach for carrying out the goal of the project.

2.1 Description

This project consists of creating a report on aiding doctors in large multinational hospitals to understand different patient behaviors. Fundamentally, the project goal is to showcase the power of Artificial Intelligence and Machine Learning in healthcare and how to provide a better patient experience by classifying them on their emotions, mainly the four basic emotions (happy, sad, angry, and relaxing) and accompanying the ones that are in pain and require immediate or more attention and care. This document consists of various research analysis, model formation and producing high accuracy solutions.

Main research question

How can the AI technology help in augmenting the relationship between the patient and the doctor by cognizing their emotions?

Research sub-questions

1. What ethical concerns does this technology raise and what are its available solutions?
2. What steps should be taken to familiarize this advancement to the different age grouped patients?
3. At what level of personalization would be available and what role will security play?

2.2 Project Constraints

Defining constraints automatically defines a proportion of the project's scope. It's difficult to define the project's scope and domain without addressing these constraints. To ensure that the project's quality is maintained, it's critical to keep these constraints in mind throughout the process. The following are the project's constraints:

- The model must involve an algorithm which provides the best accuracy rate on different test samples.
- The model shouldn't be biased towards one feature and shall have high variance.
- The data used must be following the data privacy regulations.
- The model must be anti-racial that is it should accept every individual without taking the color of their skin as a factor.

2.3 Project Goal

The goal of this project is for the patient to be able to showcase its face onto the camera through which the AI model can identify its emotions and will be stored. At a time at most four patient's data would be taken and the algorithm would categorize them according to their emotions from the list of our four basic emotions which are happy, sad, relaxing, and angry. From the list, the patients who illustrate the sad and/or angry emotions would require immediate attention and would signal the doctor to personally attend them.

2.4. Method of Approach

The method of working to be followed throughout is Agile methodology. So, since we are having 8 weeks for this project, having 4 sprints of 2 weeks each would be essential.

Sprint 01 – Project Proposal Document, Start Exploratory Data Analysis of Dataset

Sprint 02 – Finding right algorithm, Training the dataset

Sprint 03 – Designing the model/Areya.Inc and fitting the model

Sprint 04 – Performing analysis, testing, and reducing any possible error

Research Methodology

The research framework used for this project is the DOT Framework, which consists of five strategies that split available work, the Areya.Inc context, and the innovation space. These strategies are Field, Library, Workshop, Lab, and Showroom.

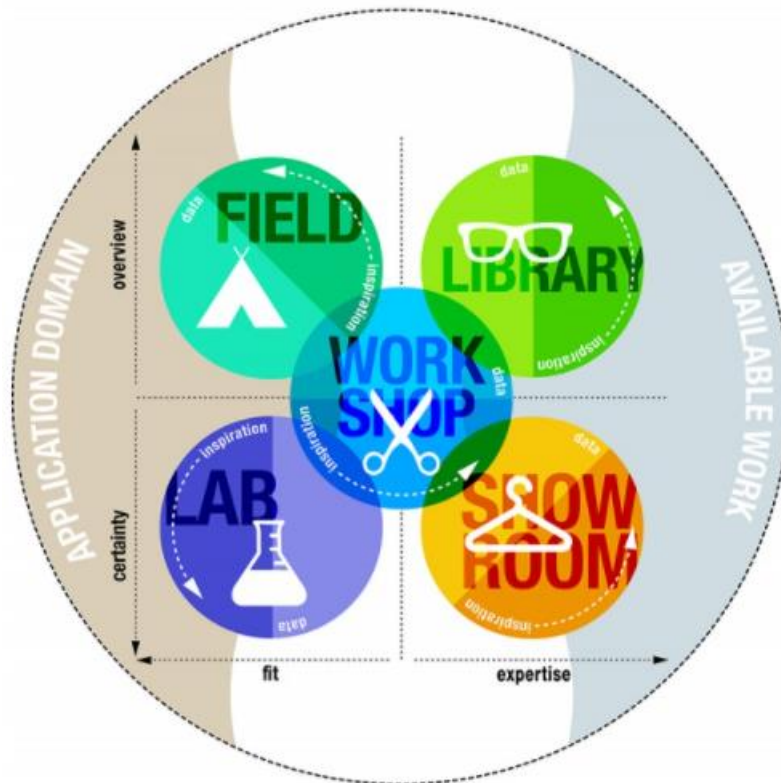


Figure 01: DOT Framework

Library

To understand how and why emotions are elicited, we first need to learn about what truly is the definition of an emotion expressed. Emotion is usually seen as episodic with the change in an individual brought about by some triggering event, which can be external (such as the behavior of others, a change in current situation, or a novel stimuli) or internal (such as thoughts, or memories). The emotion event is expected to last for some period of time and eventually fade away. If the goal of the patient is to undergo a surgery, then the stimuli here would trigger the patient to feel negative and fearful emotions. An alternative new of this scenario may include the goal of being healthy is extremely important and the event such as being diagnosed with an illness is incongruent with the goal, then negative emotions such as anger, fear and sadness are more likely to be expressed. Hence, having to be classified as sick would give rise to experiencing negative emotions.

A study conducted on a patient suffering with hip pain to understand the change in the emotions felt by him at different stages of initially being surrounded by his family and hoping to get recovered at home and eventually visiting the hospital for a better treatment. The figure below illustrates the customer journey map for magnitude of positive and negative emotions felt by the patient at three main sub-events - a primary care visit, an emergency department visit, and an in-patient hospital stay for surgery.

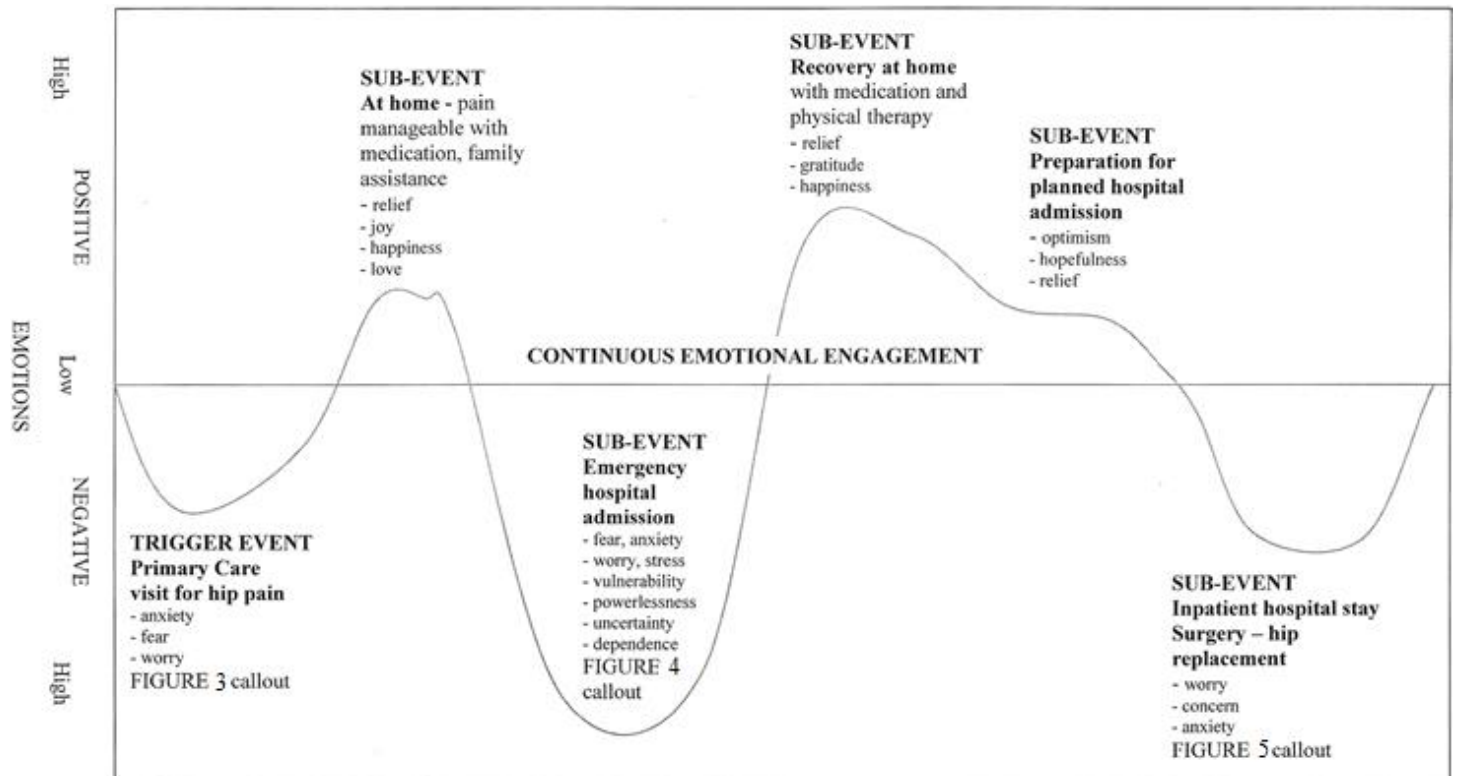


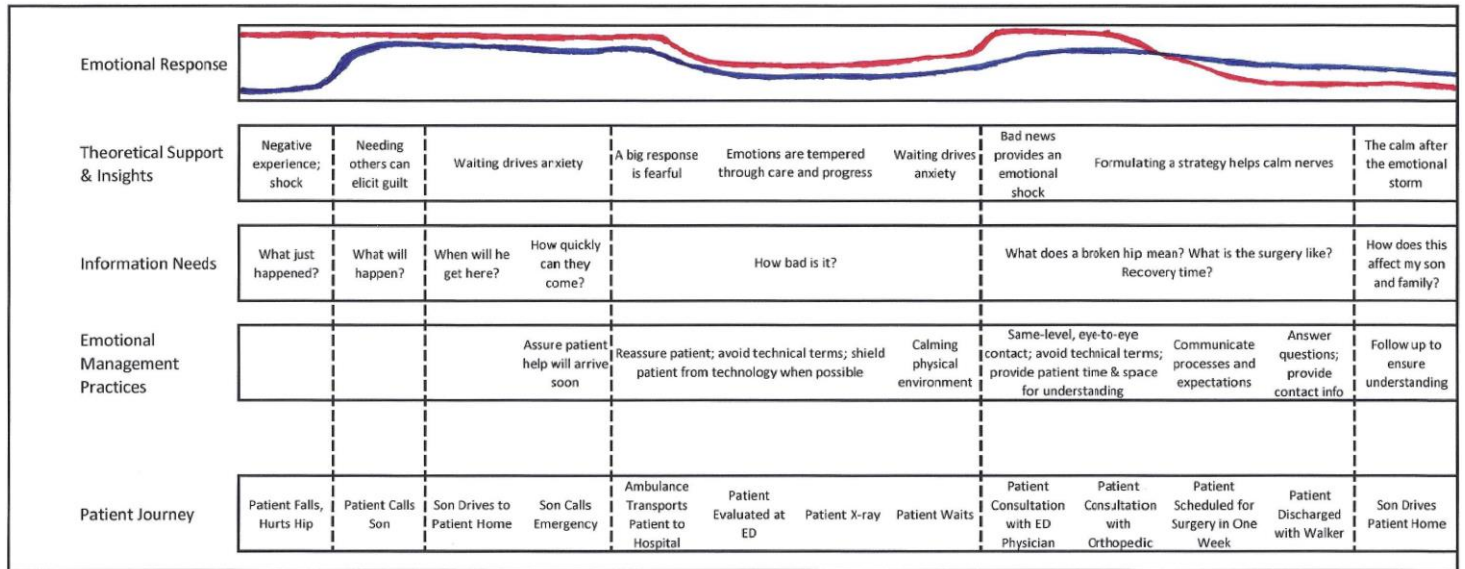
Figure 02: Overall illustrative health care customer journey map

Emotional Response												
Theoretical Support & Insights	<div>Information needs increase negative emotions</div> <div>Support from son stabilizes emotional response</div> <div>Waiting increases Anxiety</div> <div></div> <div>Waiting Increases Anxiety</div> <div>Reassurance Alleviates Patient Concern</div> <div></div> <div>Son Provides Support to Patient</div> <div>Apparent Solution Elicits Confidence</div> <div></div>											
Information Needs	<div>What is the Cause?</div> <div>How Soon Can I Be Seen?</div> <div>Son and Patient Discuss Possible Causes and Implications</div> <div>What is the Process?</div> <div></div> <div>How long will I wait?</div> <div>Shares history; understands causes</div> <div>Schedules next appt.</div> <div></div> <div>Dosing and other information</div> <div></div>											
Emotional Management Practices	<div>Provide assurance; design schedule for same-day appts.</div> <div>Warm welcome to patients</div> <div>Calming physical environment</div> <div>Nurse provides assurance and informs patient of schedule</div> <div>Calming physical environment</div> <div>Same-level, eye-to-eye contact</div> <div>Provide patient with necessary info</div> <div></div> <div>Assure patient; answer questions</div> <div>Follow up to answer questions</div>											
Patient Journey	<div>Patient Feels Pain in Hip</div> <div>Patient Schedules Appt.</div> <div>Son Drives Patient to Dr.</div> <div>Patient Checks In</div> <div>Patient Waits</div> <div>Patient Called Back</div> <div>Patient Vitals</div> <div>Patient Waits</div> <div>Physician Consultation</div> <div>Patient Checks Out</div> <div>Son Drives Patient Home</div> <div>Stops at Pharmacy to Pick Up Prescription</div> <div>Patient is Dropped at Home</div>											

P = Patient

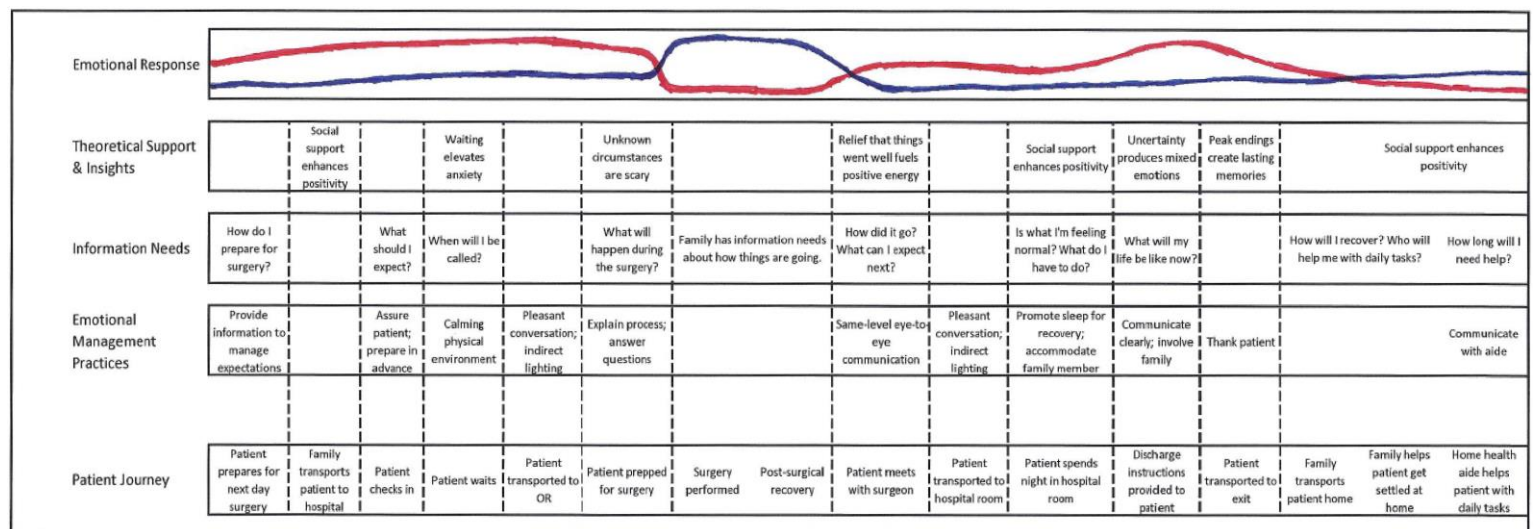
F = Family

Figure 03: Primary Care Visit for Hip Pain



P = Patient
F = Family

Figure 04: Emergency Hospital Visit



P = Patient
F = Family

Figure 05: Inpatient Hospital Stay Surgery – hip replacement

From the three tables generated above for different time scenarios for the patient, we can see what are the specific triggers which cause a drastic and uniform shift in emotions. Our focus would be on investigating Fig 05 because this paper focuses on providing help after the patient has undergone a serious treatment and is requested for hospital stay.

Field

The end users of our Areya.Inc are the doctors who would take necessary steps corresponding to the emotions illustrated by the patient. The vital need for the doctors would be to have a clear listed platform or model which offers them an overview of the current condition of the patient. It would be desired to have the doctors provide the essential care and support in the least amount of timeframe.

The patients would be our indirect users and it would be needed for the model to correctly detect and classify their emotions so as to avoid any upheaval. After the patient has undergone a surgery, all individuals irrespective of their age group, religion or gender would be considered. So, ages from newborns, to grown up individuals will be taken.

Additionally, the four main emotions depicted by humans are happiness, sadness, anger, and fear and to convert them into emotions which are possibly depicted by a patient we will be using happy, sad, relaxing, and angry.

Lab

In the predictions phase of the AI methodology, the final testing and conceptual of the product will be carried out.

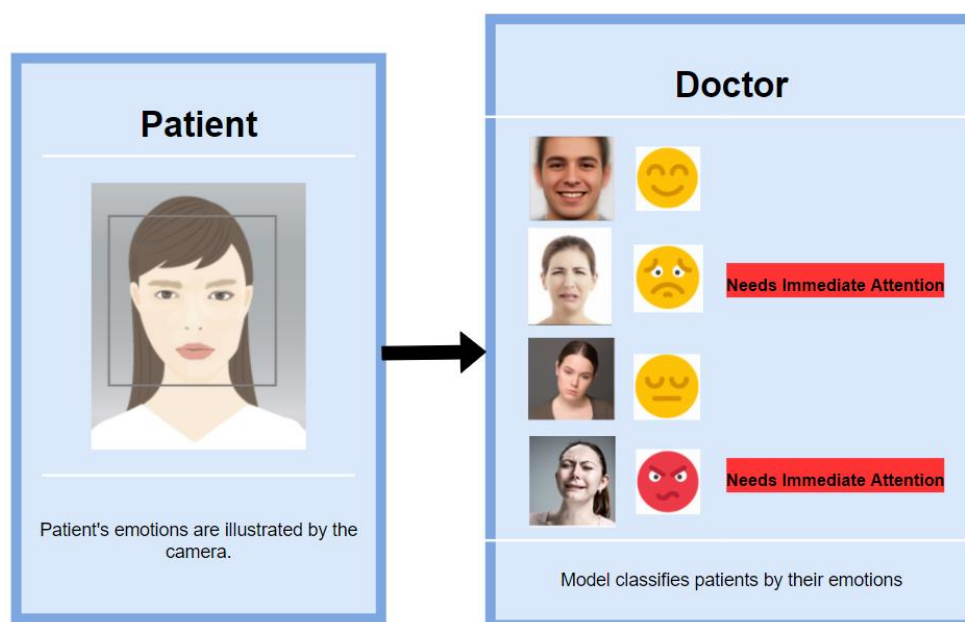
Showroom

Showroom research is done to test your ideas in relation to existing work. Showing your prototype to experts can be a form of showroom research or spelling out how your product is different from the competition. Also testing your product to general guidelines is a form of showroom research.

The product's prototype will be checked once the proposal and provisioning phases of the AI methodology have been validated and accomplished. Only, then the testing and showing our of discoveries of the data made by our model would be showcased.

Workshop

The initial prototype of the model is displayed below. While the patient's emotions are recognized and stored, the model predicts the attention rate, and the doctor gets to know it and eventually offer his care.



2.5 Project Deliverables

Following mentioned are the specific documents what will be delivered at the end of the project. While most of them would be updated time to time after receiving feedbacks from the mentors.

1. Project Proposal Document
2. Python Jupyter Notebook (containing Areya.Inc)
3. Infographic
4. Project Results and Deployment Document

3. Social Impact Framework

This section of the proposal document highlights the impact the Areya.Inc is aiming at producing with mixing Artificial Intelligence in healthcare.

3.1 Augmenting AI in healthcare

As researched by Eric Horvitz, an Artificial Intelligence and Research and head of Microsoft Research's Global Labs, "AI- based Areya.Inc could improve health outcomes and the quality of life for millions of people in the coming years". One of the Areya.Incs invented by Microsoft involving patients, was of predicting the probability that a patient would return after being discharged. Because hospitals are becoming the mainstream area and is a place where people go in hope of making their lives easier and better, by using some techniques of technology we can help the healthcare professionals in maximizing their efficiency, making new discoveries, providing a data driven approach which would predict results of patients with more accuracy in less time. Considering these factors, augmenting AI in healthcare is definitely something the healthcare professionals should look at with faith as the technology's only aim is to provide help in getting innumerable things in less time.

The mechanism of our Areya.Inc involves monitoring the shift in the facial emotions of various patients after their surgery has been taken place. This is being done in order to provide better and immediate care to the ones who require it most. After the emotion of a patient has been recorded into the system, the model predicts whether the patient requires a visit from the doctor or is just relaxing. The use of AI in our Areya.Inc comes into picture when classifying the different emotions and eventually predicting the attention rate. By using various classification supervised machine learning algorithms, the process can be performed with high accuracy percentage.

Following is the process diagram of how the AI would play a vital part.

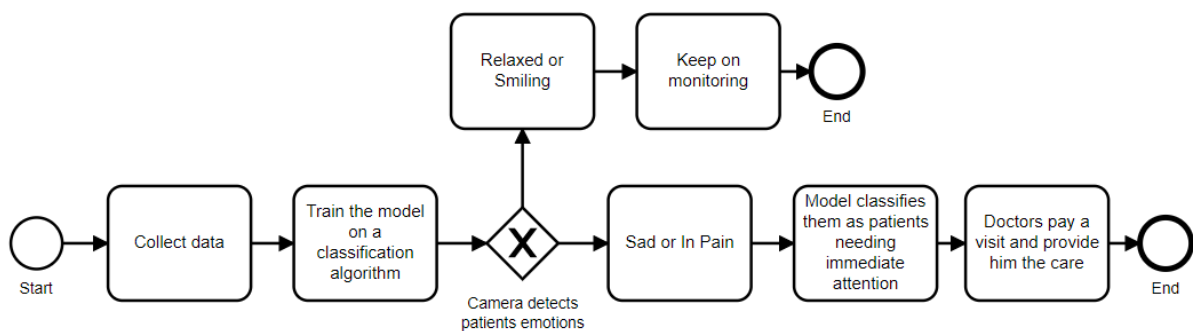


Figure 06: Implementation of AI in the system

Benefits to the Society

The Areya.Inc aims at providing positive benefits to the health care professionals and providing a better experience to the patients with more care and immediate response. The model will be trained on strong supervised machine learning algorithms so as to predict and classify emotions of patients correct. The goal is to make the patient experience more relaxing and anxiety free. This is due to the reason that many are afraid when the talk of surgery comes in as it's a very crucial process which requires great concentration.

So, while the patient has agreed to undergo surgery, he or she will be experiencing a rapid change in negative emotions as depicted in fig 05 . This effect also influences the family members as well therefore after the surgery has been performed the patient needs to be put into strict surveillance and along that process if the professionals can understand the change in emotions being felt by the patient, they can provide more effective which would help the patient recover mentally as well making him or her feel relaxed and stress free.

Stakeholder Analysis

Every corporation has a set of internal and external stakeholders. Internal Stakeholders are the individuals who are directly involved in the management of the business and hence are directly affected by a slight change in the business. In our case, Government, Public, NGO, Health Insurance, Health Care Professionals (Physician, Nurses, Pharmacists), Paramedical Personnel, Hospital Administration are the internal stakeholder or in simpler terms, the ones who work for the company.

On the other hand, external stakeholders are the group of people who are not directly influenced by the performance of the business. They are only interested in the performance and the success of the organization, but they are not directly affected by it. In our case, the major stakeholders are Suppliers, Patients, Financial Community, Special Interest Groups.

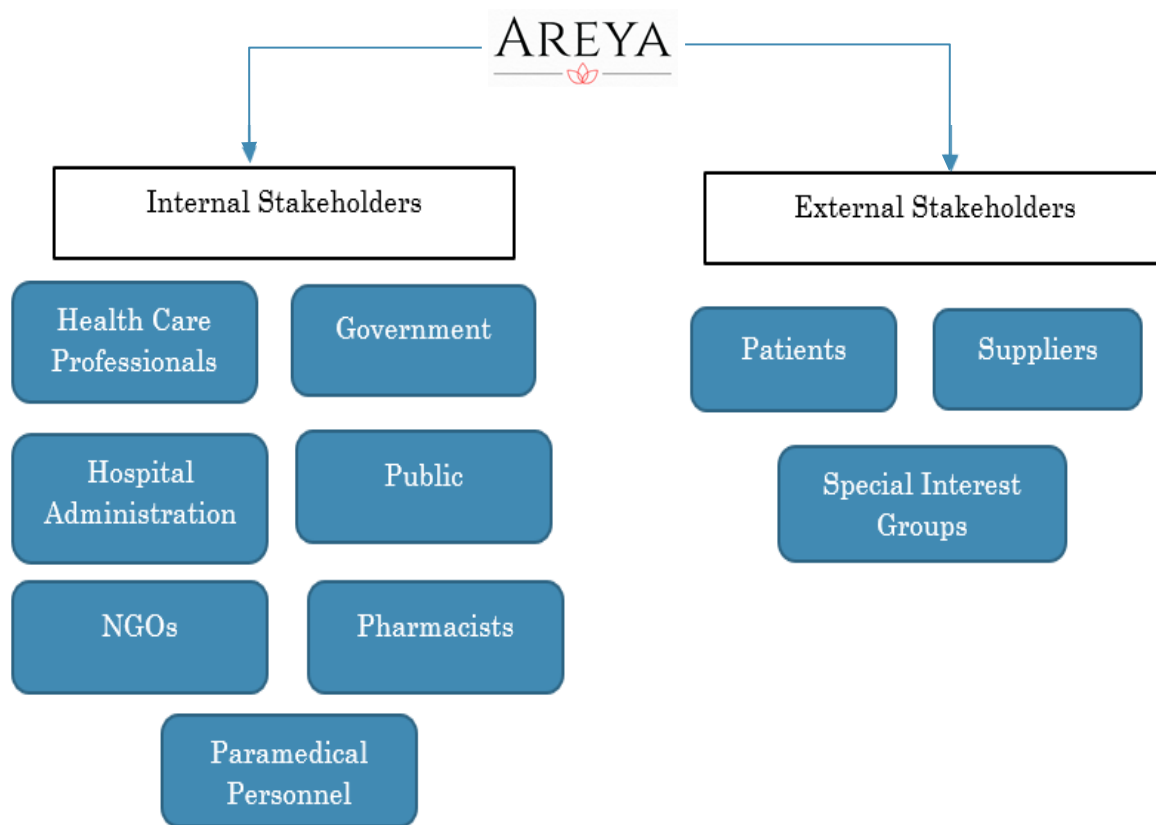


Figure 07: Stakeholders Analysis

3.2 Technology Reliability

This section talks about the use of the technology and the issues related to its privacy, transparency, and the inclusivity of the Areya.Inc.

Privacy

The technology will be registering the change in different emotions of a particular patient which is the key data parameter. With that, the patient ID, the room number of the patient would be stored. The magnitude of the privacy concerns is medium but the storing and use of the emotions would only be used fairly and the developers will be extra aware.

The technology will be GDPR – compliant and will be following the data protection law while keeping the design on the technology rather simplified.

Data

For this project, the use of FER-13 dataset will be used, and the key objective is to classify the emotions with providing suggestions with high results. Keeping in mind that use of the

data would be all in fair terminology and will only be collected to provide a healthier familiarity.

The data collected for training essentially will be limited to the dataset being used but as time passes, we will let the technology develop itself, there will only be moderation on extreme new behavior arisen from the self-learning. The Areya.Inc might have some advancement in order to correspond with the features or terms on which it will be running on in the future and if needed would deploy the then most powerful algorithm.

Transparency

To ensure the transparency of our Areya.Inc, the following actions would be taken:

- a) To share the results of our Areya.Inc, communicating about what went wrong and what can be improved with the key stakeholders.
- b) To share some fruitful insights to our users through the use of articles or on a possible website if constructed.
- c) To communicate on regular intervals with both internal and external groups and collect feedbacks to understand how the user analysis and sharing it to users.
- d) To make available the goals, vision, mission, and the policy statement to the user. Also, if possible, a small instructional video of how the things going under the hood to make the users understand the working of the technology.
- e) Providing valuable insights into the operation and action history of AI-systems while also taking care of the integrity of AI systems.

3.3 Ethical Concerns

This section deals with the ethical concerns which could be raised and what actions would be taken in order to ensure the smooth and harmless procedure with the objective of investigating and implementing AI in accordance with human rights and universal values.

Sustainability

Technology has no impact on sustainability (for example, by the energy that it consumes), but quite likely a much larger indirect impact. The technology would be made fully on algorithms and doesn't require any environmental material. Hence, we prevent any kind of harmful impact on the environment.

Hateful and Criminal Actors

When brainstormed if our technology can be transformed into a negative viewpoint which would be used to hurt, bully, or harass individuals, the persona of a bad character came into picture. Since, our technology isn't being used directly by the users rather just capturing their emotions and predicting without any socialistic or regional interests the attention rate that they require. Subsequently, our technology is more of a self-working algorithm, therefore initially or somewhere down the line it could not perform well and give out wrong predictions which would have a direct impact on the neediest patient. To solve this issue, the objective is to collect as much data and be able to train our model with high classification report values.

Additionally, our model involves emotional recognition through facial recognition, therefore there would be an equal ratio of examples provided into our training set for different races and genders so as to make our technology non-gender specific. Lastly, to not let any outside or criminal actors invade into the privacy of the model, the security domain will be having strict roadmap to follow and regularly check if any unknown data has been stored or any cache has been stored to improve performance.

Human Values and Interests

The technology identifies the users by their emotion felt. The technology shouldn't be perceived as stigmatic because the model isn't distinguishing its users by their race, religion, or caste and neither will categorize the attention rate of patients by their certain belief or world view. The aim of creating this technology is to provide a fair and caring experience for patients.

The technology isn't being used directly by the patients, the model captures their emotions, and the model will be making decisions for them, making the technology user independent. The technology aims at benefiting the health and the well-being of the users so as to provide them quick attention when required.

The technology would be constructed in a user-friendly user interface which will be providing a vexing and warm experience.

Directions for future research

Considering about the possibilities or the directions this technology can take in the future, firstly, it would help improve the relationship between health care professionals and the patients and would let each of them know on a more understanding level. Secondly, the technology would help improvise the time management of the immensely diligent doctors. This is because their days are scheduled per hour and so if they get an accurate overview of the patient's feeling in the situation, it will foster growth and improved efficiency.

When thinking of the impact this technology can do in the future scenario, in the utopian culture for instance, it holds a lot of positive possibilities and features that could be later on implemented such as not only recognition but also aiming at making it more personalized for each user and maybe even making the users a direct user with a connection separate platform.

5. Conclusion

In conclusion, the goal of creating this Areya.Inc is to improve the situation of the busy healthcare professionals in understanding the emotions of their patients after a surgery has been performed so as to offer them homelike care. This would eventually be made by keeping in mind all of the aspects of ethical, human values, privacy concerns and the direction the Areya.Inc can take in the coming years. The technology ensures to guarantee the safety and integrity of its users while complying with the laws and regulations on data protection.