AI/Big data session 6-20-20 Q&A

Eric Topol MD
Vivian S Lee MD PhD MBA
Olivier Elemento PhD
Anthony Chang MD, MPH, MBA, MS

"Regarding career development, I am currently an MD/PhD student interested in deep learning research. For faculty and leadership positions in AI-related medicine, is it better to have a PhD in CS or Biomedical Engineering?"

OE: hands-on experience, impactful publications on projects involving deep learning or other AI techniques would likely help a lot more than getting a PhD in CS. As discussed, AI tools are mature and accessible (PyTorch, TensorFlow etc). Picking the right question and obtaining/using the right data are now the most important drivers of impact in my view

VSL: Look at the faculty in your university and find those who are doing AI/deep learning projects. They could be in CS or BME or other departments altogether. If you have the luxury of PhD time during your training, you'll be able to do projects in depth that will equip you well.

AC: I am a believer in the "Medici Effect" in which everyone can bring something to the domain of AI in medicine. I think I would recommend to get education and experience in an area that you are passionate about rather than try to guess which areas or subareas will be more productive. My personal feeling is that deep learning will be yielding fewer dividends and we need to consider more cognitive elements in AI to push AI into the next frontier. In other words, I would recommend 1) staying flexible and get expertise in a myriad of areas and not only in the deep learning area (as Wayne Gretzky stated "I skate to where the puck is going to be, not where it has been") and 2) invest in clinical experience and expertise so your dual education in medicine and engineering can be geometric (rather than additive if your perspective is asymmetric).

I would recommend also to go "deep" into your chosen area outside of medicine and remain humble as there will be a few in every domain (more from the elite academic institutions) who possess some hubris and may feel threatened with anyone who has a similar background (I call this prejudice "institutionalism" as opposed to racism and sexism).

Overall, we cannot simply use data science alone (adequate for complicated problems that are more predictable to solve like autonomous driving or SpaceX landing back on Earth) to solve the nuances of a complex biomedical domain (which will require understanding of chaos and complexity theories by clinicians and others).

"Do you have any recs about choosing a specialty given how quickly AI/tech seems to be changing the practice of medicine? For instance, can we really (as trainees) get a sense for what Pathology/Radiology will be in 10y, or surgery, where surgical robots will be more popular in 10-15y?"

OE: imaging-heavy specialties like pathology/radiology will likely be heavily impacted by AI in next 10 years. Some less obvious fields will also be impacted eg gastroenterology (endoscopies), reproductive medicine (especially on the embryology side), cardiology (automated ECG assessment). In all these

AI/Big data session 6-20-20 Q&A
Eric Topol MD
Vivian S Lee MD PhD MBA
Olivier Elemento PhD
Anthony Chang MD, MPH, MBA, MS

areas, AI will automate certain tasks, but new technologies that make more complex measurements will also appear eg molecular, single cell imaging, high-resolution, live radiology that will continue to need expert human insights and reasoning. If you like technology, I tend to think radiology and pathology will likely be impacted in a positive way by AI and technologies and become more exciting than they perhaps were before. I also tend to think it'll be a while before robots broadly impact surgery

VSL: AI/deep learning are tools that will be universal in your careers. Do whatever specialty you find most attractive, and you'll find the chance to bring AI/ML into it, if that's your passion. As I showed in my presentation--this can be in the form of the analysis of big data of any kind, whether it's synthesizing continuous glucose monitoring data, images of meals, medications, and clinical questions, or as Olivier suggests, imaging (yes we've been doing computer-assisted diagnosis in Radiology for over twenty years). That said, it will be universal. Our company is using AI/ML in almost every medical specialty.

AC: I think most if not all areas will be accommodating various AI tools so I would recommend just go with your passion in clinical medicine. My upcoming book has a separate section for each of the many subspecialties and I was pleasantly surprised that there is much going on in most of the subspecialties but the AI influence is still early in most of these areas (I also wrote on what can be explored in each of these subspecialties).

You could even be one of the first cohort of clinicians to promulgate AI in that subspecialty. In cardiology (my area), there are very few with an AI background and yet there are so many ways to accommodate AI as cardiology has a good balance of the clinical trinity of perception/cognition/operation (the three main areas in a clinical subspecialty). Right now AI in more pervasive and mature in the perception area but the other two areas will mature (especially if we clinicians push for AI in our subspecialties)

"(1) What is being done to share data among all the players in AI applications to healthcare? (2) With few established methods to understand what is happening inside the "black box" of AI algorithms and no concrete stability proofs such as Lyapunov methods in Control Theory, how do we ensure these systems are reliable especially in edge cases?"

OE: (1) complex question - data sharing academic consortia eg GENIE in cancer genomics are being formed. The ACR is trying to organize collection of a large multi-institution radiology dataset for Covid research. It's hard because there are few incentives to share data in the fragmented, ultra-competitive US healthcare system. Ideally federal agencies would mandate such data sharing but clearly they haven't quite embraced that yet(2) the black-box nature of AI algorithms is over-stated as there are many ways to inspect AI algorithms and understand what they look at eg class activation maps in neural networks, which features are important, etc. Managing edge cases can be done in a variety of ways, such as collecting more data on edge cases or outlier analysis followed by reflex to a human expert

VSL: Great question. Some terrific efforts--the All of Us precision medicine initiative to the OHDSI collaborative. There's a lot of this going on now.

AI/Big data session 6-20-20 Q&A
Eric Topol MD
Vivian S Lee MD PhD MBA
Olivier Elemento PhD
Anthony Chang MD, MPH, MBA, MS
AC: (1) There is not nearly enough being done if this area of data sharing and I spend a significant time advocating for this. Imaging someday we can have an international data repository to allow for continual international collaboration (using the space analogy again, a medical "international space station"). Those of us who are not passionate about AI can perhaps invest time in informatics or data management to help the entire data->AI pyramid (data->information->knowledge->intelligence->wisdom). The entire pyramid could use lots of support and help from clinicians.

(2) I feel that the black box perception of AI in a bit exaggerated but totally understandable that this is an issue. I think it is not really "explainability" that is the central issue but "interpretability". As a cardiologist, I have many patients with pacemakers and I do not possess total explainability of the engineering aspects of the pacemaker, but I do trust it enough to possess "interpretability" which has more to do with trust and functionality (than engineering details and nuances). The AI community is, however, working on explainability especially with more sophisticated tools like deep learning (there is a somewhat inverse relationship between accuracy and explainability). Many groups are working on this issue, including one such effort called LIME (local interpretable model-agnostic explanations) to improve understanding of model predictions.

"What metrics or performance thresholds do AI algorithms have to achieve before they are considered to be reliable enough to be diagnostic or predictive?"

OE: Required performance thresholds depend on how/where AI models are used, but broadly speaking I'd say that AI algorithms need to be as good and ideally better than the current gold standard, whatever it is. How this is assessed is critical - it requires independent replication using other datasets generated at other institutions and prospective validation that limits the inherent biases that exist in retrospective analyses

AC: This depends sometimes on the clinical context (skin cancer detection vs rash diagnosis that is not life threatening) as well as AI technology. In addition, one common misconception is that the AUC of the ROC is accuracy of the diagnostic test when in fact it is easy to have a high AUC if there is asymmetry of the population (rare disease in large patient population). In these instances, we need to factor in other elements like precision/recall and F1 score (explained in detail in the eBook as well as the upcoming textbook).

"Is there any efforts to align movement/work toward population health (VBC) and away from fee for service between healthcare systems, physicians in the field, lifescience companies, and insurance companies? If there is any close communication / collaboration?"

OE: a bit off topic and honest answer would likely be not real

VSL: The value-based payment initiatives from Medicare have been underway for a while; the most major push was from the Affordable Care Act under Pres Obama. Administrator Seema Verma has continued to move the value based payment agenda forward. Examples include Medicare Advantage

AI/Big data session 6-20-20 Q&A
Eric Topol MD
Vivian S Lee MD PhD MBA
Olivier Elemento PhD
Anthony Chang MD, MPH, MBA, MS
(proving more resilient now in Covid-19--there's a piece in Bloomberg) and the bundled payment initiatives, for example. Systems like Kaiser Permanente, Intermountain, Geisinger, and many other integrated payer-provider systems have great examples. In North Carolina, partnerships between Sec Mandy Cohen and the major insurers there are just one of many state-level examples. (This is a topic I have researched deeply for my book)

AC: This is a complex (vs complicated) imbroglio that we humans will need to solve, hopefully in our lifetime. I remain optimistic that AI being incorporated into some aspects of this complex ecosystem (such as use of robotic process automation for automating straightforward decisions and use of deep learning for diagnosis of medical images etc) will avoid this ecosystem becoming a chaotic one that will be nearly impossible to solve in the future (even for intelligent humans) and bring about even more burnout for clinicians and others.

Can AI Med help provide education in these areas? Help shape the dialog on what competencies should physician scientists/physicians have in AI?

AC: The AIMed (www.ai-med.io) meetings (many throughout the year) usually address these issues and challenges and we would really like students and young clinicians even more involved (historically we have supported hundreds of young clinicians and students in the form of scholarships for accepted abstracts that require more thinking of solutions and less projects that require data from patients). The AIMed meetings are especially designed for the clinicians but these are very multidisciplinary with entrepreneurs/startups, clinical organizations (AMA), industry (IBM, Google, etc), administrative (C-Suite), and regulatory agency (FDA) representation. These meetings have a "real-world" perspective and not only data science in abstracts but little if any clinical or real world relevance or application. We have also embraces young students and clinicians and provide them an opportunity to present (rarely done at meetings in general) as our philosophy is to provide everyone with a platform to learn and to share.

Most of the aforementioned issues are also addressed in the textbook in detail and will also be focused upon in the journal of the same title (Intelligence-Based Medicine: Artificial Intelligence and Human Cognition in Clinical Medicine and Healthcare). I am also presently working on two ambitious educational projects: a book series to focus on each subspecialty area (like population health, pediatric medicine, etc) as well as an accompanying video series on topics in AI in medicine as well as use of AI in various subspecialties.

In addition, our Medical Intelligence Society (MIS) that gathers clinicians with education/affinity for data science and AI (but open to all) is supported by our Medical Intelligence and Innovation Institute (MI3) and is maturing and have an upcoming meeting (last year we had over 100 international attendees).

AI/Big data session 6-20-20 Q&A

Eric Topol MD
Vivian S Lee MD PhD MBA
Olivier Elemento PhD
Anthony Chang MD, MPH, MBA, MS

Lastly, I am working diligently on the multidisciplinary American Board of AI in Medicine (ABAIM) that will democratize AI in medicine with a certification process and eventual board certification for clinicians (in 3-5 years).

AI is a once-in-a-generation resource and gift from our technology colleagues.

All of the above efforts, like APSA, are to promote something truly important for patient outcome and are labors of love as you all know.

I/We welcome anyone who would like to help and contribute to any of these projects as there is a lot of work to do.

All of these efforts will be an amazing platform for all of you as well as patients (we will all be one or already one) in the near future.