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Week 3 Practice

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1. **Please give 1-2 examples of a problem/scenario/task faced by healthcare providers that could be well solved by a machine learning algorithm. Why do you think this/these issues are especially suitable to an analytical approach?**

In my personal experience working at Memorial Sloan Kettering Cancer Center, I have seen quite a few applications of Machine Learning in the hospital. A lot of the technology was in nascent phases, but there were a few examples of clinical decision support tools used in the hospital that I found intriguing. To highlight a couple of examples:

1. Detection of cancer on pathology imagery1 – Pathologists train for decades and specialize into sub-specialties to identify cancer on pathology slides. There are many AI startups today, notably Paige.AI in NYC and Path.AI in Boston, that are training machine learning algorithms to detect cancer on slides that have been digitized. To date, Paige.AI has received FDA approval to detect Prostate Cancer on H&E images taken on a Philips UFS scanner. Cancer hospitals always have at least 2 pathologists looking at slides to prevent mis-diagnosis and having computer assisted tools will help even further.
2. Machine learning to detect sepsis in the ICU2 – Sepsis is a leading killer of patients in the ICU and early detection helps prevent sepsis from becoming fatal. Sepsis is life-threatening organ dysfunction caused by a host’s response to an infection. Machine learning algorithms take real-time metrics from the patient in the ICU to detect early signs of sepsis and alert ICU nurses and doctors.

These 2 examples are suitable for an analytical approach because they both require processing of vast amounts of data. Human doctors learn to intuit processing the data over decades of training. As with human drivers, the drawback of relying on human information processing is that a human cannot be alert at all times and the computer can. If computers can one day be as reliable as humans that it will provide a significant gain for healthcare.

1. **What are 1-2 examples of problems/scenarios/tasks faced by healthcare providers where a machine learning/analytics approach would not necessarily be the best choice? Why is this the case?**

In my experience, machine learning is quite narrow and does not perform well with multi-modal data though there are many efforts to help accentuate machine knowledge with knowledge graphs to help machines build webs of knowledge as a human does.

1. Redaction of patient health records – Computers can help with some efforts to de-identify patient data but cannot be guaranteed to provide exact results every time. This is the case because de-identification has 0 tolerance for identifying information to fall through the cracks.
2. Patient interaction – Companies that rely on chat bots and other automated forms of communication with customers are often rated as having poor customer service. Given that healthcare is a very personalized field with a huge body of knowledge, I think it would inappropriate for hospitals to communicate with patients via any form of AI. The reason AI is not good here is because natural language is complex and changes over time.
3. **According to the epidemiologic transition theory, as countries develop financially there is a shift in the long-term patterns of disease and mortality. During this transition, countries tends to move from high rates of infectious and nutrition-related diseases, high mortality rates, and low life expectancy to lower rates of infectious and nutrition-based diseases and a higher life expectancy – but, higher rates of chronic diseases (i.e., “man-made diseases”). How does such a transition change providers’ approach to healthcare? And by extension, how does it change the approach of healthcare analysts?**

Healthcare needs to be localized to respond to the needs of the community it serves, while also being prepared to fight rare or novel diseases at the same time. It was only a century and a half ago where the United States was a more agrarian society and industrialized heavily after the end of the civil war. Prior to the civil war, families were much larger and infants often died at a young age. While America was industrializing, child labor led to many chronic illnesses and workplace safety was not taken as seriously as it is today. In today’s industrialized world, people are living longer and suffer more from diseases of age like Cancer and Alzheimers. Ebola is a concern in central Africa like the congo, but almost unheard of in North America. While Ebola is unheard of in North America, during the outbreak in the mid 2010s in central Africa, an American doctor from NYC working with Doctors Without Borders brough the disease home with him to NYC. Even though NYC does not regularly see cases of Ebola, the healthcare system would be wise to be prepared for such rare events.

When it comes to healthcare analysts, we need to choose priorities for the society to tackle the problems faced by that society’s healthcare system. While we should have people in the United States studying diseases like Ebola, it may make sense to invest more in Cancer Research as the nation faces far more incidents of Cancer. It was really remarkable to see how healthcare systems around the world were able to mobilize for the COVID-19 pandemic. Whilst there are many complaints regarding the costs and efficiency of the healthcare system in the United States, US Pharmaceutical companies were better prepared to bring a vaccine to market faster than any other healthcare system. It is often said in debates that the US healthcare system is optimized for innovation and a side-effect of that is that we have the largest costs for healthcare in the world.

I really want the US to be a leader in biotech innovation going into the next century. My own family benefited from recently FDA approved personalized cancer immunotherapy and I feel a debt of gratitude towards the system and want many other families to benefit as well.

1. **The readings discussed how some of the most promising areas for machine learning in the provision of healthcare include: disease identification/diagnostics, personalized treatment/behavior, imaging (e.g., radiology), and the use of smart electronic records/patient tracking. Can you find a real-world example of an analytics company working in one of these areas? Describe the health challenge they are working on and how their analytic tool/algorithm/app/etc. will help to solve this problem. In your opinion, what are some advantages/disadvantages of their approach? Can you think of any ways to make their approach stronger/more effective?**

For this example, I will again bring up Paige.AI (I know I bring them up a lot, I know the top Brass at the company and heavily involved in the domain). Paige.AI is working to provide a Slide Viewer called FullFocus to hospitals that enables hospitals to view slides digitally on a computer and take advantage of Paige’s machine learning algorithms to detect cancer on pathology imagery.

One of the big problems pathologists face is productivity. The case load that pathologists are viewing increases year-over-year and puts a lot of demand on pathologists to continually sign out more and more cases every year. There are many nations around the world with very few pathologists and cannot adequately delivery healthcare to their populace. With tools like Digital Pathology, hospitals from elsewhere can submit cases for consultation digitally and have the case reviewed by a doctor at a hospital accepting digital consultations.

The advantage of Paige’s approach is that they have partnered with the largest cancer institute in the country and have more data than competitors. They are also backed by $90M of venture capital and are poised better than their competition. The disadvantage, and this applies to the whole computational pathology space, is that many healthcare providers are skeptical of the technology and not ready to embrace it yet. There are also very high integration and start-up costs for hospitals to start using Digital and Computational Pathology and year over year pathologists’ claim that the experience of viewing slides under the microscope is superior to viewing them on a computer.

Developing the technology and expanding to more disease types will help make Paige a more compelling solution for hospitals, but I actually think that their number one problem is on user experience more than the technology. Pathologists claim that viewing slides on a computer is fatiguing and often fall back to physical slides. Nonetheless, I think this is an interesting area to watch in the future, but I am dismayed at seeing Philips drop in share price over the year. I think Digital and Computational Pathology is currently experiencing a winter of low investment.

**References:**

1. Paige Receives First Ever FDA Approval for AI Product in Digital Pathology (Sep 2021) - https://paige.ai/paige-receives-first-ever-fda-approval-for-ai-product-in-digital-pathology/
2. Early Detection of Sepsis With Machine Learning Techniques: A Brief Clinical Perspective (Feb 2021) - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7906970/