# How Technology can Defeat COVID-19

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**Abstract**

COVID-19 has spread globally since its discovery in Wuhan, Hubei province, China in December 2019. The viral etymology was initially found out to be from bats and it spread like a wild fire all over China and through its travelers all over the World, thereby getting categorized as a Global Pandemic by WHO. The aim of this review article is a critical analysis of diagnostic and surveillance technologies for SARS-CoV-2 and their performance characteristics. This comprehensive article reviews about new technologies that can be developed from existing technologies that can help in tackling this pandemic and many more such in the near future. We describe ways and methods with which we can extract as much useful data as possible and use this data as a powerful tool to conclude important results. This article will throw light on existing technologies that have been used and being studied that can be applied to tackle epidemics and pandemics. This article stresses on existing methods that can be applied by Governments and Civic bodies to take a stochastic approach in these unpredictable and testing times towards detecting symptoms and conduct random tests in areas where the people show more symptoms and are likely prone to be affected.

**Keywords:** Pandemic, WHO, SARS_CoV-2, Diagnostic, Surveillance, Stochastic, Governments, Civic Bodies.

## 1. INTRODUCTION

Coronavirus are a group of related viruses that causes diseases in mammals and birds. The latest variant of it labelled as SARS-CoV-2 is creating a havoc across the world and is called the worst tragedy after World War 2 and countries all across the world are dealing with a crisis situation, since a proper vaccination is not available anywhere, and will take at least a year or so. The only prominent solution available now is social or physical distancing, which helps in the control of spread of virus among communities. And to help this cause, we as engineers can utilise the technology that we have to identify areas where this virus has spread massively and classify these areas as hotspots and predict the growth of cases in the coming days and helping the Governments assess the situation and take suitable steps. It is best to say that mass testing of communities will be a key factor in completely tackling such epidemics and pandemics in the near future. This data collected from the technologies that are proposed in this article will help a great deal in identifying the spread of this virus in a community by overcoming some of the listed challenges faced in laboratories in testing as mentioned in[1] and reduce the burden of laboratories. This article is inspired from the South Korean Government's initiative of mass testing which reduced the number of cases per day drastically. We can make sure this is done only in association with the Government since this data is very personal and can be misused anytime against them. The citizens have to be taken into confidence before such kind of a medical investigation.

## 2. METHODOLOGY

### 2.1 How Can Symptoms Help in Mass Testing?

The common symptoms noticed in a COVID-19 patient are high fever that develop at first, then a dry cough, fatigue, sputum production and shortness of breath[2]. Since the testing kits are only available for the medical community and not yet public, people cannot self-test and self-diagnose themselves. Hence ,we propose an idea of using trained robots that can measure the person's temperature using thermal cameras fixed on the robots, check their breathing rate, take samples of maybe Nasopharyngeal or oropharyngeal swab, or blood samples, test it in the laboratory with certain protocols as mentioned in[3], and come up with a conclusion that this person tested is showing symptoms or asymptotic and by what percentage.

This robot will have a voice assistant that will ask a few questions on the person's age, travel history over the past few days, and his health-related issues, whether he/she smokes etc. and record it, thereby collecting as many data points of a person as possible.

### 2.2 Implementation of Such Medical Camps in Communities

The above mentioned robo-doctors, as we can call them will collect all these samples and further these samples are tested in labs for symptoms and use all this information to label a patient as risky, moderate or healthy, thereby giving a clarity to local authorities on how risky are its people to be prone to the virus or if they can recover from treatment or not. Since these things are done by robots, a greater number of people are tested and accurate results can be obtained.

This idea can be credited to a Robo Doctor in China which was trained with medical text books and previous medical cases and which cleared the Medical Examination in China, some time back. These are prototypes now which are still being improved and used as assistants by doctors to recommend the best medicine available for a patient or give critical suggestions to doctors, and encouraging to develop such technologies with doctors, researchers, data scientists and AI professionals would be very resourceful.

### 2.3 DRONES: Modern Day Soldiers

#### 2.3.1 In sanitizing large areas[4]

An advantage of drone is it can carry heavy payload and have a long range of operation. The sanitizing chemicals are filled in sufficient amounts in the drones and they can be sprayed over large areas, critically in places like slums, and other unhygienic places[5]. It can simultaneously track any break of quarantine rules by people on streets by using a camera and alert them immediately. It can also collect air samples at regular intervals and these air samples can be brought back to labs to monitor air quality and possible spread of viruses by birds or other animals.

Also drones can be used for drone surveillance of movement of citizens in public places during times of a total lockdown of areas. All this can be done by training the drones to act accordingly. Factors like the spread of spraying, the amount of chemical sprayed and making sure it does not come in contact with any human since they are harmful chemicals are to be taken into account.

However, it is also essential to develop suitable software programs for the post-processing of data, to increase both the usability and speed of calculation to assist decision making of quantity and area of spraying.

#### 2.3.2 In Medical and Food Supplies

With evolving cases like a delivery boy contracting to the virus in India, the trust on home delivery of essentials reduces, and to keep it as non-contact as possible, drones can be used to deliver essential medications to people and also food supplies possibly.

The orders are received and the drones are trained or guided to the exact address or location and deliver the needful. And the most important thing is that these private projects need to be undertaken by the respective Governments since there is no legal approval to fly drones in civilian areas as of now[6].

Drones have the potential to be reliable medical delivery platforms for microbiological and laboratory samples, pharmaceuticals, vaccines, emergency medical equipment, and patient transport. Government agencies have placed drone use on the national agenda. The next steps include aggressive research initiatives in the areas of safety, industry expansion, increased public awareness, and participation.

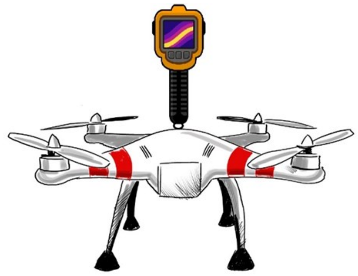

**Figure 1. A long-range thermal camera attached to a drone to monitor body temperatures of people in crowds in public places like airports, railway stations, bus stands etc.**

## 3. MATHEMATICAL APPROACH

In this article, we try to give the readers a very rough idea of the tech concepts that can be used and rather graze upon the theory behind it to make sure that the readers are convinced that the ideas proposed are practical and can be implemented. Like how tech giants like Google and Facebook where they predict things based on the activities of their respective users, similarly, we have proposed applications of certain algorithms that can be used to predict a risk score for a certain individual. Basically, the process goes like this: we can collect the above-mentioned information (in section II) from a patient with the help of the above mentioned trained Robo doctors and treat them as data points of that individual and evaluate a score of how risky is the person to contract the virus and what are the mortality rates of each community/district by taking a collective average over the population per area, which will be a statistical analysis[7]. The popular backend algorithms that can be used to train such data to end up with a risk score or come to a conclusion are:

*Decision Tree Algorithm*: It is a popular classification algorithm which use multiple algorithms to decide to split a node into two or more sub-nodes. The creation of sub-nodes increases the homogeneity of resultant sub-nodes. In other words, we can say that the purity of the node increases with respect to the target variable. The decision tree splits the nodes on all available variables and then selects the split which results in most homogeneous sub-nodes[8].

The algorithm selection is also based on the type of target variables. Some of them are mentioned below with the method of how scores will be calculated for each target variable thereby being able to plot a disease trajectory for a particular area.

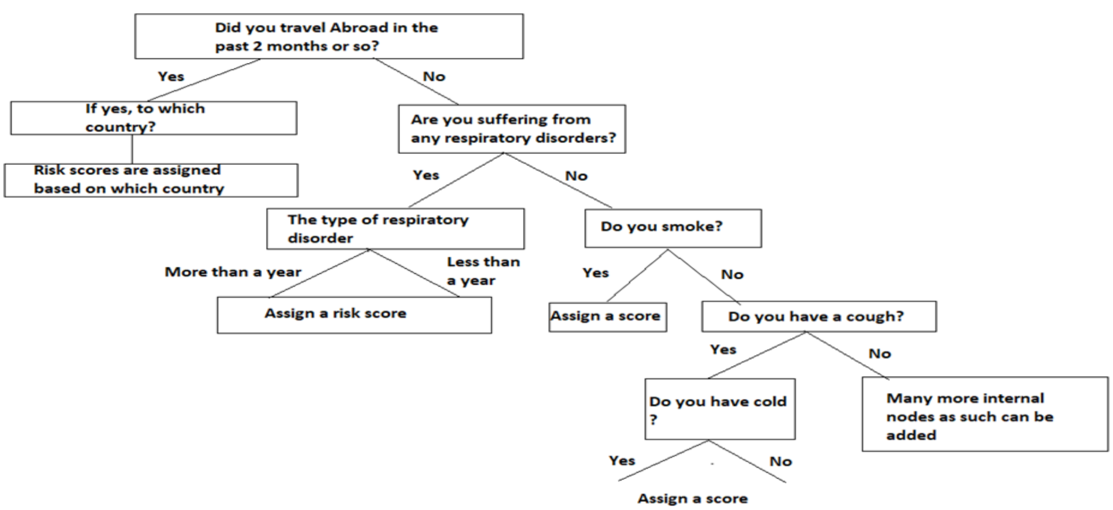


**Figure 2. Decision tree created with questions to be asked to a person and how nodes are split into sub nodes and assigned scores**

### 3.1 Health Related Issues

The patient is enquired about whether he is ailing with a respiratory disease already or not, to which he can answer yes or no, which become the nodes, and later if his answer is no, his credit score is increased, if yes, his risk score is increased

### 3.2 Travel History

Based on the countries or states a person has travelled over the past few days is questioned , a score is calculated based on the number of cases and fatalities in that place, which are individually calculated on the basis of a ratio of positive cases is to recovered patients is to number of deaths.

ID3 , a type of decision tree ,follows the rule — A branch with an entropy of zero is a leaf node and A branch with entropy more than zero needs further splitting. Information Gain is important because it used to choose the variable that best splits the data at each node of a Decision Tree. The variable with the highest IG is used to split the data at the root node[9].

IG=Entropy (Parent Node)- [Weighted Average] *Entropy (Children Nodes) ………………… (1)

For Multiple Attributes

E (T, X)= Σ ((P(c)E(c)) …………………… (2)

where $T \rightarrow$ Current state and $X \rightarrow$ Selected attribute and $c \in X$

Equation (1) and (2) gives us knowledge from which we can evaluate **the risk score** of an individual.

Please note that for computing the entropy none of the remaining attributes, attribute values matter, also the order of the attributes don't matter and that makes it easier and faster since there is no need of sorting data in an order.

**Table 1. Table of some attributes selected and different scoring conditions**

| | Attributes Table | | (Approximate Estimation) |
|---|---|---|---|
| Abroad / Inter State Travel History | Respiratory Issues | Smoking Habits | Risk Score (Say in the range of 0-100) |
| Yes | Yes | Yes | >75 |
| Yes | Yes | No | >50,<75 |
| Yes | No | Yes | >50,<75 |
| Yes | No | No | |
| No | Yes | Yes | >35,<50 |
| No | Yes | No | >35,<50 |
| No | No | Yes | >20,<35 |
| No | No | No | <20 |

The above-mentioned table is conceptualized based on how dangerous can it be for a person to be dealing with an existing respiratory disorder and is a smoker to contract a virus and face consequences quicker than an average healthy, non-smoking adult.

More factors can be added to the decision tree assigning fractions of scores and make the system more accurate, like the common notion practiced; more the data, more the accuracy.

## 4. USE OF INFORMATION THEORY

The induction task has been characterized as: give n training set consisting of an object described by a fixed set of attributes; and given an outcome known for each object example, find a rule that expresses the objects class in terms of the values of its attributes we would like to induce a set of rules whose application will yield a recommendation given the values of scores.

A non-trivial task would be to induce a set of rules that will be applicable in diagnosis from data collected and possibly stored in a dataset.

Building a decision tree:

- Collect examples to build a test set.
- Select one of the attributes to be the starting point or root node of the tree.
- Split up the test set into a number of smaller tables, each containing examples with the same value of the selected attribute.
- If the values in the class is partitioned, then the same process is complete. Otherwise, select a new attribute and split the set again.

Note that attributes have either truth values or numerical values. The sample space could also include counter example, as well as examples. After the tree is completed, a set of IF-THEN rules from this tree can be produced by following each branch from the root to a terminal node. Each rule is a series of conditions consisting of attribute and value pairs, followed by a single conclusion that contains the class and the corresponding class value. The intermediate nodes and their branches form the conditions of the rules; the terminal nodes form the rules' conclusions.

Consider an example case:

If patient has a travel history and a respiratory illness, he is more likely to get affected and suffer from the virus attack. Hence if such people are showing symptoms, they are to be categorized as high-risk patients and assigned a higher risk score. We can do a probability analysis running along the same lines, which is known as Information measuring. If you have two messages, one with probability of p1, and the other with p2, you could say that the quantity of information these two messages convey is related to 1/p1 and 1/p2, respectively. However, if you think of the two as a compound message, the probability becomes p1 x p2. For example, if p1 is 1/3 and p2 is 1/5, the probability of two compound messages should be 1/3 x 1/5 = 1/15. Therefore, the information content can be quantified by using probabilities such that: I (1/ (p1 x p2) = I(1/p1) + I(1/p2), Where I denotes quantity of information. We should now realize that the only mathematical relationship to satisfy this equation is logarithm. Therefore, we can say that the quantity of information associated with a probability of p1 is I(1/p1) = log(1/p1). In general, a message could be a specific value appeared in a scientific test, a state of an object, a character in a transmitted string within a communication network, or any data such that its frequency of the appearance in the system is measurable. One such statistic coming from information theory is called information entropy and is a measure of the uncertainty of classification of that object with regards to all objects being classified.

## 5. CONCLUSION

Once an individual is assigned a risk score, the crucial part of this system is to study how are people responding in a bounded geographical area and identify the trends and patterns and compare them with areas bordering a certain geographical area and see if these trends are different and by what amount or these trends are repeating in multiple areas as such.

This demographic analysis will be a powerful tool to predict the patterns of by how much the virus might spread and be lethal, depending on the outcomes of the analysis. Say an area's collective risk score is comparatively high, what next? The civic bodies can be advised to conduct as many random tests as possible, apart from the tests conducted on sick people showing symptoms, and make sure that area is secured and the high risk people are kept under the radar until a point where the area yields a successful outcome of zero cases for at least a week or so and make sure that the curve does not spike up again, thereby flattening the disease trajectory. We can apply these methods to predict a COVID-19 epidemic's evolution in a particular geographical region, based on reported cases data from that region.

Our model focuses on unreported cases, symptomatic infectious cases, and division of the epidemic's evolution through a succession of phases. Our method can be predictive when the epidemic is growing exponentially in phase II. Specifically, we demonstrate a technique to identify the exponentially increasing rate of cumulative reported cases in phase II . When public measures to ameliorate the epidemic begin during this phase, we model these measures with a time-dependent exponentially decreasing transmission rate.

These mitigations result in phase III: a subsequent reduction in daily reported cases[10]. These measures should begin as early as possible and be as strong as possible. If such efforts cause the epidemic to substantially subside, the situation in South Korea indicates that a background level of daily cases may persist for an extended time. If countries reduce major distancing measures too early or too extensively, the epidemic can enter a new phase II and undergo another exponential increase in cumulative cases.

Control of COVID-19 epidemics is possible, as evidenced by the situation in South Korea [10]. The future of COVID-19 and its human toll is currently uncertain, and we hope that mathematical models will be of use. In these times of a Global crisis caused by a pandemic, when things are treated naively with lack of information, it is important to extract as much data as possible and utilize it for faster and better results. Since it deals with human beings, it is crucial that as much information possible is extracted and analyzed.

Also, with existing technologies like drone technology, which is flexible and convenient to use, can be used as a strong tool to aid humans in any way possible, like supply of food and medications. Together, the world of technology and the research and development community can pull an act together to curb such pandemics and epidemics in future and this pandemic will be a classic example to the future world and will be part of 21st century history.

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