The Role of Machine Learning, Artificial Intelligence, and Analytics in Pandemic Management

Steve Thompson, associate professor of management, focuses his research on how healthcare organizations utilize information technology and data analytics to improve the cost, quality, and accessibility of healthcare services. Prior to academia, he spent more than ten years in the healthcare industry and continues to work with healthcare providers on technology-driven health improvement initiatives. Jim Morrison, adjunct faculty member in the business school, specializes in IT and data analytics. Jim has spent the last 25 years both in healthcare consulting with Deloitte and EY, and as a healthcare operations leader with large health systems. Jim’s recent focus is working with faculty members Steve Thompson, Doug Bosse, and Tom Mattson as they explore using machine learning and advanced cognitive analytics to create actionable insights for providers and payers.

Q: What are the keys to managing a pandemic?

A: A pandemic is a special case of a disaster, but more widespread than other types. Disaster management plans typically consist of four stages: response, recovery, mitigation, and preparedness. With COVID-19, we are currently focused on the response stage and the response strategy centers on containment and suppression via social distancing. All four stages require decision-makers at all levels to gather and process enormous amounts of information, and this is where machine learning (ML) and artificial intelligence (AI) technologies can help.

Q: Since we are in the ‘response’ stage, how might ML and AI technologies be helpful?

A: Right now, the keys to success are adhering to social distancing guidelines and widespread testing for the virus. Social distancing will slow the spread and widespread testing will provide the data hospitals, physicians, and public health officials need to make good decisions. As testing ramps up and more data are gathered, ML and AI could be used to track the progression of the virus across human migration channels. In essence, the virus goes where people go and algorithms applied to GPS data and mapping App requests could be used to trace the routes taken by infected patients and subsequently identify individuals at elevated risk of exposure.

Q: What are the most significant challenges facing public officials?
A: Obviously, ensuring hospitals have sufficient resources to handle an influx of patients that exceeds their planned surge capacity is the number 1 priority right now. Because of the delay in proportional response to the rate of spread of this virus, technical flaws and regulatory hurdles to approving a COVID-19 test, and lack of leadership on multiple levels, wholesale testing and containment were significantly delayed\(^1\). The good news is that resources are being mobilized and production of necessary supplies is ramping up. From the perspective of using ML and AI technologies, the inability to easily and quickly share data compounds the problem. We gave the example of using GPS data and information related to route planning requests as one example of how these technologies could be used. However, there a number of legal and regulatory challenges to effective and complete health information sharing. From the perspective of data aggregation, Federal agencies, State agencies, local municipalities, and the private sector are all collecting data, but it takes time for the data to be consolidated, and that makes syndromic surveillance even more difficult. From the perspective of legal and regulatory constraints, there are a number of laws that actually prevent public health officials from even gaining access to certain data.

Q: Are there other barriers to the effective use of AI and ML technologies to assist with our national response?

A: The pace at which these tools are being applied in healthcare, both public and private, is accelerating. But these tools and capabilities have their challenges. For example, Machine Learning requires massive amounts of data to “train” the predictive algorithm. Once it is “trained,” it can be deployed. The training data are historical, and if the data are limited or just emerging in real-time, ML will have limited training data to build predictive algorithms, but other AI tools can be deployed.

Q: What are some examples of how AI and ML can be used in each phase of Disaster Management?

A: Technologies such as AI and ML can be helpful in all four stages but are not equally useful in each phase. In the response phase they can be used to predict hotspots and send alerts via multiple different communication channels including social media. Natural Language Processing can be used to codify text from non-traditional health data sources like Twitter, or Facebook, and use this codified information to support Machine Learning algorithms to predict potential hotspots.

In the recovery phase, these technologies can be used to identify best practices by analyzing clinical interventions, patient characteristics, and the corresponding outcomes. In non-clinical settings, AI can be used to assess the impact on financial performance and assist organizations in adjusting production schedules, supply chains, and resource allocations.
The mitigation stage is more forward-looking and focused on building better infrastructure, public education, and risk assessment. AI and ML can be used, for example, to support risk stratification and improve forecasts of patient demand. With this virus, we know that some people show no symptoms whatsoever. A study conducted in a town in Italy found that for every person that exhibited symptoms, however mild, there were ten people who displayed no symptoms at all. We also know that relatively young people who were otherwise healthy are also succumbing to the virus, albeit at a much lower rate than the elderly and infirm. The question for AI and machine learning is then to try and determine whether there are common features or characteristics beyond age and the presence of comorbid conditions that are useful predictors of who might run into serious complications.

In the preparedness stage, public health officials are primarily concerned with making sure they are ready if something like this happens again. AI and ML technologies can be very helpful in this stage and can be utilized for tasks such as automated syndromic surveillance, looking at symptoms of severe infection with poor outcomes or unusual patterns in hospital admissions that suggest a pathogen is becoming very active.