

## Role of Data Science in COVID-19 Vaccine Development and Distribution

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Data Science has played an important role since the beginning of the COVID-19 pandemic. Tracking the hospital bed capacity during the outbreak, identifying high risk patients, determining the mortality risk and predicting chronic diseases in the affected patients were a few of its applications during the first few months of the pandemic. As the world has now entered the most awaited vaccination phase, data science has been incorporated in this process and proven efficient in speeding the development and the production of the vaccine.

Being a novel virus, Coronavirus had not only made it a challenge to diagnose and treat the disease, but also made it difficult to develop an efficient vaccine. Even though, the vaccine developers were trying their best to move as quickly as possible, the process had to be very scrupulous. Some studies showed how AI could be used to identify patterns in the virus, make predictions from the observations and even guide the companies towards the right drugs for testing. It also helped in speed testing of coronavirus and diagnosis of people in need for a CT Scan. China used AI in drones

to identify the hot spots of the disease in the country and spray disinfectants on those regions. Big data was used to access and analyse the extensive amount of data available in online medical records and this helped vaccine developers in understanding the reaction of the vaccine on people with different allergies or other chronic diseases.

Incomplete grasp of the immune system in a human body, genetic variability in different humans and the variations of pathogen were some of the major challenges faced by the pharmaceutical companies during the manufacturing of the vaccine. Even though data science cannot solve all these challenges but it did provide applications like Alphafold and LinearDesign which came to aid. Alphafold is a deep learning-based tool which helps in the protein structure prediction using convolution neural network which predicts the distance and torsion angles between amino acid residues. These values are used to determine the potential of the protein statistically. LinearDesign is a tool used to design optimized m-RNA sequence towards vaccine development using computational linguistics and approximation algorithms to determine a fast solution with high accuracy.

According to studies, data science was also deployed in accelerating the process development where it was used to reduce the number of experiments needed for the vaccine, manage and organize a way to scale-up and transfer the technologies so that the company can quickly and efficiently produce hundreds of millions of doses globally. In order to improve the vaccine development, a tool called Design of Experiment was used which prepared a set of representative experiments in which all factors that had to be investigated were varied simultaneously and systematically and through

this a model can be derived that captures the relationship between the factors and the responses. Design of Experiment supported accelerated screening by which the developers of the vaccine were able to scrutinize multiple parameters at the same time thus reducing the time taken and the cost of experimentation. It also helped in process optimization by determining factors such as range and inputs for a specific goal and thus helping produce high-performing and safe products. The most important parameters, which have an effect on the most critical quality attributes, were derived using regression models. For scaling up the production, multivariate data analysis was used to reduce the number of batches to prove robustness. In addition to improving the experimental process for vaccine development using Design of Experiment, Multivariate data analysis can be used to gain insights swiftly. It provides a data summary that can be visualized using plots and used to provide the relevant information.

Once the vaccines were produced, countries had to decide who should be first in line to receive the shots as the supply was limited. The most important factor to take into consideration here is the determination of the health risk of the individuals or else the meagre resource will be dissipated on those less in need while blocking access for the most vulnerable. Relying just on age as the most crucial factor or selecting employees from a particular industry and identifying them as the high-risk group will result in vulnerable population being overlooked and might cause avoidable deaths. To identify the people who are most at risk, countries had to search a way of not solely analysing the demographic data but also of taking into account underlying health conditions, social and environmental cognitive factors of health. For this, the best tool which can observe necessary hidden patterns that will otherwise go unnoticed and determine the people who are most in need of the vaccine is Machine Learning. An Information Science company, designed a machine leaning platform that brings along parameters concerning an individual's health history combined with social and environmental conditions of their area and other infectious diseases. These factors can be used in predicting the chances of getting adverse health outcomes from COVID-19 and thus helps in categorising them in the most at-risk group.

To sum up, Data Science has helped us in many ways since the beginning of the outbreak and will continue to be used in the improvement of the manufacturing process and product quality. Considering the lack of complete understanding of the immune system

of a human and the way in which a vaccine can interact with the human body, ensuring whether the vaccine is safe or not is of utmost importance. Side effects of the newly invented vaccine should be taken into consideration before vaccinating an individual. The use of science and data driven approach will help the countries to determine the right person for the vaccine at the right time and no individual will be left behind.

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