**COVID-19 Testing at Scale Using Machine Learning**

In early 2020, COVID-19 invisibly and rapidly spread via airplane travelers, leading to countless hospitalizations and deaths in cities and towns across the world. This was exacerbated by a limited ability to test for it, treat it, and slow down its spread, leading to massive worldwide numbers of infections, hospitalizations and deaths. With no better way to take control of the situation, entire countries and continents were locked down, with schools and businesses haphazardly shut down. This first wave is now resulting in numerous second-order effects including disruptions in global food and drug supply chains as well as massive layoffs and a growing wave of bankruptcies.

The world is therefore desperately looking now for ways to safely reopen their economies without risking an even worse second wave, at least until the population has developed herd immunity through vaccination or repeated waves of infection. In the United States, a bipartisan group of over 45 experts outlined in a report entitled a "Roadmap to Pandemic Resilience" what they believed was necessary to safely reopen the U.S. economy. The report states: *"We need to deliver 5 million tests per day by early June to deliver a safe social reopening. This number will need to increase over time (ideally by late July) to 20 million a day to fully remobilize the economy."* [1] They further add that hundreds of thousands of testers and contact tracers will need to be hired and trained. As of early May 2020, the U.S. was conducting just over 120,000 tests a day. The number of daily tests would therefore need to increase by over two orders of magnitude to achieve the stated 20 million tests per day goal, with the report identifying a clear need for "innovation in testing" to help close that gap.

One such potential innovative approach has been developed by Bitscopic, Inc. in collaboration with the division of Public Health Surveillance and Research at the U.S. Department of Veterans Affairs. The Bitscopic / VA team has developed a machine learning algorithm-based method to test for COVID-19 using only standard blood panels and vital signs. Machine learning algorithms enable computers to learn from large volumes of existing data in order to automatically detect patterns that are often difficult for humans to identify alone.

The machine learning model was developed with one of the largest datasets of COVID-19 patients available in the world (the U.S. Veteran's Affairs Hospitals), with a training and testing set of over 30,000 patients. This was possible because of years of earlier collaborative work between Bitscopic and the VA using the Praedico platform, which enables medical data from VA hospitals and labs across the country to be aggregated several times per day and data rapidly analyzed. The results have been submitted this week to a major medical journal as a manuscript entitled "A COVID-19 Prediction Model from Standard Laboratory Tests and Vital Signs."

Payam Etminani, Bitscopic's CEO, explained: "This method of testing using machine learning on blood panels and vital signs can be a powerful complement to standard molecular tests such as PCR (Polymerase Chain Reaction) tests. It is not meant to replace these tests but to supplement them using information that is already readily available to hospitals. Think of it like a first line of defense that can be rapidly and inexpensively deployed on a massive scale. The patients that the algorithm flags as likely COVID-19 infections can then be identified for further molecular-based testing."

Dr. Vafa Bayat, Bitscopic's Program Head of R&D, described why they explored the machine learning approach: "While we know that potentially more accurate COVID-19 tests will continue to emerge, they still need the same basic PCR technology and specialized equipment to analyze, so they may have difficulty scaling to the massive levels needed. Meanwhile, we saw in early studies that labs of COVID-19 patients showed low counts of white blood cells, lymphocytes and platelets. We hypothesized therefore that, with the help of standard machine learning methods, we could use the aggregate of small differences across a number of commonly administered labs to infer the likely presence of COVID-19. This tool can also be very important in the identification of clusters of hospital-acquired COVID-19 infections in patients that were being treated for other conditions."

Dr. Steven Phelps, Bitscopic's Head of Data Science, described further details of the algorithm: "Drawing on 54 features from vital signs and common lab markers, our model is currently showing a negative predictive value (ability to say for sure if someone does not have COVID-19) of 94.5%, with an overall accuracy of 88.2%. Existing PCR tests sometimes have very high false negative rates, as documented in a recent *Annals of Internal Medicine* review article [2]. For instance, they observed that if a person is tested on the first day of infection before symptoms are manifesting, the false negative rate can be close to 100%. Having this additional blood lab-based test, used as a supplement to the PCR test, can help confirm a negative diagnosis to a higher degree of confidence."

Farshid Sedghi, Bitscopic's Chief Operating Officer, described how hospitals can deploy the scoring system: "While we have initially developed and deployed this system with the VA's VistA Electronic Medical Record system, we will also be able to integrate with other EMR systems. Our model, which was initially trained on over 30,000 patients at the VA, will also be able to be fine-tuned with new datasets from hospital systems that we work with."

Further information about deploying the Bitscopic machine learning algorithm can be obtained by contacting Bitscopic directly at info@bitscopic.com.

[1] https://abcnews.go.com/US/road-map-recovery-report-20-million-coronavirus-tests/story?id=70230097
[2] https://www.acpjournals.org/doi/10.7326/M20-1495