Artificial Intelligence, Learning the Basics, and the Future of Pharmacy

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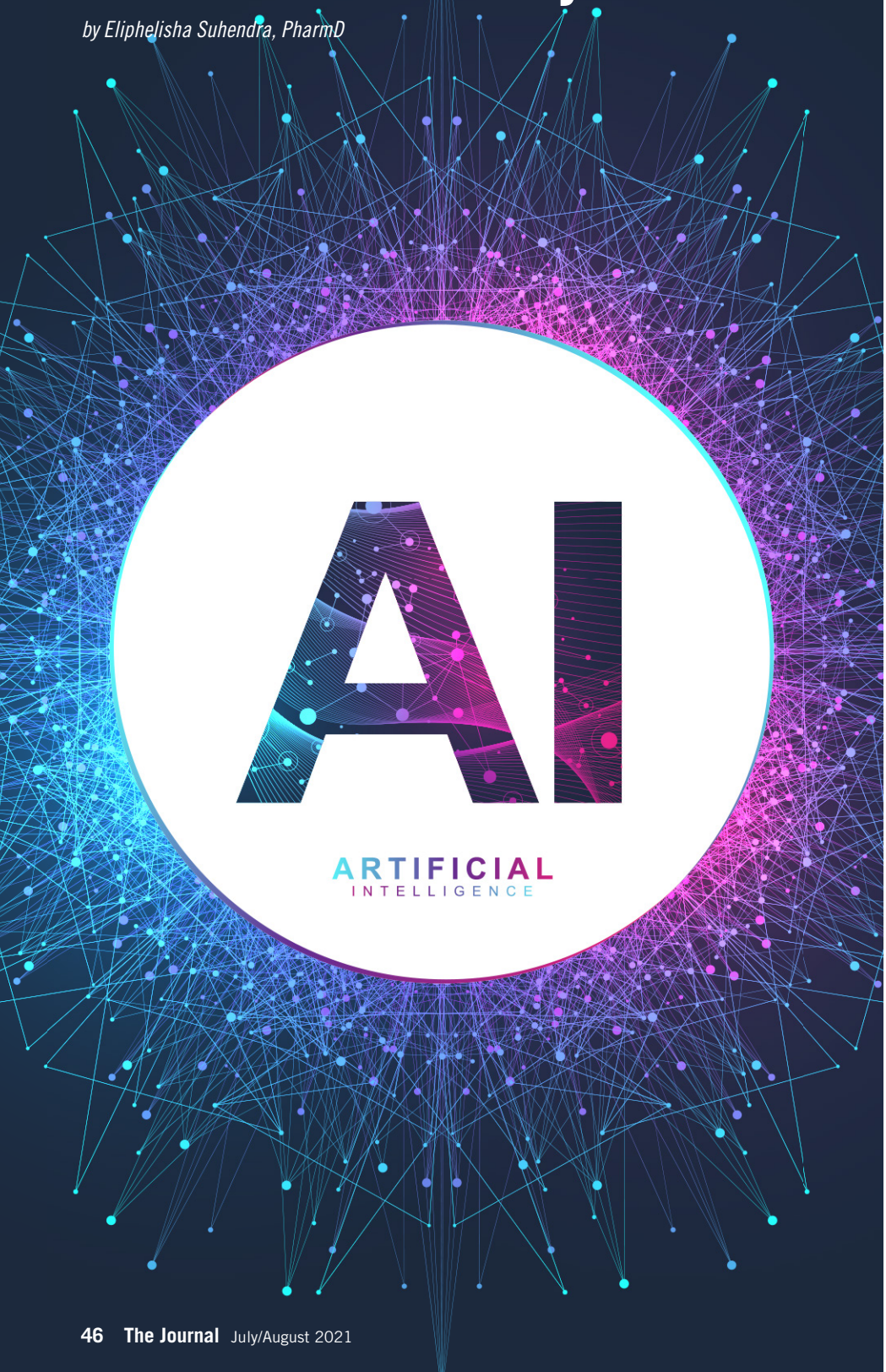

What do you think is the future of pharmacy? is a question that many pharmacists are asking. One area of study that's gaining more prominence in the healthcare space is artificial intelligence (AI) and machine learning (ML). Navigating the world of complex algorithms and increasingly complicated theoretical data models can be a challenge for pharmacists and pharmacy students, unless they know where to look for guidance and are open to struggling through difficult concepts. The objective of this article is to introduce pharmacy professionals to helpful resources where they can learn about AI; to share my experience as a student going through these resources; and to highlight a few potential limitations of AI in the future of pharmacy.

Artificial intelligence (AI) is a broad term for any computer system that can mimic human intelligence, and is a particular area of interest in medicine. A tool often used in AI is "machine learning," another broad term that describes a computer algorithm that can be trained and tested by a set of data to predict, sort, or identify the data in a way that is desired by researchers. In my last rotation as a pharmacy student, I learned about AI and ML terminology, and compiled some resources to learn more about this area of study. The two articles that helped me the most to construct the framework for understanding AI were "Demystifying artificial intelligence in pharmacy" by Dr. Scott Nelson and "Using artificial intelligence in health-system pharmacy practice: Finding new patterns that matter" by Dr. Allen Flynn, both in the American *Journal of Health System Pharmacy*.[1,2]

These articles do a great job of breaking down the concepts of AI in the medication-use process by using simple diagrams and outlining examples of each use case.

Another resource that I found particularly informative was a podcast by Dr. Dalton Fabian that discusses important applications of ML in his own practice as a pharmacist and data scientist.[3] The relationship between AI and healthcare often involves data science, the study of data organization and analysis. This area of study isn't usually on the radar of the

average pharmacy student or practicing pharmacist, but can be a useful area to explore for those who want to know more about the intersection of healthcare and technology. Dr. Dalton Fabian's blog, The Data Science Pharmacist, goes into detail about what being a data scientist and a pharmacist looks like, complete with guides for learning programming and data science, and navigating related career paths.[4]

The next useful resource is Kaggle.com.[5] While the resources suggested so far provide a great framework for how data science fits into pharmacy, how do pharmacists learn these skills? Kaggle has free courses on data science, and thousands of data sets to create whatever you'd like to explore. Some potentially important skills for pharmacists who are interested in this field are SQL, a programming language that allows data analysts to pull specific health information out of electronic health records, and R, a programming language for statistical analysis that allows analysts to identify trends and patterns in data. These resources can help pharmacists implement technology to improve patient care.

Getting Familiar with the Concepts

In my experience, an effective way to approach learning complex and difficult concepts is with growth, resilience, integrity, and tenacity (GRIT).[6] This mindset has been shown to be closely correlated with academic and professional success, especially in the medical field. It is important to keep in mind that no one becomes familiar with ML algorithms in a few days, so when I look back at what I have learned so far, I can also look forward, certain that there is only more learning ahead. Reading scientific literature about AI or ML can be overwhelming, full of obscure concepts that are difficult to understand. One concept that continues to be tricky for me to understand is the pseudo R2 value, a very common statistical measure, of how likely an ML algorithm is to predict an outcome correctly. With concepts like this, I need to employ the GRIT mindset, which helps me to appreciate the overwhelming knowledge gaps I have and stay motivated to learn more.

Having the right mindset is one thing, but tackling subjects that experts have spent decades mastering is another. In this case, what is important to master is self-directed learning.[7] Setting goals, having a structure, and creating a timeline really helped me learn difficult material. My first struggle in learning AI concepts was understanding terminology. So my first goal was to understand the field's vocabulary. Seeking out resources for novices was done with help from preceptors and friends, and long hours of browsing internet tutorials, articles, and learning modules.

The Current Status of Machine Learning

Many pharmacists have some anxiety about AI taking their place as medication experts. The thinking goes, "Why trust a human, who can make errors, when an AI program can perfectly manage patient medications?" In my opinion, AI is nowhere near capable of replacing a well-trained pharmacist. Based on my research, it seems the scope of ML is infinitely broad, but its potential is still severely limited.

As pharmacists, we are expected to know which medications will best fit a patient's health needs. If this task is replaced by AI, the expectation is that ML algorithms will be able to predict the effect of every possible medication on a given patient, and determine which one will be the most safe and effective. This idea is often referred to as "precision medicine," a field that factors in a patient's individual characteristics, such as genetics, behaviors, past medical history, and other biomarkers, and then selects therapies and predicts health outcomes.[8] One area where ML and precision medicine are of increasing interest is in psychology, where the selection of therapy is often trial-and-error, and what seems to work is as unique as the patients themselves.

The most recent scoping review and meta-analysis (SRMA) in the field of psychiatry and ML is a 2018 study from the University of Toronto, where researchers assessed 20 studies using ML models, using various patient factors to predict health outcomes in depression.[9] They categorized the predictive factors used by each study into: neuroimaging, phenomenological, genetic, and combined factors. Then, they assessed the accuracy of each ML model in predicting the response to antidepressant therapy. The combined accuracy of all the studies to be 82%, with ML models using combined factors the most accurate, reaching 97% accuracy. Though promising, the adoption of ML algorithms to model a disease like depression, or any complex disease state, is problematic, due to the lack of foreseen benefit and the disproportionate consequence of failure. To elaborate, there is nothing to compare ML to when it comes to predicting therapeutic outcomes in current practice, outside of provider experience and expert consensus.

To date, there is no baseline for accuracy for providers predicting health outcomes for their patients when choosing therapy, so, in essence, there is no baseline to compare to ML that would show whether it is more or less effective. Additionally, the liability of treatment or diagnosis failure falls to no single entity, making AI algorithms risky to health institutions despite the promisingly low error rates. Prescribers have well-established national organizations that protect the public from malpractice and protect prescribers from malpractice claims, while AI algorithms do not have these protections. Protecting patients from malpractice from AI integration is a serious concern that is difficult to address when proposing AI-integrated initiatives. These limitations, among others, make ML far from being integrated into the medical field. However, I have only mentioned a single application of ML in medicine, and there are infinitely more possible applications in areas like clinical decision support, disease screening, diagnostic tools, and health outcome management. In all these cases, nonetheless, I believe that AI-integrated technologies are not a replacement for a highly-trained healthcare worker, but rather a specialized tool that can be used to implement quality patient care.

The future of AI in pharmacy is a certainty, as healthcare becomes increasingly reliant on technology with improving quality patient care in mind. I also believe it is a certainty that pharmacists will someday be required to understand and help implement AI-integrated practices, as AI-based technologies gain more trust from institutions, patients, and providers. New pharmacist jobs that focus on maintaining and utilizing AI-integrated health programs are more likely in the next few years. For now, I believe it is important for all pharmacists to keep an eye on the future,

and to understand the limitations and opportunities AI presents.

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