Artificial Intelligence for Lung Cancer Pathology Diagnosis

1. **Pedigree of inventor(s) and team**

   Kun-Hsing Yu, MD, PhD is a Harvard Data Science Fellow at Harvard Medical School. He received his PhD in Biomedical Informatics and PhD Minor in Computer Science from Stanford University under the supervision of Professors Michael Snyder and Russ B. Altman. Prior to joining Stanford, he graduated valedictorian from National Taiwan University School of Medicine. He received the Microsoft Azure Research Award, the Pacific Symposium on Biocomputing Rigorous Secondary Data Analysis Award, and research grants and awards from the Howard Hughes Medical Institute (HHMI), Amazon, and NVIDIA Inc.

   Isaac S. Kohane, MD, PhD is the Chair and Marion V. Nelson Professor of Biomedical Informatics at Harvard Medical School. Over the last 30 years, Isaac Kohane's research agenda has been driven by the vision of what biomedical researchers could do to find new cures, provide new diagnoses and deliver the best care available if data could be converted more rapidly to knowledge and knowledge to practice. In so doing, Kohane has designed and led multiple internationally adopted efforts to instrument the healthcare enterprise for discovery and to enable innovative decision-making tools to be applied to the point of care.

   Dr. Kohane has founded two companies. One called Correlagen – https://www.correlagen.com/index.jsp was acquired by Labcorp. The second company is ACT.MD https://act.md/ funded by Rose Park Advisers

2. **Best data, or demo (video can be helpful)**

   We established a fully-automated artificial intelligence (AI) system to diagnose lung cancer pathology with expert level accuracy. We built machine learning models using pathology images from 857 lung cancer patients. Our system distinguishes tumor from non-tumor regions with an area under the receiver operating characteristic curve (AUC, a measure of prediction accuracy) greater than 0.93, and recapitulate the diagnosis informed by a panel of expert pathologists and genomic sequencing results (AUC>0.88). We validated the results in a second multi-center cohort (n=124), with AUC>0.85. These results show that our machine learning-based system can achieve expert-level accuracy in diagnosing lung cancer and inform clinical decision making.

3. **History of project as a venture so far**

   We the help of the Harvard Office of Technology Development, we have submitted a provisional patent application to the United States Patent and Trademark Office (USPTO) last autumn. We are working with a group of Harvard MBA students to commercialize this invention.

   We have not formed a company and are considering both the newco and licensing paths for this technology.

4. **Has this tech been used in a real trial with CRO / added value to a hospital?**

   We are conducting a prospective clinical trial with the Department of Pathology at Brigham and Women's Hospital to evaluate the utility of our invention in the real-world clinical settings.

5. **Details of previous companies founded by investors**

   Dr. Kohane, MD, PhD is a co-founder of ACT.MD, a start-up that developed coordinated electronic health record and backed by the Rose Park Advisors. He serves on the Scientific Advisory Board of HealthReveal, pulseData, and MedAware.

   Dr. Yu is a co-founder of MentorWan, a Silicon Valley-based social enterprise that matches young professionals with potential mentors.

6. **Technology backstory**

   Since medical school, Dr. Yu is always intrigued by how pathology images are underutilized by the current clinical practice. Whole-slide pathology image contains billions of pixels and presented diverse morphological patterns of healthy and diseased cells. However, the pathology slides were only glanced by clinicians in a few seconds, and inter-rater disagreement in pathology diagnosis is not rare. Studies showed that the inter-rater agreement in diagnosing lung cancer types can be as low as 70%. In addition, there will be a net deficit of 5,700 full-time equivalent (FTE) pathologist in the U.S. in the 2020s. Dr. Yu works on the automated analysis of pathology slides since 2012. His published peer-reviewed papers were published in high-impact journals, including *Nature Communications* and *Cell Systems*, and were covered by more than 17 national and international news media. Since Dr. Yu joined Harvard Medical School in 2016, he and his primary mentor (Dr. Kohane) continue to refine the AI-based pathology diagnostic system for clinical use.

7. **Do you have any info on the fate of analogous companies?**

   PathAI is a start-up working on a related technology specifically for breast cancer. They just raised an $11M Series A round of funding in November 2017.