CBI4AI - GROUP 03

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Understanding the problem

After a preparation week held at the IED Barcelona where we had our first contact with the concept of the Sustainable Development Goal and also learned how AI (Artificial Intelligence) can be a fundamental part of this project by learning more about the ATTRACT technology, it became clear that our intention as a team was to find a solution for our chosen

SDG by making use of one or more of the ATTRACT technologies, integrating both projects in a way that could potentially serve society solving real life issue.

The kick-off of our project happened at the IdeaSquare headquarters at CERN. There, our journey began by brainstorming specific issues related to our chosen SDG (Sustainable Development Goal by the UN Project) namely “Good health and well being”[1].

Brainstorming

Led by our coach Jordi, our team gathered problems related to the main concern of our topic, focusing on what prevents people in our modern societies from having full access to health in the bigger sense of disease prevention. In the following, we discussed our points and grouped them into clusters according to their proximity of content. This step intended to help better understand each member's knowledge and concerns about the universal health topic and how these problems would either repeat themselves, complement each other or show us their complexity due to their different aspects.

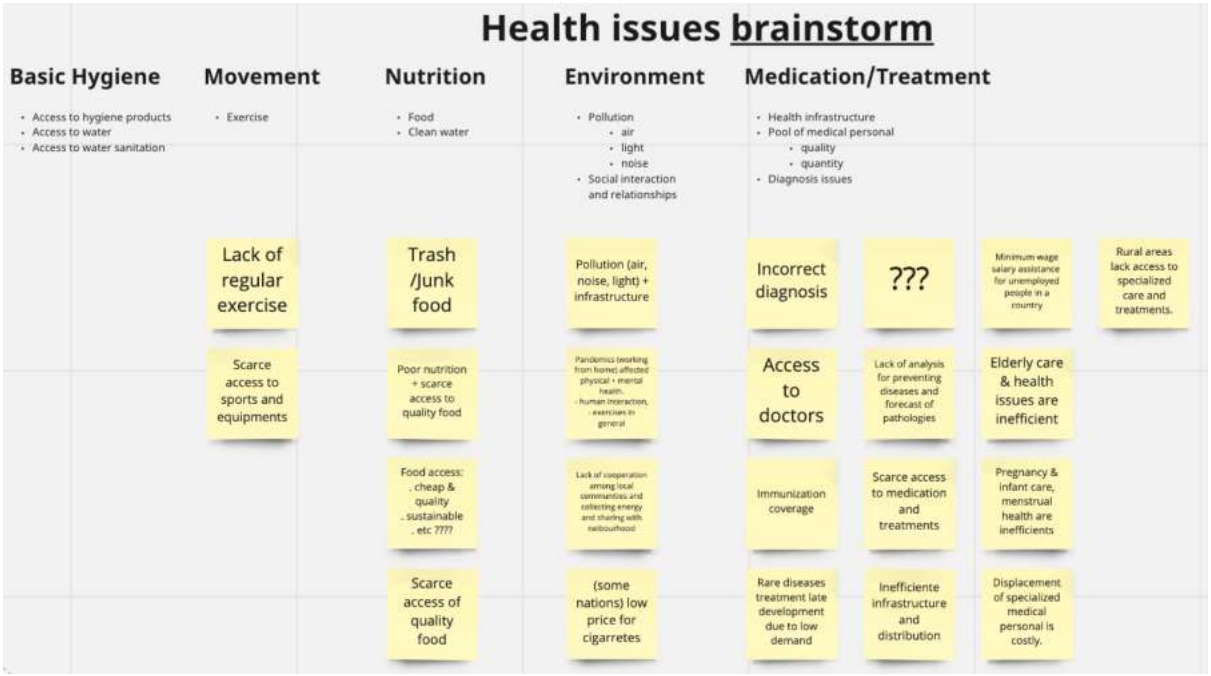

Image 1.0: Screenshot of the Miro Board with the result of the brainstorm

Data analysis

Analyzing our data, we perceived that our problems could be clustered into groups ranging from basic hygiene, movement/exercise (or the lack of it), (access to) nutrition,

[1] https://www.globalgoals.org/goals/3-good-health-and-well-being/

environment and medication/treatment. We were also able to divide these groups into prevention and disease control categories again.

With all this data at our hands, we understood that this topic has an immense range and we had to make a decision on which one of these aspects we would focus on. For that, following the design thinking process, we developed a decision axis where we would lay all our main issues (that were once more clustered together by topics) considering both the number of people impacted by each problem and how much technology might be potentially used to solve such an issue, since our focus was also to use AI technology in this process.

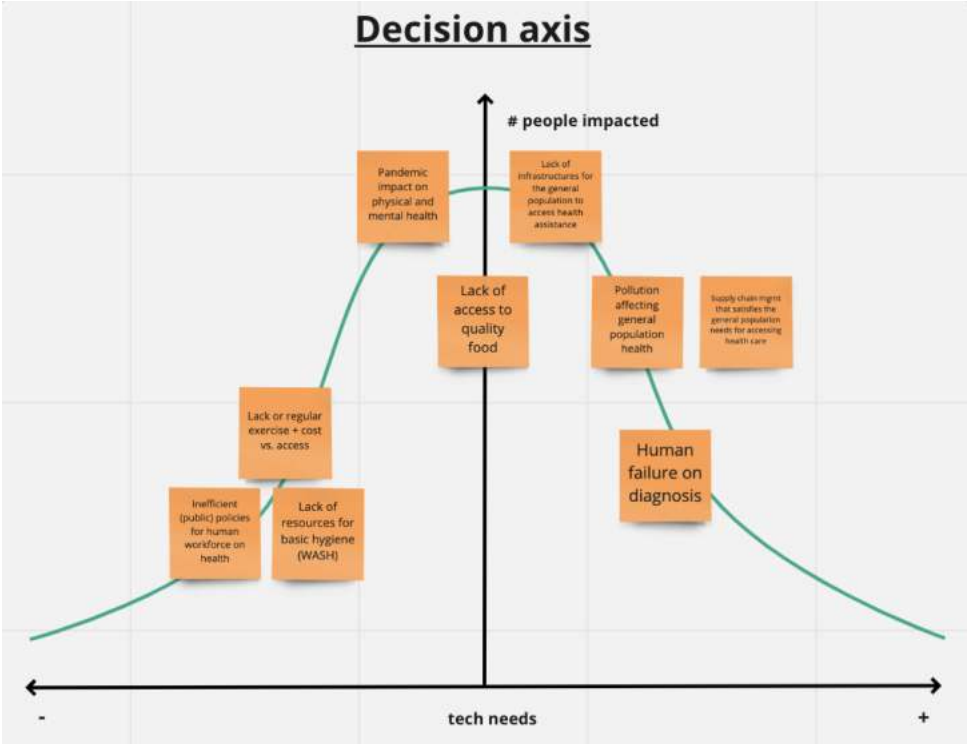

Image 1.1: Screenshot of the Miro Board with the result of the Decision Axis

Finding our persona

Following the next coaching session, this time moving to ESADE, we had a workshop for building our personas by choosing our three main topics: mental health, infrastructure and pollution, as they maximized both impact and personal interests.

The value of a persona comes from developing a fictional character that can be used as a role model, in the sense that anyone on the team can imagine and empathize with them, due to its similarity to a potential real user who can benefit from our project. Also, with a persona in mind it's easier to move towards the next step, user research, since we then have in mind which people we should recruit for our project.

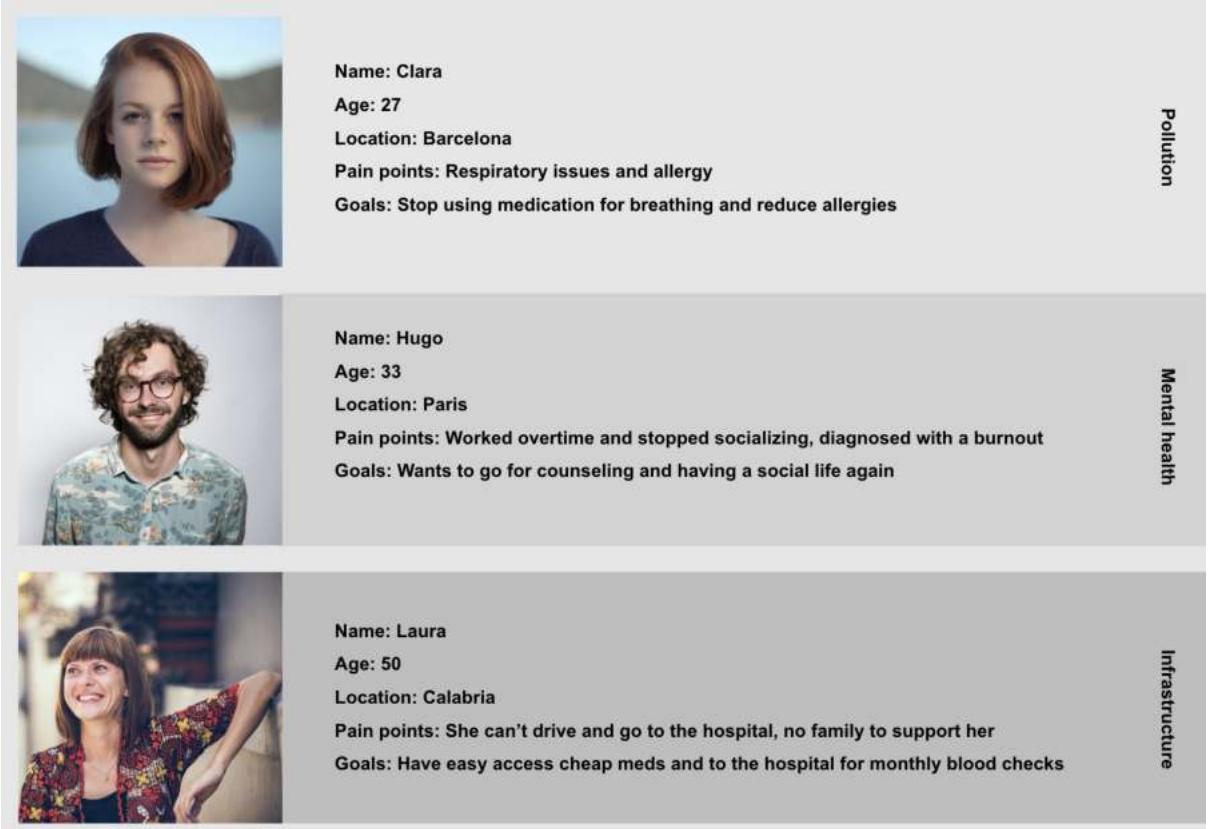

Image 1.2: Personas created for pollution, mental health and infrastructure issues.

Due to our limited resources coupled with our team members' interests we picked one persona and our topic to focus on. Our persona, and also our target group, became people with respiratory issues, usually **asthma or COPD**, that potentially also live in **highly polluted areas**, such as Barcelona for example.

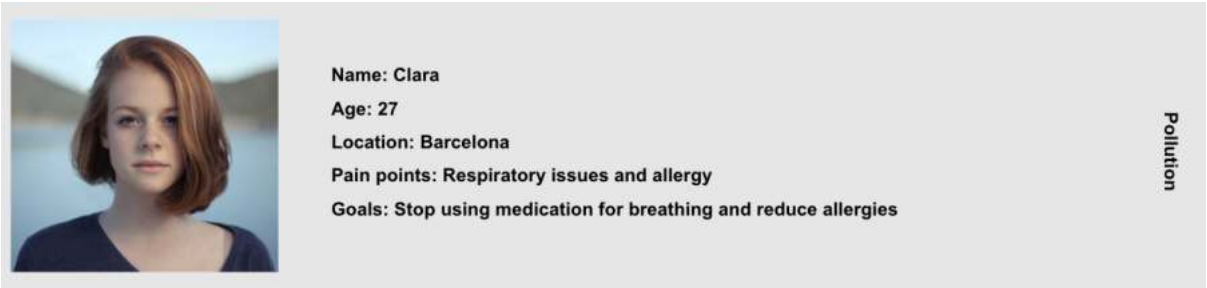

Image 1.3: Details of previous image with our persona defined.

Desk research

Performing our desk research on asthma attacks, we found out that they can be caused by a big variety of risk factors causing respiratory insufficiency, such as:

1. Climate

    a. Pollution levels
    b. Temperature
    c. Humidity
    d. Pollen levels from trees and flowers
2. Human activity and diseases
    a. Running, sports, and working hard
    b. Colds
    c. Cigarette consumption
    d. Allergies
3. Closed environments
    a. Dust in beds, pillows and from sweeping
    b. Fire smoke
    c. Animals with fur

On the other hand, regarding the treatments known nowadays, we found out that more than 50% of patients don't have a written management plan and 60% take emergency relief medicines. The key takeaways from researching treatment options are:

1. Current self management is not effective because there are a lot of possible causes of the crisis, leading patients to treat consequences with urgent short-term reliefs. [2]
2. It's important that the medical doctors agree with the patients on the best and the most appropriate treatment for each of them. [3]
3. Advanced machine learning models can help tackle the complexity of asthma risk factors to provide tailor-made management plans. [4]

User interviews

We proceeded then to make qualitative interviews with patients who have respiratory issues, such as COPD and asthma. We recruited 7 people in total, ranging from places such as Barcelona to India, with ages from 23 to 65 years old, males and females.

As **pain points** from our interviewers we found: difficult access to medication and doctors, lack of general information about asthma attacks, anxiety triggering new attacks which can turn into a feedback loop, management of one's diet in order to keep new attacks at bay, and smoking behaviors that can potentially worsen one's condition. Here are some of the most interesting remarks from our interviewees:

- "**Refilling my meds** is a pain in the ass especially now that I live in a rural area." [...] "**Seeing a doctor** is at least a 40 minute commute and would be starting from scratch at a new clinic." (33-year-old male on Reddit)
- "I had my **first attack** when I was in my first year of Engineering College." [...] "I **use my inhaler twice a day**." (28-year-old male from Bangalore, India)

[2] OECD/EU (2018), Health at a Glance: Europe 2018: State of Health in the EU Cycle, OECD Publishing, Paris.

[3] Eurostat (2015), Causes of death — diseases of the respiratory system, residents, http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[4] European Respiratory Society (2011), European Lung White Book, https://www.erswhitebook.org/chapters/the-economic-burden-of-lung-disease/

- “I have **nightmares** and **anxiety which got my asthma crisis triggered**.” [...] “I’m making sure **my eating habits don’t provoke any crisis**.” (23-year-old female from Barcelona, Spain)
- “**Smoking** is one of the major causes inducing respiratory diseases." (Head of Pulmonology Dept., Benevento Hospital, Italy)

From those interviews, we figured that the main **motivations and needs** of our group were:

1. Remote check with telemedicine of spirometry and oxygen saturation
2. A convenient and reliable method of tracking vitals
3. Predicting device for notifying future asthma attacks

Our **main takeaway** was that the **anxiety induced by future unpredictable attacks** was a key problem from our interviews.

How might we

Using the “How might we” framework, we could define our issue:

How might we **design and build a product** which will help >500m people suffering from respiratory issues **improve their well-being**?

Conceptual development

ATTRACT technology and hypothesis

Searching the ATTRACT database, we came across the **RPM3D**[5] (3D kinematics for remote patient monitoring) which was developed for helping patients recovering from a brain stroke to rehabilitation done remotely based on the analysis of 3D movement using a smartwatch.

Our **hypothesis** was then to leverage the RPM3D ATTRACT technology to predict asmathic crisis. Our idea consisted of monitoring symptoms of asthma in selected and severe patients. To achieve this, we proposed to link two key tools, the **portable spirometry/PEF** and RPM3D ATTRACT technology, together, in order to better control symptoms and prevent asthma attacks. On top of that, we suggested creating a machine learning model to elaborate our data with environmental ones.

The usage of these two instruments would allow us to create a database from which we could extract extra information to improve the treatment of the patients' chronic diseases.

[5] https://phase1.attract-eu.com/showroom/project/3d-kinematics-for-remote-patient-monitoring-rpm3d/

Stakeholders

Our solution involved a variety of actors, from public authorities to tech companies such as Apple. Moreover, our direct stakeholders would be pharmaceutical companies, wearable companies and Research centers. Below is a more detailed description of all stakeholders involved.

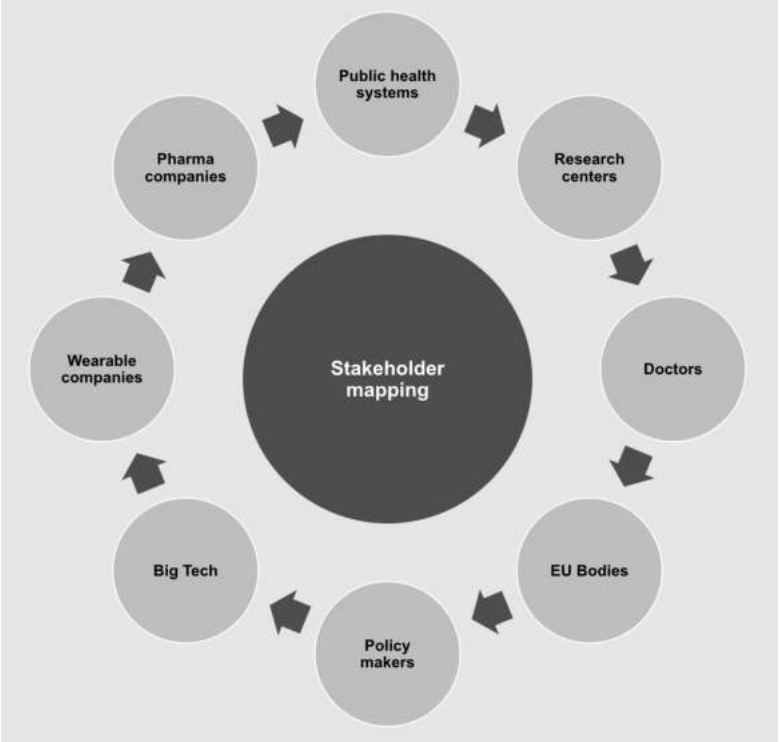

Image 2.0: Stakeholders map

The following steps would then involve meeting AI specialists, performing desk research and interviewing our target users again.

Academic research

Knowing the target audience, the problems and the technology that would potentially impact our product, we conducted once again desk research, reached out to a few AI specialists via email and also researched in the field. We also contacted an Italian pharmaceutical company who conducted a hackathon[6] in the same field (asthma prediction) but unfortunately no emails were replied.

Our goal was to better understand if the ATTRACT technology could potentially work for the prevention of asthma attacks as well, deviating from its main purpose of remote assessment for brain stroke rehabilitation.

[6] https://www.chiesihack4breath.com/

We then hit a wall. We found it almost impossible to find any kind of data from research that could correlate asthma and musculoskeletal health. And with this doubt, not knowing why that idea was neglected so far, we had a coaching session that changed our perspective as a team. We were then able to understand that this was the major pain point we could help to solve. If our ultimate goal was to help to improve the lives of the patients, we had to first help move forward research in this field.

What was the problem with recent asthma prediction research that made it so hard to have a clear understanding of what is missing for making a fairly reliable model for asthma prediction?

Our desk research about asthma attacks prevention models using machine learning successfully found this answer in a paper called “Predictive models for personalized asthma attacks based on patient’s biosignals and environmental factors: a systematic review”[7]. Using papers published on PubMed, ScienceDirect, Springer, and IEEE databases, the above mentioned study reviewed **1068 published articles** (published between January 2000 and December 2020) which were **refined to 44** with their selected criteria.

Key takeaways

1. There is a lack of utilizing advanced machine learning methods, like deep learning techniques due to **lack of (big) data**. Currently available models have datasets with no more than 350 patients.
2. Most existing asthma attack prediction models (in this study) used **less than ten variables**. By utilizing a comprehensive set of predictors linked with a large number of populations, the model’s accuracy will likely further improve.
3. Asthma attack predictive models become more significant when using both the **patient's biosignal** and **environmental factors**.
4. **Combining EMR** (Electronic Medical Record) and **wireless sensor** is the ultimate method that provides the best historical data and precise biosignals measurements.

Change of direction

Thanks to this paper, we understood that the **portable spirometry/PEF** could be potentially used as one out of the many inputs needed for the model, so there was no need to focus on the device itself anymore. Seeing the incomplete academic research then made our **target user** switch from patients to academia.

Finally, we could state that the **RPM3D ATTRACT** technology potentially plays an important role in the development of this model, since it can provide the biosignal data

[7] https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-021-01704-6

needed for the construction of the algorithmic model. (The detailed model can be found at the annex section of this report.)

New How Might We

How might we help to **advance research on asthma attack prediction?**

Solution

Proposal

Our idea is to create a **usable database for researchers** where they find relevant and vast data for working on a predictive model for preventing asthma attacks. A usable platform, appropriate funding and collaboration with tech companies, used along with a **wearable device** using **RPM3D technology**, that collects both biosignal data (e.g. heart rate variability, oxygen saturation, sleep patterns) and environmental data (e.g. local weather temperature, humidity, pollen or pollution, etc.) will feed the database.

This way we tackle both the lack of complex data (meaning the more than 20 variants for the building of a minimally reliable asthma attack prediction model) and the lack of the volume of data itself. If this project is funded by appropriately large capital, it can potentially reach more than thousands of people in a short period of time (e.g. in 1 year of research).

The AI approach

Making use of this model, we get two main outputs. Firstly, **patients** get help in reducing the anxiety of not knowing their next attack by giving them predictions that could even be hours in advance. This way, they have enough time to take action by either taking their medication or simply changing their environment. Secondly, for **public health policies and hospitals**, our model can predict (mainly due to environmental issues such as the weather) the number of patients that will need hospitalization each day, making it easier for hospitals to manage their supplies and medical force beforehand.

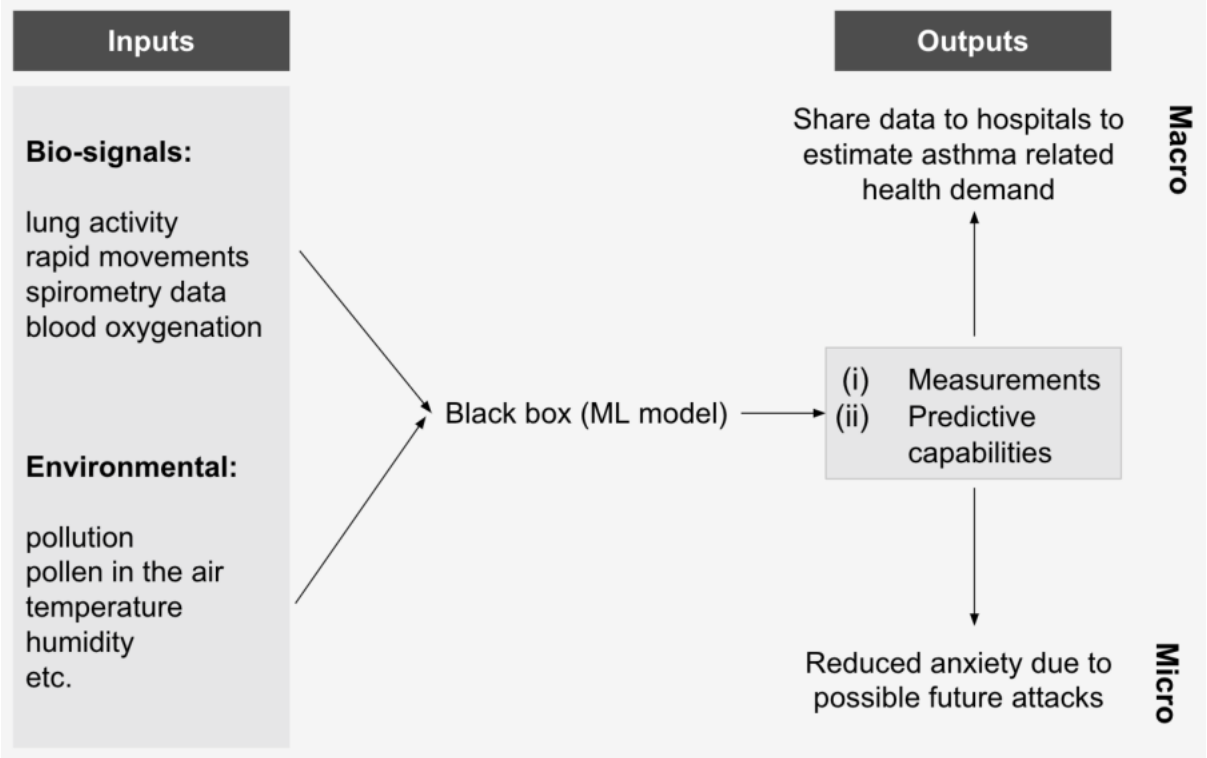

Figure 3.0: Screenshot of the proposed AI model as presented to the coaches

Prototype

The **database** can be found on our **project website**[8] where one can also read about our project mission, relevant details about the technology, blog posts, etc. There, all data should be open and anonymised for research, including a bibliography of state-of-the-art academic papers on asthma attack prediction. Researchers can contribute to the platform with input and feedback.

For the **wearable device**, we plan to use the **RPM3D** wearable device that potentially will also have a more robust technology to collect more data such as:

1. Biosignal data
    a. 3D movements measurements
    b. Heart rate variability
    c. Oxygen saturation
    d. Sleep patterns, etc.

2. Environment data
    a. Local temperature
    b. Humidity
    c. Pollen count
    d. Pollution, etc

[8] Prototype here https://bit.ly/3Oz6ouH

The real life application would include a collaboration with wearable device providers to implement the model into their products and real-time sharing of actual asthma attacks to hospitals.

Figure 3.1: Screenshot of a model wearing a fitness watch

Summary

Our **next steps** are:

1. Launching an open-data platform for collaboration of academic researchers.
2. Targeting EU grants for a multicentre study in hospitals to collect vast amounts of data from asthmatic patients.
3. Applying the machine learning model to wearable devices to predict attacks on an individual basis.

The **impact** we estimate is to improve the health of 70 million people in Europe and reduce the economic burden of more than 55 billion Euros annually on healthcare systems.

Funding is a huge topic for us, since doctors will share anonymous data on asthmatic patients if hospitals receive funding. In this sense, scientific EU grants can help advance data collection at scale in multicenter studies.

Conclusion

Interestingly enough, as most academic researchers state in their conclusion, this project shows that more research in the field is needed. But not only that, this project proposes a solution that is feasible and impactful. It was a long journey and we found many roadblocks on the way. Overall, it was an intense learning curve and surely the tangible gain from this project does not even closely reflect all the intangible experiences learned on this journey.

Annex

The AI model

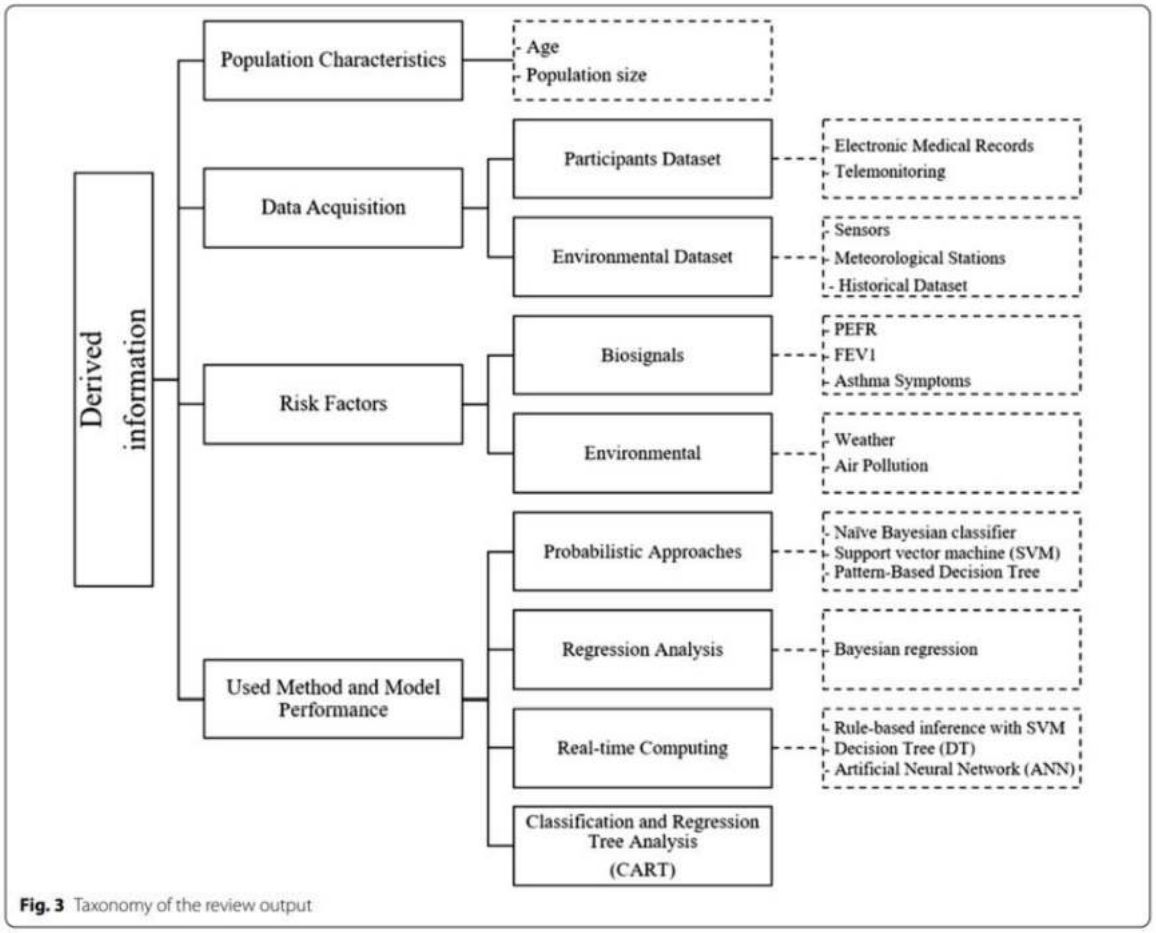

Figure 4.0: The model proposed by the academic systematic review paper