Research Statement

Research Experience and Summary

I came across a professor who specialized in biomedical informatics. Her enthusiasm and tenacity in her research studies captivated me. After working in a lab as an undergraduate for a year, I was determined to begin my doctoral program and pursue a career in academia. After five years of PhD study, I have gained extensive expertise in biomedical informatics. At the moment, I use my computer science skills to do cutting-edge translational research.

My research is primarily concerned with population analysis and clinical diagnosis. My goal is to comprehend the underlying principles of machine learning algorithms and how they can be applied to diagnose various diseases. As a researcher, I can apply data analysis to clinical domain and offer innovative solutions to improve diagnosis. In the last five years, I've established several fruitful cross-disciplinary partnerships with the Medical College of Wisconsin, and I've co-authored over ten journal papers with medical doctors and students. As a scholarly reviewer, I reivewed over 20 papers on 8 different prestigious biomedical informatics journals. My understanding of disease diagnosis have grown significantly during collaboration and paper production. Together with other researchers, my studies will make a substantial impact to your research community.

Project 1: Machine Learning-based Elderly Fall Detection

In the United States, we are witnessing an unavoidable aging trend. Elderly-focused care is becoming increasingly important in clinical practice. Elderly citizens' falls are a major cause of morbidity and mortality. In the meantime, lowering the risk of falls will increase elderly people's quality of life and improve healthcare. My research in this area suggests the possibility of artificial intelligence-driven methods for fall prediction. My research is distinctive due to the incorporation of machine learning techniques into my methodology. The integration will support departmental collaboration and enable translational research.

Current studies have rarely delved deeply into this subject from a AI-drive perspective, and even fewer have discussed what the positive factors of elderly falls are in a machine learning

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model. In my doctoral thesis, I demonstrated the feasibility of machine learning models in detecting elderly falls. My thesis also investigated the prediction model's potential for use in clinical practice. The findings show that this model has improved its ability to automatically alert older adults who are at higher risk of falling.

Also, my findings opened the door to identifying the elderly's unique risk factors, making personalized fall interventions possible. In the future, there are still lots of questions to be answered: What forms of data can be used? What clinical factors should be included? How do we select the appropriate machine learning models? By far, I found a few socioeconomic factors in our study that factors of demographics, socioeconomics, diagnoses, and medications can be used as predictors. However, there are still more factors to be found that can predict elderly falls. My ongoing research will be an invaluable asset in the discovery of new forms of elderly care, lowering the risk of falling, and benefiting all elderly Americans.

I delved into one of the details to better understand how machine learning can be used to improve elderly care: One of my studies is starting a case study on temporal bone fractures, which are a common result of elderly falls. Using free-text clinical notes, machine learning has successfully classified patients' diagnostic outcomes. However, due to the model's complexity, interpreting a classification result remains difficult. A complex machine learning model is frequently referred to as a "black box," which makes understanding the mechanism difficult. I proposed a novel method to interpret the machine learning model so that the model shows the key clinical factors that lead to the AI's classification decision. This study demonstrates that our interpretable text explainer helps doctors understand machine learning models and make informed decisions in their healthcare practice. My proposed method can increase physicians' trust in computerized models. My model can aid decision-making. The research adds to the big picture of care for the elderly and makes care for the elderly more open and clear.

My mresearch has led to a lot of publications. Part of the results on this ongoing project have been published in the 46th IEEE Annual International Computer Software and Applications Conference (COMPSAC) and the journal Applied Clinical Informatics.In addition, my paper on machine learning model interpretation has been submitted for publication in Computer Methods and Programs in Biomedicine Update, a prestigious peer-reviewed journal in biomedical informatics.

Project 2: Gaps and Inequalities in Telemedicine Adoption During the COVID-19 Pandemic

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The outbreak of coronavirus disease 2019 (COVID-19) has accelerated the deployment of telemedicine services. To improve patient adoption of telemedicine services, it is critical to first understand the patients. I examined the socioeconomic characteristics of telemedicine users to better understand potential socioeconomic gaps and disparities. I conducted a cohort study in collaboration with the College of Medical Wisconsin to see whether socioeconomic factors may influence telemedicine adoption. I found that social determinants of health, such as income, education level, race, and insurance, had a significant impact on telemedicine service adoption. The study uncovers potential inequities and disparities in telemedicine adoption.

Many socioeconomic factors may affect telemedicine adoption, including income, education level, race, and insurance type. Among many indicators, zip code is a key predictor of increased telemedicine adoption in Southeast Wisconsin. There are several possible explanations for lower telemedical service utilization among disadvantaged populations, including a lack of insurance coverage, limited access to high-speed internet or smartphones, lower health technology literacy, poorer health communication skills, and less control over work/home life. Our findings revealed inequity in telemedicine adaptation, which is closely related to social determinants. More research is needed to determine the underlying causes of the disparity.

Another study's goal in this project is to determine which types of remote care are associated with patients' socioeconomic factors. I also examined the use of in-person, phone/message, and telemedical care since the start of the COVID-19 pandemic. My finding shows that telemedicine is currently unable to close the utilization gap for low socioeconomic status populations. Patients with low socioeconomic status use in-person care less frequently. The unusually high use of telephones or messages for the disadvantaged group is unlikely to provide the same quality as in-person or telemedical care. As a result, it is critical to understand the causes of the disparity. Our study emphasized the need to propose a solution to improve equal access to care for all patients. This study was recently submitted to the IPEM-Translation journal.

These two studies are extremely important for the future healthcare industry. Such methods can be applied not only to the pressing issue of COVID-19 pandemic care but also to other analyses of clinical facility care utilization. In fact, these results have built cross-institute collaborations with physicians at the Medical College of Wisconsin. We analyze socioeconomic factors in the patient population, and the analysis has yielded many publications. We found that many socioeconomic factors can influence the adoption of care in a variety of specialties, including rhinology, post-tympanotomy tube otorrhea, vestibular schwannoma, dysphonia, and endoscopic procedures. My published work shows that I can do cutting-edge research independently and work with clinical practitioners at the same time.

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Future Projects

In the short term, I will investigate the shortcomings of clinical diagnostic models based on machine learning, particularly in the detection, prevention, and surveillance of elderly falls. I'll focus on the interpretability of machine learning features. In the long run, I plan to investigate the feasibility of implementing machine learning model in traditional healthcare settings. More importantly, how can the use of such models affect patient health outcomes? In many situations, predictive performance is difficult to translate into causal effects. My approach to this problem will be to map the outputs of a machine learning model to a treatment policy and then use causal estimation methods to estimate average patient outcomes under that policy. Collaboration with physicians and the implementation of a workable model will be critical components of my long-term future work. To summarize, adoption and popularization of AI in healthcare will improve public health outcomes and people's quality of life. This is an ongoing commitment.

My research grants will be critical in completing my research objectives and fostering the research community. Government and funding agencies will prioritize AI-based healthcare projects, particularly those with methodological innovations, such as my research. I will write grant proposals to the National Institutes of Health and other foundations.

Undergraduate Research Considerations

Machine learning is always a hot topic in the healthcare field. My projects are ideal for an undergraduate with a research passion, particularly for those pursuing a minor in computer science. It is a priceless opportunity for undergraduate students to learn domain applications in a laboratory setting. It also requires minimal device requirements. For starters, the required equipment is limited to computers and databases. Traditional onsite lab training can be transferred to an online environment. Students will learn data analytical techniques by working in my lab. I can offer undergraduate researcher positions to the community, help students develop their skill sets, and empower the community to contribute to the future transformation of digital health.

I have specifically designed research projects that are available to graduate students. In addition to undergraduate students, I have successfully trained graduate students in several of these statistical techniques. Graduate students will gain experience in developing their own research plans, make assumptions, analyze data, prepare poster, talk, and manuscript. My proposed research will supplement existing research and provide opportunities for both undergraduate and graduate students to conduct exciting health informatics research for the future of your research community.

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