ARVO. EDUCATION COURSE

Saturday, May 4, 2024
8am – 4:30pm
Seattle Convention Center
Seattle, WA

How AI is transforming clinical research and practice in ophthalmology

Course organizers

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

Course description

Although ophthalmology has driven some of the earliest applications of AI in medicine, issues of reliability and inherent bias remain due to imperfect training data. These challenges must be overcome before AI can be more fully integrated into clinical practice.

This course brings together experts in the field of AI research to provide a behind the scenes view of how AI programs are developed. Participants will discuss options to improve how data is collected, curated and annotated within the clinic setting to improve the quality of the AI training data sets. Options to be discussed include the use of large language models to collect clinical data and the use of deep learning to examine image data. Participants will leave the course empowered to contribute to research efforts, make informed decisions, and drive advancements in this rapidly evolving field.

Learning objectives

Attendees will leave this session with the ability to:

- Cite emerging trends and future directions in the clinical applications of AI in ophthalmology and visual sciences.
- Recognize basic concepts in large language models in the context of ophthalmology and their potential applications.
- Describe the latest updates and developments in ARVO, AAO, and NEI initiatives for AI and big data in ophthalmology and visual sciences.
- Identify specific challenges and limitations associated with AI implementation in ophthalmology.
- Identify potential biases and disparities that can arise in applications of AI in ophthalmology and evaluate different approaches and techniques for ensuring transparency and interpretability.

Presentations

Speakers and presentations may change.

Time	Topic	Speaker
8 AM	Welcome address	Daniela Ferrara, MD, MSc, PhD, FASRS, Tufts University School of Medicine
	This course is designed for researchers, clinicians, and industry professionals seeking to stay at the forefront of advancements in ophthalmology and visual sciences, focused on recent developments utilizing artificial intelligence (AI). By harnessing the power of AI, the ophthalmology field is exploring the possibilities to improve patient outcomes in clinical research and clinical practice. In addition to the potential and current applications of AI-based technologies, this course will also discuss ethical considerations and regulatory compliance, underscoring the imperative of patient privacy, data security, and adherence to evolving regulatory frameworks. Challenges and pitfalls of the broad implementation of AI-based technologies in ophthalmology and healthcare will also be discussed by leading experts directly involved in this technological transformation. This course is a crucial rendezvous aiming to navigate the dynamic landscape of ophthalmology research, armed with the insights necessary to harness AI for precision medicine and elevate the standard of science and care in the field.	
Large language models and AI global trend in Ophthalmology		
8:15 AM	AI in Ophthalmology: Global Trend	Daniel Ting, MD, PhD, Singapore National Eye Center
	The global AI trend in ophthalmology is notably advancing through privacy-preserving technologies, generative AI, and health economics, fostering innovation while addressing key challenges. Privacy-preserving technologies ensure patient data confidentiality as AI algorithms analyze retinal images to detect and predict ocular diseases like diabetic retinopathy and glaucoma. Generative AI is revolutionizing personalized treatment approaches and creating synthetic datasets for training, enhancing diagnostic accuracy without compromising data privacy. Meanwhile, the integration of health economics is optimizing resource allocation, making eye care more accessible and cost-effective. These developments not only promise improved diagnostic precision and patient outcomes but also embody a shift towards more sustainable, efficient, and patient-centric healthcare systems globally.	
8:30 AM	Large Language Models in Medicine	Arun Thirunavukarasu, MA, MB Bchir, University of Oxford
	This presentation will discuss the technical basis and development underpinnings of large language models (LLMs) such as GPT-3.5, GPT-4, LLaMA 2, and PaLM 2. The development of LLM applications such as ChatGPT and Google Bard will be described, as well as how LLMs have	

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	been applied in clinical contexts. Benchmarks used to quantify the clinical performance of LLMs will be described, presented, and critiqued. Specifically, caution about drawing conclusions about clinical applications from preclinical data will be emphasised. Comparisons of LLMs with human clinicians will then be described: in ophthalmology this is restricted to examination benchmarks, but general medical advice, clinical reasoning, and note writing have been tested. Opportunities for further research and development will be outlined, such as improving pretraining and fine-tuning with domain-specific data, and designing clinical studies to evaluate novel applications.	
8:45 AM	Large Language Models in Ophthalmology	Ting Fang Tan, MD, LSU Eye Center
	In this segment, we will look at the overview of large language models and understand the various strategies used to optimize LLM performance. We will then explore their opportunities and use cases specific to the field of Ophthalmology. Finally, we will discuss its limitations and explore future directions.	
9 AM	Ophthalmology AI models using electronic health records	Sophia Y. Wang, MD, Stanford University
	This presentation will provide an overview of artificial intelligence models developed for ophthalmology using electronic records data. Highlighted examples in glaucoma will cover the use of structured electronic health records data as well as free-text clinical notes data. The audience members will gain an overview of the particular challenges of and approaches towards working with structured and free-text electronic health records data for AI modeling in the ophthalmology domain, with a particular emphasis towards data quality, feature engineering, and modeling approaches. Strengths and limitations of different modeling approaches will be covered. Considerations for generalizability and fairness will also be discussed.	
9:15 AM	The Power of AI in Glaucoma and AMD: Current State of the Art and the Future	Eleonora M. Lad, MD, PhD, Duke University Medical Center
	This presentation describes the current state of the art of artificial intelligence (AI) efforts in AMD and glaucoma diagnosis and progression prediction. It summarizes the prior studies on diagnostic, quantitative and predictive algorithms. The future of AI in AMD will involve screening of patients with various AMD stages for referrable pathology, diagnosis of entities that mimic AMD to inform need for additional imaging, prediction of staging and conversion from nonexudative to exudative AMD, and monitoring of patients with exudative AMD to predict need for retreatment. The future goals for AI in patient-centered glaucoma management are physician cognitive support in diagnosis, promoting health equity via	

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	teleophthalmology, deployment and successful integration of AI in clinic, including patients' diverse perspectives and resolving the ethical concerns regarding the use of AI regarding data ownership, medicolegal and "black box" nature of algorithms. Generally, the goals of a clinically meaningful software as a medical device are improved clinical outcomes in a racially and ethnically diverse patient population and cohort identification for clinical trial enrollment, among others. The specific elements necessary to reach these future ambitious goals are large, labeled image datasets, validation of models across these diverse datasets, solutions for data sharing to overcome restrictions on data privacy and security, improved knowledge of machine learning development in clinical ophthalmology settings, benchmarking of algorithms for FDA clearance/approval, and resources for successful integration of AI models in clinical practice.	
9:30 AM	Q&A	
9:45 AM	Break	
AAO and ARVO Initiatives for AI and Big Data		
10 AM	Implementing AI in clinical workflow	Leopold Schmetterer, PhD, FARVO, Singapore Eye Research Institute
	Artificial intelligence (AI) has attracted major interest in Ophthalmology in the recent years. Although many papers on disease detection have been published, the clinical use of AI support systems is still very limited. In the present talk some of the obstacles in translating this technology to clinical praxis are discussed. Most AI systems were generated using research datasets rather than clinical datasets. This makes it doubtful how they would work in real world data that may have different disease severity and a larger number of non-gradable images. Another issue relates to cost-effectiveness. For most applications such analysis has not been done and financial planning is difficult for stakeholders. Importantly a "one fits all" solution is most likely not going to work, because of the differences in healthcare systems. This is also related to issues on how to implement AI support systems into clinical workflow. At the end of the day the acceptance of AI solutions by patients will determine on how extensively they will be used.	
10:15 AM	AAO (ophthalmology) initiatives in ocular imaging standardization	Aaron Y. Lee, MD, MSCI, University of Washington
	Imaging standards in ophthalmology are essential for ensuring accurate diagnosis, effective treatment, and consistent monitoring of eye conditions. These standards provide a benchmark	

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	for the quality and consistency of images, crucial for detecting subtle changes in eye structures over time. In conditions like glaucoma, diabetic retinopathy, and macular degeneration, high-quality imaging is vital for early detection and monitoring progression. Standardized imaging also facilitates comparison of patient images over time and across different healthcare providers, enabling a more comprehensive understanding of a patient's ocular health. Moreover, these standards support the development of advanced technologies like artificial intelligence in diagnosing and managing eye diseases, ensuring that these technologies are built on reliable, high-quality data. Thus, imaging standards are fundamental in advancing ophthalmic care and improving patient outcomes. This session will focus on the efforts from the AAO to encourage standards adoption for clinical research and care.	
10:30 AM	AI in Updating the Conventional Eye Grading System	Ramin Tadayoni, MD, PhD, Hopital Lariboisiere-Ophthalmologie
	This presentation discusses the reasons the diabetic retinopathy grading system needs to be updated and how AI can help accelerate the design and implementation of a new grading system. EviRed, the French government funded project addressing exactly this goal will also be exposed.	
10:45 AM	NEI initiatives for AI	Michael F. Chiang, MD, FARVO, National Eye Institute
	This talk will discuss current initiatives at the National Eye Institute related to AI and data science.	
11 AM	Regulatory considerations in the implementation of AI-based devices	Speaker (request pending)
	This talk will discuss the regulatory considerations when implementing AI-based medical devices.	
11:15 AM	Q&A	
11:30 AM	Lunch	
Clinical applications and challenges of AI		

Time	Topic	Speaker
12:30 PM	AI in clinical trials for retinal diseases	Daniela Ferrara, MD, MSc, PhD, FASRS, Tufts University School of Medicine
	The landscape of clinical trials for vision-threatening ophthalmological diseases presents a myriad of intricate challenges for researchers and clinicians alike. This talk delves into the current challenges in drug development and discusses the transformative impact of artificial intelligence (AI) on advancing drug development and optimizing clinical trials in ophthalmology. With a special focus on retinal diseases as illustrative examples, this lecture showcases how AI-driven approaches are revolutionizing the traditional drug development paradigms, offering unprecedented opportunities, from trial design to patient recruitment, from trial conduct to real-time monitoring, to reliable and reproducible outcome measures. The introduction of AI-powered tools has the potential to enhance trial efficiency, reduce costs, and elevate the probability of successful outcomes. The lecture concludes with high level considerations on the translation of clinical trial results into preferred treatment patterns at the point of care, and the evolution of personalized medicine in ophthalmic care, as AI-powered tools decode clinical data to identify imaging biomarkers, predict treatment responses, and optimize therapeutic strategies aiming to improve patient outcomes in the clinical research or clinical practice settings.	
12:45 PM	AI for fluid segmentation	Dinah Chen, MD, NYU Langone Health
	The focus of this talk will be to give a broad overview of the current state of AI applications in fluid segmentation on OCT imaging, with a specific focus on applications fr Age-Related Macular Degeneration (AMD) and Diabetic Macular Edema (DME). It will highlight the potential future applications for clinical trials and clinical practice and use of segmentation models as a foundation for additional model development. It will discuss challenges associated with reference standard generation in the setting of a lack of consensus definitions. Finally, it will touch on practical considerations such as interoperability and integration into clinical workflows.	
1 PM	AI for diabetic retinopathy	Dawn Sim, MBBS, FRCOphth, PHD, Genentech
	Diabetes presents a global health challenge with an estimated 463 million people worldwide currently living with diabetes. This number is expected to climb to 700 million by 2045. Diabetic retinopathy (DR) is a leading cause of new-onset blindness among adults aged 20–74 years with a global DR patient population estimated to reach 160 million by 2045. This talk discusses current uses of artificial intelligence (AI) in the detection of DR in screening programs, the	

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	efficacy of AI-Human partnerships, and potential applications and limitations both in a clinical practice and clinical trials setting.	
1:15 PM	AI in OCT angiography	Yali Jia, PhD, Oregon Health & Science University
	Optical coherence tomographic angiography (OCTA) is a non-invasive imaging modality that provides three-dimensional, information-rich vascular images. With numerous studies demonstrating unique capabilities in biomarker quantification, diagnosis, and monitoring, OCTA technology has seen rapid adoption in research and clinical settings. The value of OCTA imaging is significantly enhanced by image analysis tools that provide rapid and accurate quantification of vascular features and pathology. Today, the most powerful image analysis methods are based on artificial intelligence (AI). While AI encompasses a large variety of techniques, machine-learning-based, and especially deep-learning-based, image analysis provides accurate measurements in a variety of contexts, including different diseases and regions of the eye. In this talk, I will discuss the principles of both OCTA and AI that make their combination capable of answering new questions. I also review contemporary applications of AI in OCTA, which include accurate detection of pathologies such as choroidal neovascularization, precise quantification of retinal perfusion, and reliable disease diagnosis.	
1:30 PM	Predictive analytics in glaucoma	Sally Baxter MD, MSc, University of California San Diego
	In this lecture, I will discuss AI models and predictive analytics in glaucoma, including work that involves electronic health record (EHR) data, imaging data, and multi-modal analyses. I will also review visualization approaches aimed at helping promote explainability, transparency, and trust in AI models for glaucoma. Finally, I will review considerations for clinical implementation of AI in glaucoma, including issues such as data standardization, interoperability, and infrastructure needs for designing point-of-care decision support systems.	
1:45 PM	Health equity and diversity in AI and transparency in reporting	Lama A. Al-Aswad, MD, MPH, NYU Grossman School of Medicine, NYU
	The rapid integration of artificial intelligence (AI) into ophthalmology is revolutionizing the diagnosis and management of eye disease. However, it is imperative to ensure that it doesn't only improve diagnostic accuracy but also promotes health equity and diversity among patient populations. This presentation aims to explore the intersection of health equity, diversity, and transparency in AI-driven ophthalmology, fostering collaboration and innovation in addressing these critical issues.	

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	• Health equity in ophthalmology: Examining the disparities in AI-based eye disease diagnosis and treatment, and strategies to mitigate biases that may exacerbate health inequities. • Diversity in AI datasets: Discussing the importance of diverse and representative datasets in training AI algorithms to ensure fair and accurate outcomes for all patients. • Transparency in AI reporting: Exploring the need for transparency in AI model development, validation, and reporting to build trust among clinicians and patients. • Ethical considerations surrounding AI implementation in ophthalmology. • Clinical Adoption: Challenges and opportunities in integrating AI technologies into clinical practice and the impact on healthcare providers and patients. • By promoting a collaborative approach across multiple disciplines, our goal is to expedite the responsible and fair incorporation of AI technologies into ophthalmic practice, ultimately benefiting patients from diverse backgrounds.	
2 PM	Q&A	
2:15 PM	Break	
Responsible and Explainable AI in ophthalmology		
2:30 PM	ChatGPT Use in Scientific Paper Writing for Ophthalmology	Neil M. Bressler, MD, FARVO, Wilmer Eye Institute
	Artificial intelligence chatbots have arrived and are relatively easy to use. However, their arrival has prompted editors to consider new policies regarding scientific paper writing for ophthalmology that are relevant to editors, reviewers, authors, and readers of the peer-reviewed literature. This presentation will highlight those policies and the rationale behind them, including topics to explain why an AI chatbot cannot be an author and why an AI chatbot is permitted to be used by some journals, e.g., JAMA, JAMA Ophthalmology, and the other JAMA Network of specialty journals, to create content or assist with writing or manuscript preparation.	
2:45 PM	Image Curation for Artificial Intelligence	Amitha Domalpally, MD, PhD, University of Wisconsin, Madison
	Image curation for training deep learning models is an important yet often underestimated aspect of the AI development lifecycle. It is a labor-intensive process yet a fundamental determinant of an algorithm's efficacy in real-world applications. This presentation aims to analyze the nuances of establishing reference standards, essential in creating responsible AI development. Details to generate high-quality ground truth including image formats, metadata,	

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	annotation styles, reproducibility, and advances in the use of AI-assisted labeling will be discussed.	
3 PM	Leveraging AI Powered Systems for Retinal Disease Interrogation and Trial Endpoints	Justis P. Ehlers, MD, Cole Eye Institute, Cleveland Clinic
	This presentation will focus on the opportunities for using AI for evaluating retinal disease features in multiple modalities, such as OCT and UWFA. Through the evaluation and quantification of imaging features new opportunities exist for enhanced characterization of disease prognosis, treatment response, and precision medicine. In addition to clinical care, these systems provide unique opportunities for optimizing clinical trial design, study population enrichment, and identifying potential new endpoints. Examples from multiple diseases will be included, such as diabetic retinopathy and dry age-related macular degeneration.	
3:15 PM	AI and ophthalmic surgery	Theodore Leng, MD, Stanford University
	Artificial intelligence (AI), computer vision (CV) and deep learning (DL) have become important tools in medicine and society in general. This presentation will review how AI can be used to extract data from ophthalmic surgery to evaluate, teach, and aid the surgeon in all phases of surgical management. DL algorithms are being applied to help evaluate and teach surgical trainees. AI and CV tools are improving real-time surgical instrument tracking, phase segmentation, interoperative decision support, and image enhancement, as well as enhancing the safety of robotic-assisted vitreoretinal surgery. CV/DL applications will help push the boundaries of what surgeons can accomplish to improve patient outcomes and increase safety.	
3:30 PM	AI Challenges in Real World Deployment for Ophthalmology	J. “Peter” Campbell, MD, MPH, Casey Eye Inst, Oregon Health Science University
	In this presentation, we will review common translational challenges that may be encountered when developers try to bring artificial intelligence (AI) algorithms out of the development environment and into clinical use. This will include a brief overview of the regulatory oversight of AI technology in the US, and other potential barriers to clinical adoption.	
3:45 PM	Ethics in AI and big data	Emily Y. Chew, MD, FARVO, National Eye Institute
	Artificial intelligence (AI) has the potential to improve clinical research and health care that decreases disparities, lowering cost, and promoting health care by teams. The development of	

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	AI and other machine learning techniques for potential diagnostic and prognosticating purposes, and the use of big data, especially ophthalmic images require thoughtful considerations for fundamental ethical issues of nonmaleficence (physician causing no harm), autonomy and equity. Thus, the collection of data and the implementation of the AI-assisted algorithms need to be conducted in multiple racial groups as well as achieving equality in gender. The challenges with the use of ophthalmic images include the fact that the retinal images are considered biometrics that uniquely identify each individual. These images are considered personally identifiable information (PII) or protected health information (PHI). Protecting our patient's privacy and the integrity of our datasets is essential for researchers who are developing these AI-assisted algorithms, machine diagnostic systems, also called software as medical devices. The work of the subgroup of the Collaborative Community of Ophthalmic Images (CCOI) is focusing on the issue of ophthalmic imaging and the issue of whether these are indeed PHI/PII. This subgroup involved numerous experts including bioethicists, AI-algorithm developers, members of the Food and Drug Administration and other regulatory agencies, industry, patient advocacy groups, clinicians, and their professional societies. The progress of these deliberations will be presented. Discussion of how these conclusions fit into the broad discussion of establishing equitable and autonomous datasets and implementations of AI-assisted medical devices will be provided. Achieving such foundational knowledge will be helpful for future successful introduction into high quality medical care with increased accessibility for all with lower cost.	
4 PM	Privacy Enhancing Technology for Digital Masking for Facial Photos	Haotian Lin, MD, PhD, Zhongshan Ophthalmic Center, Sun Yat-sen University
	The storage of facial images in medical records poses privacy risks due to the sensitive nature of the personal biometric information that can be extracted from such images. To minimize these risks, we developed a new technology, called the digital mask (DM), which is based on three-dimensional reconstruction and deep-learning algorithms to irreversibly erase identifiable features, while retaining disease-relevant features needed for diagnosis. In a prospective clinical study to evaluate the technology for diagnosis of ocular conditions, we found very high diagnostic consistency between the use of original and reconstructed facial videos and comparable diagnostic accuracy was observed. Identity removal validation using multiple-choice questions showed that compared to image cropping, the DM could much more effectively remove identity attributes from facial images. We further confirmed the ability of the DM to evade recognition systems using artificial intelligence-powered re-identification algorithms. Moreover, use of the DM increased the willingness of patients with ocular conditions to provide their facial images as health information during medical treatment. These	

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	results indicate the potential of the DM algorithm to protect the privacy of patients' facial images in an era of rapid adoption of digital health technologies.	
4:15 PM	Q&A	
4:30 PM	Adjourn	