ARVO EDUCATION COURSE

Saturday, April 22, 2023
1-5pm
New Orleans Ernest N. Morial Convention Center
New Orleans, La

Improving artificial intelligence (AI) and data trust in ophthalmology: From clinical trials to real-world adoption

Course organizers

Daniela Ferrara, MD, MS, PhD, FASRS, Tufts University School of Medicine
Daniel S.W. Ting, MD, PhD, Singapore National Eye Centre
Dawn Sim, MBBS, FRCOphth, PhD, Genentech Roche

Presentations

Presenters and presentations may change.

Time	Topic	Speaker
8:00-8:15am	Welcome Address	**Organizers and Speakers:** **Daniela Ferrara, MD, MS, PhD, FASRS**, Tufts University School of Medicine **Daniel S.W. Ting, MD, PhD**, Singapore National Eye Centre **Dawn Sim, MBBS, FRCOphth, PhD**, Genentech Roche
Section 1. Basic concepts of AI, Big Data, and Population-based Studies		
8:15- 8:30am	NEI Initiatives for AI and Big Data	**Michael Chiang, MD,** National Eye Institute
National Eye Institute Initiatives for AI and Big Data: This presentation will summarize the rationale for the National Eye Institute's interest in AI and big data and will describe specific areas of interest such as generalizability, bias, standards, and education.		
8:30-8:45am	AAO Initiatives on Image Standardization	**Aaron Lee, MD,** University of Washington

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This presentation will focus on ways AI can be integrated into clinical trials and real world clinical workflows. Many AI projects begin and end in the research space, but certain applications of AI can be used to accelerate clinical trials leading to faster drug discovery and cheaper trials. In addition, AI holds the promise of building efficient clinical workflows. Both of these applications require building trust with AI and the datasets that drive them.		
8:45-9:00am	Predictive AI algorithms and data interpretation	**T. Y. Alvin Liu, MD,** Wilmer Eye Institute
The talk will cover a selection of published predictive AI algorithms and potential use cases. It will also discuss the challenges in training, deploying and interpreting such predictive AI algorithms.		
9:00-9:15am	Basic principles of AI, ML, and DL	**Kabilan Elangovan,** AI Researcher, Singapore National Eye Centre, Nanyang Technological University
This presentation will introduce the fundamental concepts and techniques of artificial intelligence (AI), machine learning (ML) and deep learning (DL). The topics covered will be: 1. Introduction to AI: The history of AI, including its definition, goals and applications 2. Machine Learning: The basic intuition of ML, including supervised, unsupervised learning and reinforcement learning and its vast applications in our daily lives. 3. Deep Learning: An introduction to DL, the intuition behind the neural networks and the rise of deep learning in recent times. 4. AI vs ML vs DL: Highlighting the key differences and connections between AI, ML and DL 5. Role of AI in Healthcare: Showcasing the practical applications of AI in Ophthalmology and its impact in clinical applications.		
9:15- 9:30am	Predictive AI models in Ophthalmology	**Josef Huemer FRCOphth, PhD**, Moorfields Eye Hospita
This presentation looks at past and present prediction models in Ophthalmology across different subspecialties.		
9:30- 9:45am	Panel discussion	All speakers from this section
9:45- 10:00am	Break (15 minutes)	
Section 2. Creating a trustworthy and sustainable AI and data ecosystem		
10:00-10:15am	Pearls and pitfalls of AI and digital innovation: crossing valley of deaths	**Tien Wong MBBS, MMED (Ophth), MPH, PHD, FRCSE, FRANZCO, FAMS**, Tsinghua Medicine & Singapore National Eye Center
AI and other digital technology (e.g., telemedicine, mobile health etc.) has vast potential to impact on healthcare and ophthalmology. However, the pace of adoption of AI and digital technology has been slow, due to complex interplay of technical and non-technical factors. Non-technical factors (e.g., patient and physician acceptance, support from professional bodies, data security and medico-legal risks, government funding and reimbursement)		

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impede the adoption and scaling of AI technology in ophthalmology. This talk will share concepts of AI and case studies and lessons learnt in ophthalmology, covering digital “virtual (without doctors)” clinic where non physician technicians evaluate patients and doctors have video-consultations, implementation of a home-monitoring app to monitor stable patients at home, and an national AI-telemedicine “hybrid” screening program in diabetic retinopathy. Understanding pearls and pitfalls are critical to cross the valley of death from concepts to clinical implementation.		
10.15- 10:30 am	Importance of AI explainability in eyecare	**Ranya Habash, MD,** LifeLong Vision SPAC, Byers Eye Institute, Stanford University
Artificial intelligence can enable faster and more accurate analysis of vast amounts of patient data, leading to more personalized care. AI can be used to identify patterns, develop predictive models, and create digital twins. By simulating the impact of different treatments on a patient's digital twin, we can identify which options lead to the best outcomes. These are the key concepts behind AI for precision medicine in eyecare.		
10.30-10:45am	The use of blockchain to regulate data and AI models	**Daniel Ting MBBS, MMed (Ophth), FAMS, PhD, Duke-NUS Medical School, Singapore National Eye Center**
Artificial intelligence (AI) has sparked tremendous interest in the medical fields. The development and testing of AI models require clinical datasets. The use of blockchain could be a potential solution to track the transfer of data, AI models and the testing results.		
10.45-11:00am	Federated ML: how to facilitate cross-border collaboration without needing to transfer data?	**Zhen Ling Teo MD, Singapore National Eye Center**
Deep Learning (DL) in ophthalmic imaging has sparked tremendous interest over the past few years. However, due to data privacy rules between different institutions, it is challenging to share data to build robust artificial intelligence (AI) models. Federated learning (FL) in AI is a distributed machine learning framework that allows for multi-party collaboration while preserving data privacy. This makes FL an appealing machine learning subfield in the health care domain and especially advantageous in niche research areas where publicly available data is limited and/or restricted. FL is increasingly seen as a key strategy in privacy preserving AI health research.		
11:00-11:30am	Panel discussions	**All speakers from this section.**
11:30am-12:30pm	Lunch break	

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Section 3. AI in clinical trials: Research and Development of new therapies in Ophthalmology		
12:30-12:45pm	Clinical trials basics and a user-centered approach	**Dawn Sim FRCOphth, PhD,** Genentech, Moorfields Eye Hospital, University College London
Artificial intelligence (AI) has the potential to make a significant, positive impact on the diagnosis and management of patients with age-related macular degeneration (AMD). This would be important as the number of persons affected with AMD globally by 2040 is estimated to be 288 million. The development of an effective AI device for the clnical care of persons with AMD faces a number of challenges. Currently, we do not have a Food and Drug Administration (FDA) authorized AI device for AMD. Existing infrastructure for robust AI development for AMD includes several large, labeled data sets of color fundus photography and OCT images, including data from previous clinical trials. However, image data often do not contain the metadata necessary for the development of reliable, valid, and generalizable models. Data sharing for AMD model development is made difficult by restrictions on data privacy and security, although potential solutions are under investigation. Despite such challenges, a number of research groups have produced potential AI models for AMD for screening, diagnosis, prediction and potential monitoring of AMD based upon some of the existing datasets. The future goals include defining benchmarks to faciliate regulatory authorization and subsequent clinical setting generalization. Clinical trials will be needed in the future to test the potential AI based device. Delivering an FDA-authorized AI based device for clinical care in AMD involves a number of considerations. These include the identification of an appropriate clinical application in the appropriate population with the appropriate time frame of referral; acquisition and development of a large, high-quality data set prospectively; development of the AI architecture; training and validation of the model with efficient study design; and functional interactions between the model output and clinical end user. The research efforts undertaken to date represent starting points for the medical devices that eventually will benefit providers, health care systems, and patients in the development of AI for the management of AMD in the future.		
12:45- 1:00pm	Current and future state of AI in clinical trials	**Daniela Ferrara MD, PhD**, FASRS, Genentech, New England Eye Center, Tufts University
1:00-1:15pm	Imaging data standards in clinical trials	**Dinah Chen MD,** Genentech, NYU
Imaging standardization in ophthalmology has critical implications in both clinical practice and clinical trial research. In clinical practice, a lack of DICOM adoption limits the capabilities of providers to access and visualize images across devices and settings. In research and clinical trials, imaging data is crucial for its role in biomarker and therapeutic discovery and understanding the pathophysiological underpinnings of disease. The focus of this talk is to highlight the impact of imaging standardization on every aspect of the data lifecycle- acquisition, management, and analysis- and how limited adoption effects timelines, costs, and discovery within clinical trials.		

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1:15-1:30pm	Reinforcement Learning in Clinical Trials	**David Kuo MD,** Genentech, Stanford University
1:30-1:45pm	Clinical trials and AI for AMD: past, present, and future	**Emily Chew MD,** National Eye Institute
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1:45-2:15pm	Panel Discussions	**All speakers from this section.**
2:15- 2:30pm	**Break**	
Section 4. Real-world applications of AI in Ophthalmology		
2:30-2:45pm	Translating glaucoma AI algorithms into real-world clinical applications: opportunities and challenges	**Louis Pasquale, MD,** Mount Sinai
I will describe 2 use cases: archetype analysis to disentangle the pathogenesis of primary open-angle glaucoma and the use of AI to detect disc hemorrhages. Archetype analysis has proven to be a transparent, 'corner-learning'		

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application that we have applied to incident visual field loss for primary open-angle glaucoma from across the US. We found that self-reported African Ancestry was a risk factor for presenting with advanced visual loss patterns. We are now exploring the knowledge gaps related to understanding why African race is linked to advanced visual field loss. We developed an AI algorithm to detect disc hemorrhages (DHs) in glaucoma as these important biomarkers are often missed in clinical practice. Developing a clinical ground truth for this outcome proved to be challenging and computer learning could not be achieved with an ordinal outcome (DHs present/absent). Learning by adding information about DH location proved to be critical to developing an effective algorithm		
2:45-3:00pm	AI for DR Screening in a national tele-ophthalmology platform	**Gavin Tan MBBS, MMed(Ophth), MRCSEd, FRCS(Ed), FAMS, PhD,** Singapore National Eye Center
The implementation of artificial inteligence (AI) for Diabetic Retinopathy (DR) grading on a national screening program will be discussed. The challenges and pitfalls of implementing and scaling up the use of AI for DR grading from the lab to the real world will be covered. The advantages and limitations of using AI alone , or combining with human grading will also be explored with an analysis of cost effectiveness.		
3:00- 3:45 pm	A real-world use case: Improving ROP AI algorithms using federated ML	**Peter Campbell MD, MPH,** Casey Eye Institute, OHSU
In this presentation, we will review a federated learning (FL) approach to developing deep learning classifiers for the diagnosis of plus disease in retinopathy of prematurity. We will compare a FL approach to a traditional centralized approach using data from 7 separate institutions. The key findings were: 1) a trained FL model performs comparably to a centralized model, confirming that FL may provide an effective, more feasible solution for interinstitutional learning. 2) Smaller institutions benefit more from collaboration than larger institutions, showing the potential of FL for addressing disparities in resource access. 3) We identified differences in the clinical diagnoses of plus disease and overall levels of ROP severity between institutions, which were consistent with demographic risk at each institution, suggesting that FL learning may represent a method to standardize clinical diagnoses and provide objective measurements of disease for image-based diseases.		
3:45-4:00pm	Using AI and external eye photographs to predict retina and systemic diseases	**Namma Hamel MD, Google**
It has been widely shown that retinal fundus photographs can be used to detect a range of retinal and systemic conditions. Here we show that deep-learning models trained instead on external photographs of the eyes can be used to detect diabetic retinopathy (DR), diabetic macular edema and poor blood glucose control. We developed the models using eye photographs from 145,832 patients with diabetes from 301 DR screening sites and evaluated the models on four tasks and four validation datasets with a total of 48,644 patients from 198 additional screening sites. For all four tasks, the predictive performance of the deep-learning models was significantly higher than the		

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performance of logistic regression models using self-reported demographic and medical history data, and the predictions generalized to patients with dilated pupils, to patients from a different DR screening program and to a general eye care program that included diabetics and non-diabetics. We additionally explored the use of the deep-learning models for the detection of elevated blood lipid levels, and on a separate dataset, for predicting systemic parameters related to the liver, kidney, bone & mineral, and blood count. Our findings provide evidence that external eye photos contain important biomarkers of systemic health spanning multiple organ systems. The utility of external eye photographs for the diagnosis and management of diseases should be further validated with images from different cameras and patient populations.		
4:00-4:30pm	Panel discussion	**All speakers from this section.**
4:30pm	Closing remarks and adjourn	**Course organizers.**