AI against COVID-19

An overview of AI during COVID-19's time

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1 Introduction

Pandemics have been a very huge problem for humanity for as long as there is reason. We can look back and realize the number of deaths that past pandemics have caused such as the Black Death, which caused the dead of 30% - 60% of the european population, or the Spanish flu, which caused 25 million deaths around the world.
In december of 2019 a new virus called Coronavirus (COVID-19) was discovered in Wuhan and has spread to the point of having reached all parts of the world. With the past experiences in mind, the scientific community has been involved in seeking solutions to combat the COVID-19 and part of this community is related to Artificial Intelligence.

2 Main applications

- **Early detection**: AI can analyze simple symptoms and help providing faster decisions. This can be see in cases where the medical images take part, for instance, Computed tomography or magnetical resonances of the human body.

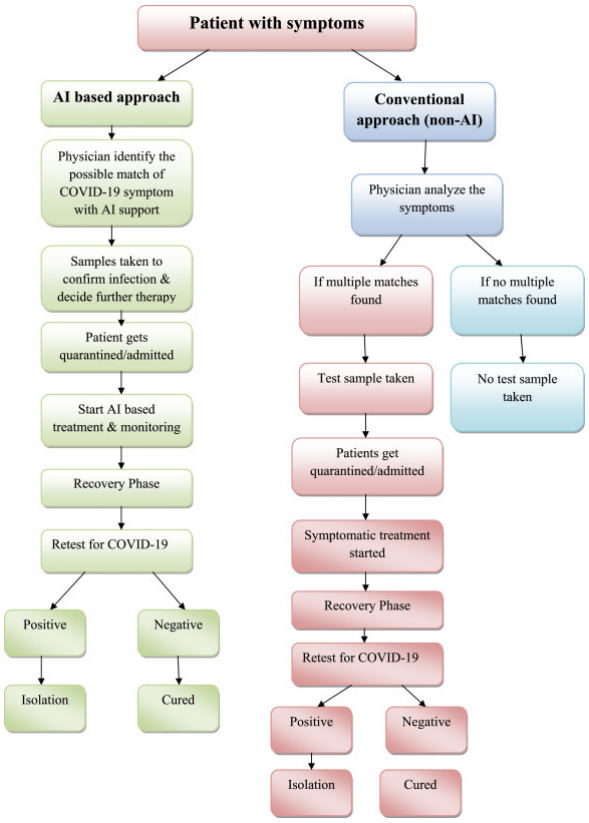

Figure 1: General procedure of AI and non-AI based applications that help general physicians to identify the COVID-19 symptoms.

- **Predict the spread**: AI can predict how the virus will spread and help monitoring

and providing day to day updates of the patients. This can be very useful also taking social and/or economic measures.

- **Predict the future course of the disease**: Related to spread prediction, AI can follow the course of the virus and the places that are most likely to be a 'hot spot', predicting the course of the virus and likely it's reappearance.
- **Predict the number of cases and deaths**: AI can predict the number of positive cases and death in any region. AI can help identify the most vulnerable regions, people and countries and take measures accordingly.
- **Development of drugs and vaccines**: AI is useful for drug delivery design and development. It is very helpful in drug development in the testing process in real time, where standard testing takes plenty of time and AI help accelerating the process significantly, which may not be possible by a human.
- **Reduce workload of healthcare workers**: Due to a sudden and massive increase in the numbers of patients during COVID-19 pandemic, healthcare professionals have a very high workload. Here, AI is used to reduce the workload of healthcare workers. It helps in early diagnosis and providing treatment at an early stage .
- **Prevention of the disease**: With the help of real-time data analysis, AI can provide updated information which is helpful in the prevention of this disease. It can be used to predict the probable sites of infection, the influx of the virus, need for beds and healthcare professionals during this crisis.

3 Researches: a brief introduction

This huge shock has entailed that a lot of research groups involved in AI and data analysis had to improve their efforts in this area, with the intent of understanding and beating the virus.

Understanding the spread of the disease has been one of the most critical challenges around the virus; thus, most of the researches has been made about predicting the spread-behave of the virus, along with the effectiveness of the lockdown systems.

3.1 Microscopic Epidemic model based on Multi-Agent system

As Dr.Changliu Liu mentions in her work *"A Microscopic Epidemic Model and Pandemic Prediction Using Multi-Agent Reinforcement Learning"* [1], this spread-behaviour can't be fully trustful due to the external factors that show different effects of the lockdown systems, based on cultural difference, individual decisions, and such.

In this work Dr.Liu suggests a model based on Multi-Agent Reinforcement Learning to face this problem. First of all she proposes a Microscopic Epidemic model, based on multi-agent systems, in an attempt to represent an environment with infected and uninfected agents. This shows a scenario where there are $1..M$ agents that interact between them, and based on their activity level of the day, $u_i \in [0, 1]$, for any *i* agent, and their chance to meet between them, $min\{u_i, u_j\}$, being *i* and *j* different agents. Then, there are defined two state values for an agent *i*, which are defined as x_i, where this *i* agent is infected if $x_i = 1$ (infected), and not infected if $x_i = 0$ healthy (susceptible).

Note: an agent gets infected when he meets another infected agent.

So, in an scenario with $1..M$ agents, where the set of infected agents on a *k* day is denoted: $I_k := \{i : x_{i,k} = 1\}$. With all this concepts, it can be summarized like this:

	$x_{i,k} = 0$	$x_{i,k} = 1$
$x_{i,k+1} = 0$	$\prod_{j \in I_k}(1 - min\{u_i, u_j\})$	0
$x_{i,k+1} = 1$	$1 - \prod_{j \in I_k}(1 - min\{u_i, u_j\})$	1

Table 1: Table of state transition probability from Dr.Changliu Liu's work [1].

Multi-Agent Reinforcement Learning: Q-learning

Having this in mind, Dr.Liu approaches the spread problem using this Microscopic Epidemic Model. One of the techniques she applies is the Reinforcement Learning in multi-agent systems, in particular, Q-learning method.

In general terms, is a method that guides an agent in which way to follow under certain circumstances, with the purpose of getting the best reward.

4 Examples and real applications

4.1 BlueDot (Early detection)

One of the main applications where AI can be a powerful tool is early detection. Warning and preventing possible contagious diseases are important tasks that, in many cases, AI can deal with in a better way than humans could. In the case of COVID-19 a startup called BlueDot was able to predict a possible outbreak in Wuhan at the end of 2019, warning their clients (governments, healthcare institutions, ...) before WHO did it. After the outbreak prediction, they also were able to list some of the main cities that the virus could spread, Bangkok, Seoul, Taipei and Tokyo.

BlueDot were able to develop this powerful tool analysing multiples sources of information like official data from some institutions, data from media, animal or plant diseases databases, flight traffic data and even some data from internet (forums). It must be mentioned that this model is evaluated and interpreted by humans, looking for the optimal application for their tool.

4.2 AlphaFold System (Treatments and cures)

DeepMind, a well known company for its innovations in the AI field, released during this year the last version of AlphaFold System and with it, they released non experimentally verified SARS-CoV-2 predicted protein structures. This software is capable of predicting 3D structures of protein based on the genetic sequence, this task is one of the most important when a new disease appears, proteins are known for dictating or indicating a specific function of a biological organism. Knowing protein's structure of a virus like COVID-19 allows scientists to develop drugs that work with or against the proteins.

This process can take months if it's treated in a classical way (determined with experiments), for this reason researchers are relying on computational models that predict its shape, and by comparing with some similar already experimentally determined protein structure they can confirm the reliability of the models.

During this summer, some of their predicted structures were validated by some experimental verified structures deposited in the Protein Data Bank, allowing AlphaFold System to improve their models with verified data and finally release five more proteins that were not been experimentally determined.

Figure 2: Blue: AlphaFold prediction, Green: Experimental structure

5 Conclusion

As we have seen, AI can be a great fighter against COVID-19, such tools like the ones we mentioned are critical for helping and assisting scientists, researchers, healthcare stuff and so on. In an age that time is crucial, having these tools helps resolving situations that could take months to solve with human intelligence and classical techniques only.

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