Interview with Dr. Phedias Diamandis

UTMJ Interview Team (Happy Inibhunu and Jeff Park)

Dr. Phedias Diamandis

Biography

Dr. Phedias Diamandis is a Neuropathologist and a Scientist at the University Health Network and Princess Margaret Cancer Centre. He completed his MD/PhD and residency training in neuropathology at the University of Toronto. Dr. Diamandis' research involves optimizing high-resolution mass spectrometry to define novel protein-based biomarkers underlying brain disorders. His research group also utilizes Artificial Intelligence (AI) to objectively differentiate brain tumour types, a task that has traditionally been qualitative and prone to interpretive errors. Dr. Diamandis also enjoys teaching, especially on his YouTube Channel called NeuroscIQ. His channel focuses on introducing various important and recent neuroscience topics to young trainees. You can check out some of his weekly content and subscribe at: www.youtube.com/c/neurosciq

Interview

UTMJ: Can you tell us about yourself and how you decide to pursue a career as a neuropathologist?

PD: I did my undergraduate studies at McMaster University and then I came to the University of Toronto's MD/PhD program. During my PhD, I was involved in a lab that studied brain cancer. There, I got exposed to the biology and physiology of brain cancer as well as other brain disorders. This fascination really motivated me to look at the neuroscience specialties: neurosurgery, neuropathology, and neurology. All three were great, but I ended up choosing neuropathology, because this field allows you to look at actual tissues and cells. Trying to understand biology and disease at the most basic level was quite exciting. It is an exciting time in medicine because we are understanding more and more about diseases and being able to look at cellular pathophysiology of diseases in patients is really cool. However, I was not really sure I was going to specialize in neuropathology until very late in my journey. I just happened to do a neuropathology rotation coincidentally, maybe two to three months before CARMS, and I loved it!

UTMJ: What led you to focus on your research area of utilizing Artificial Intelligence for pattern recognition in diseases? Did you notice any inadequacies that led you to work towards improving your field?

PD: I think it's hard to expect any human to be perfect, but there is definitely a percentage of errors that doctors make. Instead of computers replacing doctors, I am working towards a harmonious partnership with technology. Given Toronto's history of discoveries, we have this obligation to not only recreate what people have done before us in medicine but also to leave our field in a better state than how it was when we came into it. The way to do this is to embrace technology and always ask: "Can I learn about these emerging technologies, like AI, and see if we can make our jobs better." That's how I view why I do this research.

UTMJ: Can you give us some insight into your research?

PD: Pathologists try to predict how a patient is going to respond to a therapy or surgery based on the phenotype of the cells they see in the microscope. Traditionally, it has been kind of like looking at art. For instance, you can look at a painting and say this painting represents rage and then another person looking at the same painting may think it represents peace. Of course, there is some subjectivity to this art as there is in all of medicine. One person may interpret a set of symptoms slightly different from another. So one of the exciting aspects in our field is to use computers to try to objectify some of these things we see under the microscope. We are trying to find answers to the question: "Can we use computers and AI to make the task of analyzing biological patterns very similar to doing long division using a calculator?" You can kind of estimate math with good approximation, which is how we have been doing things in the past, but can we use modern tools like AI, to make this job more objective? So that is an exciting area of our lab that we invest a lot of resources and time into.

UTMJ: How do you train these AI tools to do the work it is supposed to do?

PD: Training computers is very much like training medical students. It is about memorization after memorization. You just have to provide many examples. Computers are much better than us at digesting large numbers of images. So, the more images you provide, the better the silhouettes representing specific diseases will be, and computers will use those to try to classify future cases.

UTMJ: Are we ready to implement AI in the clinical setting of diagnostic pathology?

PD: We are doing pilots all the time. Obviously, it will be very exciting to put the technology into clinical use. There are actually a lot of papers that show computers outperform humans at medical diagnostic tests given very defined tasks and controlled environments. But the concern is of course, medicine is not very controlled. You do not know what is going to walk in through the hospital door. Each patient has their unique stories. And that is what computers and AI are not really good at. If a computer does not have sufficient data on specific scenarios and uses data that is irrelevant, it is going to make errors. This is an area where human intelligence really excels. Almost without any data, we can use intuition and creativity to make very strong predictions about how environments we have never encountered before are going to play out. So, the computers may get a lot of the bread and butter cases right, but there will be a large majority of "atypical" cases where computers will not be able to handle. Obviously, from a public perception and care perspective, that would not be acceptable. These limitations and how computers and humans will work harmoniously to improve efficiencies without compromising safety still need to be sorted out.

UTMJ: Another major component of your work involves looking at biomarkers and performing proteomic analysis. Is there any utility in applying AI in this aspect or other types of diagnostic testing in general?

PD: I do think technologies need to be used together. Obviously, looking at cells under the microscope with computer aid, in theory, should be better than humans working by themselves. Some people are trying to see if they can predict mutations based on morphologic patterns under the microscope. I think although that is really interesting, no one is going to replace genetic testing with morphology-based AI testing. Sequencing a tumor is obviously much more informative. Now, there are some cases where technologies can work in harmony. For instance, there are some countries which may not have access to genetic testing. In these cases, where you cannot afford genetic sequencing, if there are morphological correlations with some specific mutations, we now provide cost-effective solutions for these countries to benefit from precision drugs without having to invest in advanced diagnostics like proteomics and genomics, until the cost dramatically comes down. The other thing for now, even at our large academic medical centres, is that you cannot order every genetic testing out there. It is too expensive even for us. Additionally, not every physician may have read the latest guidelines about what tests should be ordered based on state of the art technologies. Thus, having computers that would prompt this kind of information of ordering the right molecular test can ensure patients can access the best practices all the time. This is the beauty of computers. It is that they can continually be updated and aid in making sure patients get the right kind of diagnostic tests.

UTMJ: Computers and AI can help diagnosis and precision medicine. Do you anticipate pitfalls or negative consequences of utilizing this technology in medicine?

PD: I mean one example that comes to mind is, when I was growing up, your best friend's, your father's, your mother's phone number; you would have it memorized. That quickly fell out of favour when our phones were able to store our contacts. Obviously, when phones evolved to have contact lists, I would not even remember my own phone number. I think that is one of the challenges with technology. It makes our lives easier, but it also makes some of the first principles that stimulate our brains less relevant. Similarly with calculators; do we need to know how to do long division, if computers are very good at doing calculations? That is one of my worries. As we rely more and more on computers, I think as physicians, when new diseases emerge, that physicians are not aware of, we may not have intuition or mental strength to quickly spot them and explore them in a prompt manner. That is always the concern with a technology that makes our way of life "easier". Technology makes the difficult things that make us skillful, easier, and of course there are advantages and disadvantages that come with them.

UTMJ: What are some of the strategies you are using to improve the implementation of AI into practice? What should physicians be aware of when using AI in their practice?

PD: My research is mostly centred on understanding how and why computers make errors or "bad guesses". A lot of the AI research we do doesn't try to surpass human capabilities. I think it is very easy to get computers to do something very well. With some sophistication, we can get them to work at a level similar to humans in some cases. But the question is if we are already good and we are going to use these to help us, we are going to need to understand when they make mistakes. One way to do this is by trying to teach computers how to say, "I do not know" or "I am not sure". It is important to alert the clinician that there are scenarios where computers excel and that when there are changes in the environment, it is important to understand that the algorithm cannot be used in the new environment. Say, for example, you go to another world and there are purple octagon signs in the streets, AI might assume that any octagon, regardless of where it is, means STOP. However, it is important to know that in another universe, the octagon shape may mean GO instead. Hence, the computer needs to understand that not all octagon signs mean stop. It needs to know that having an octagon is not enough. We are trying to teach computers when they are in novel environments, and when the data we used to train them is no longer valid, to say "I do know where I am, I would be guessing". This is how we are trying to combat the major limitation in AI technology of the poor ability to generalize to novel untrained situations.

UTMJ: With your work focused on a new wave of technology, AI, being incorporated in medicine, where do you see the medical field in the next 20 years?

PD: It is hard to make predictions in 20 years. I think progress, when we look at it in the present, is relatively slow. For instance, we have heard of molecular medicine for the last 10 years and have made massive breakthroughs in sequencing and profiling. But, the home runs on how it changes medical management are relatively few. Based on this, it is good to remember that not everything is moving at the speed of light. You don't need to worry about current good technologies being updated every five years due to the next new invention.

When I started, they said do not go into pathology because molecular medicine is here. No one is going to need to look at slides. And now, they say do not go into pathology because AI is here. However, it takes a lot of time for something to change in a field like medicine where lives are at stake. This is good because if we reinvented medicine every five years, then we would probably be making more mistakes. We have a system that works. To answer your question, I think medicine will be more similar than different for the foreseeable future, so stay in school.

But, of course, there are always these kinds of disruptive technologies that completely revolutionize how some industries are carried out, such as Uber for the taxi business. If we sit back and say medicine is not changing, then trouble may occur because when it does change, you are going to be extinct. Hence, there needs to be balance. Things we have been doing are highly optimized for many decades, if not centuries. Medicine is a field practiced for as long as we know. However, at the same time, we should be hopeful and help lead improvements, to improve our field and the patients we aim to help.

UTMJ: From your own experience, what tips or suggestions can you provide to current physicians or residents who are currently using AI in their own medical research?

PD: The beauty of medicine is, by definition, there are very few people in this world that have gone to school for as long as a medical doctor. It is kind of like a marathon. If you run a marathon, even if your time is very poor, you are in a select group of people in the world that can say they have run 42 kilometres. Thus, I always think in a way, we have knowledge that very few people in Canada have, regardless of the field you are subspecialized in. With that in mind, you are already winning. There is only a small number of neuropathologists in Canada. It's a high chance one of us will help make a difference in our field, not a computer scientist or biologist working on their own.

I think that is the way one should look or think about their field. Ask yourself how you can make a difference. Even if we will likely require some cross-disciplinary collaborations, we are in a very unique situation to help make a difference.

UTMJ: What is your advice for current medical students, who would like to partake in AI or uphold the search of knowledge in medicine?

PD: The best way to continue on this path is to balance ingenuity and innovation by at least knowing what is out there and being willing to embrace change. Learn the first principles, because they were built on many centuries and decades of knowledge, while trying to be up to date with innovations. Eventually as you learn more and more theory, and the strengths and weaknesses of new technologies, it will just hit you on how to integrate them together. It probably won't happen early in your training, but if you put in the time, you increase the chances of getting a bright idea. And of course, get involved. Theory is extremely important, but it is hard to accumulate practical know-how without getting involved in ongoing projects. Thankfully, in Toronto, the opportunity to get involved in medical research is second to none.