The Bidirectional Relationship between AI and Neuroscience

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Conflicts of Interest disclosure

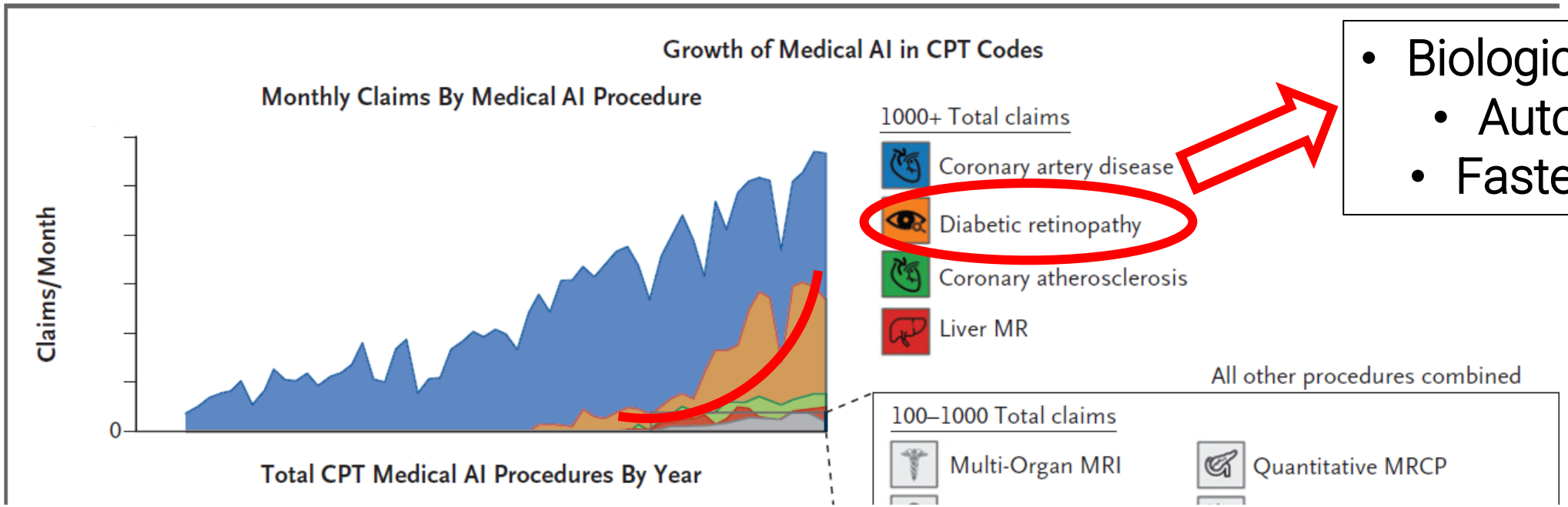
- Digital Diagnostics, Inc, Coralville, Iowa: Founder, Investor, Director, Consultant, Patents and Patent applications University of Iowa: Patents and Patent applications
- Chair, Healthcare AI Coalition, Washington DC
- Treasurer, Collaborative Community for Ophthalmic Imaging
- member, American Academy of Ophthalmology (AAO) AI Committee
- member, AI Workgroup Digital Medicine Payment Advisory Group (DMPAG) of the American Medical Association.

Biomarker-based, autonomous AI diagnosing patients daily

ORIGINAL ARTICLE

Characterizing the Clinical Adoption of Medical AI Devices through U.S. Insurance Claims

Kevin Wu, M.S.,[1] Eric Wu, M.S.,[2] Brandon Theodorou,[3] Weixin Liang, M.S.,[4] Christina Mack, Ph.D.,[5] Lucas Glass, Ph.D.,[5] Jimeng Sun, Ph.D.,[3,6] and James Zou, Ph.D.[1,2,4]



- Biologically inspired
  - Autonomous
  - Fastest scaling

Wu K, Wu C, Theodorou B, Liang W, Mack C, Glass L, et al. Characterizing the Clinical Adoption of Medical AI Devices through U.S. Insurance Claims. NEJM-AI. 2023.

Autonomous AI for the Diabetic Eye Exam

FDA De Novo Authorized, requires a pre-registered clinical trial at arms length.

Fully autonomous AI

ELSEVIER

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Vision Research

journal homepage: www.elsevier.com/locate/visres

Diabetic retinopathy is a neurodegenerative disorder

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ARTICLE INFO

ABSTRACT

- ✓ FDA 'approved'
- ✓ Diagnoses diabetic retinopathy and diabetic macular edema
- ✓ Proven to have no racial/ ethnic bias
- ✓ More accurate than retina specialists
- ✓ Medical liability with the creator

Abramoff et al. Pivotal trail of an autonomous AI-based diagnostic system for detection of diabetic retinopathy in primary care offices. Npj Digital Medicine. (2018)1:39; doi:10.1038/s41746-018-0040-6.

Autonomous vs Assistive AI

Assistive

- Medical decision by clinician
- Liability for clinician
- Patient already in care workflow
- Real world value:

~ outcome improvement for existing patients

Autonomous

- Medical decision by “computer”
- Liability for AI creator
- Point of Care and Immediate
- Can be ‘added’ wherever patient is
- Real world value:

~ outcome improvement for patients & populations – i.e. address health inequity

Abramoff, Cunningham, Patel, Eydelman, et al. "Foundational Considerations for Artificial Intelligence ", Ophthalmology (2021). https://www.aaojournal.org/article/S0161-6420(21)00643-6/fulltext.

Mitigating Racial Bias in AI

Google's Gemini (a Generative AI): advertent bias

Sure, here is an image of an early European explorer:

Generate more

Proven patient harm from inadvertent AI bias

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RESEARCH ARTICLE

Dissecting racial bias in an algorithm used to manage the health of populations

ZIAD OBERMEYER, BRIAN POWERS, CHRISTINE VOGELI, AND SENDHIL MULLAINATHAN Authors Info & Affiliations

SCIENCE · 25 Oct 2019 · Vol 366, Issue 6464 · pp. 447-453 · DOI: 10.1126/science.aax2342

99,452 1,263

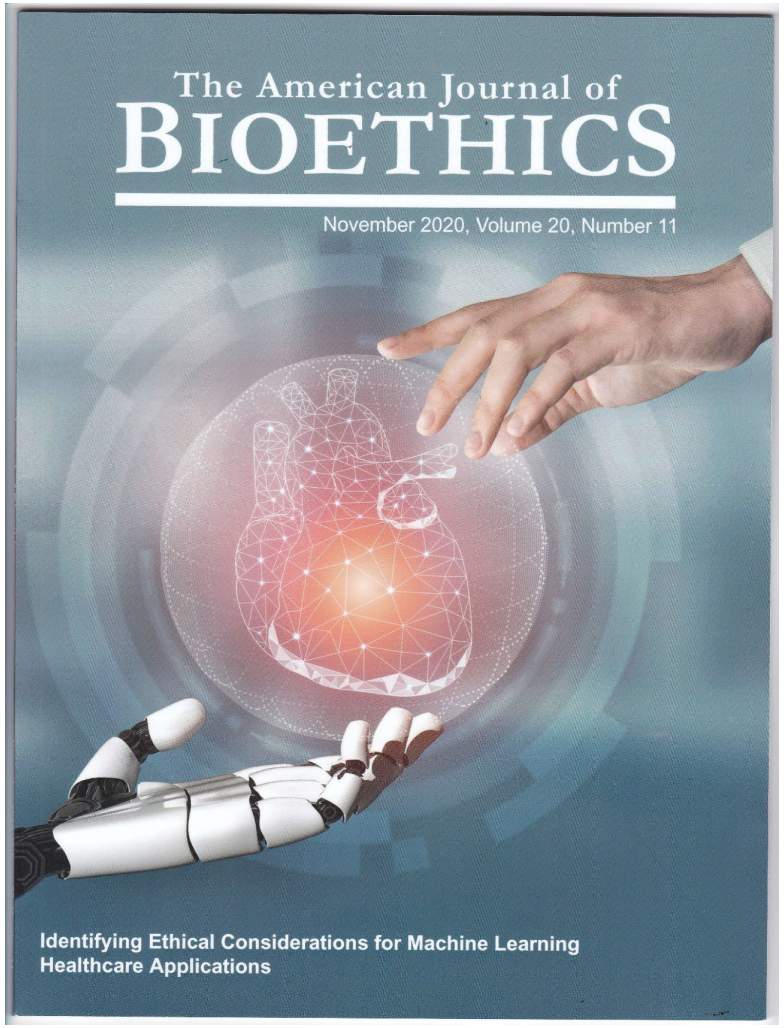
Racial bias in health algorithms

The U.S. health care system uses commercial algorithms to guide health decisions. Obermeyer *et al.* find evidence of racial bias in one widely used algorithm, such that Black patients assigned the same level of risk by the algorithm are sicker than White patients (see the Perspective by Benjamin). The authors estimated that this racial bias reduces the number of Black patients identified for extra care by more than half. Bias occurs because the algorithm uses health costs as a proxy for health needs. Less money is spent on Black patients who have the same level of need, and the algorithm thus falsely concludes that Black patients are healthier than equally sick White patients. Reformulating the algorithm so that it no longer uses costs as a proxy for needs eliminates the racial bias in predicting who needs extra care.

Ziad Obermeyer *et al.* Dissecting racial bias in an algorithm used to manage the health of populations. *Science* **366**,447-453(2019)

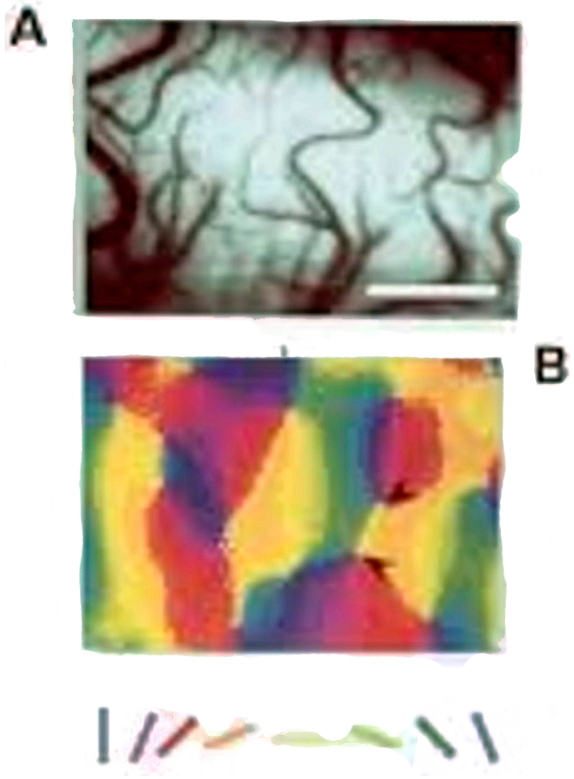
Ethical Framework for AI

» Bioethical principles
  - Non-maleficence
  - Autonomy
  - Justice (equity)
  - Responsibility



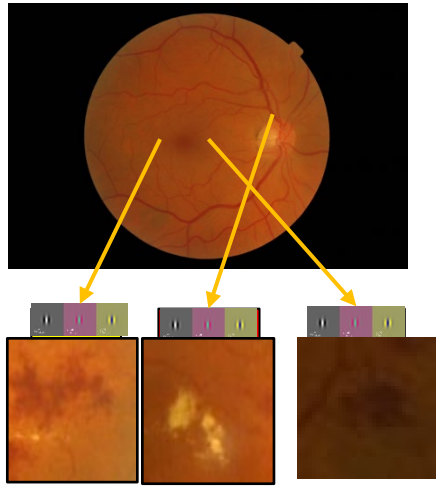
Abramoff MD, Tobey D, Char DS. Lessons Learned About Autonomous AI: Finding a Safe, Efficacious, and Ethical Path Through the Development Process. Am J Ophthalmol. 2020;214(1):134-42.
Char DS, Abràmoff MD, Feudtner C. Identifying Ethical Considerations for Machine Learning Healthcare Applications. The American Journal of Bioethics. 2020;20(11):7-17.

Mimic cortical processing of clinicians as much as possible



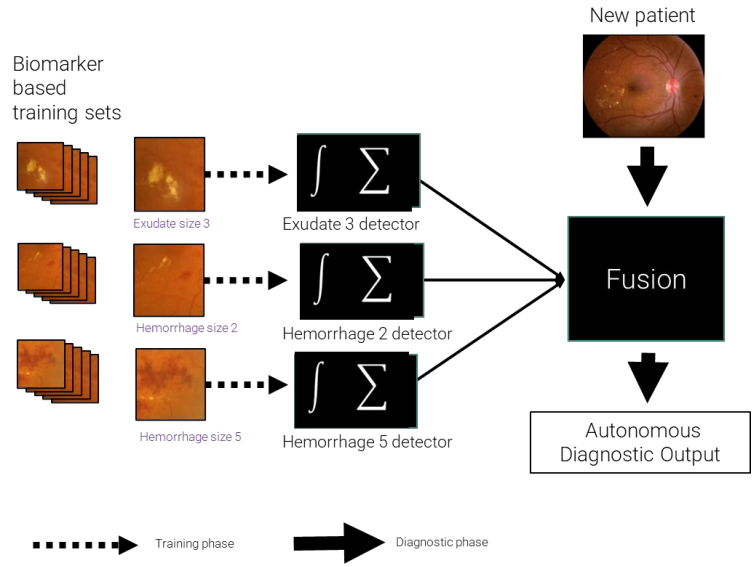
V1 cortical column orientation

Non-orthogonal biomarker detectors



Convolutional Neural Networks

Manifold Foundational Model



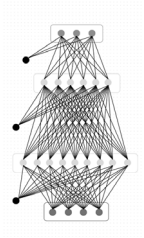
Robust against racial bias
Explainable
Unit level testing
Robust against adversarial attacks
Computational complexity < 10^26 FLOPs (Presidential EO 2023)

Abramoff et al, IOVS 2007
Lynch et al, ARVO 2018
Finlayson et al, Science, 2019
Bonhoeffer, Grinvald. Nat. 1991

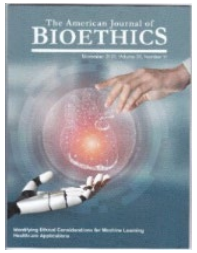
Nat Dig Med 2018
Shah et al, Proc ISBI 2018
Larrazabal et al,, PNAS 2020

Creating the Guardrails for Autonomous AI in Healthcare

'Diagnostic AI Algorithm' | Ethical Foundation for AI | Clinical trial design | Solving liability | (Racial) bias mitigation | Standards of Care | Value Based Care | Reimbursement | Real world evidence



Biomarker based AI



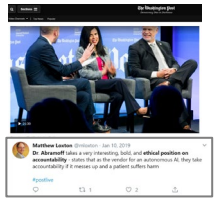
Ethical Foundations (2020)

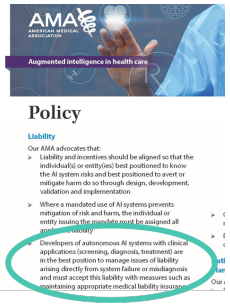
Regulatory framework

FDA

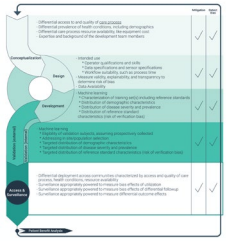
First FDA de novo clearance (2018)

Second FDA clearance with 510k (2020)





AMA AI Policy 2019



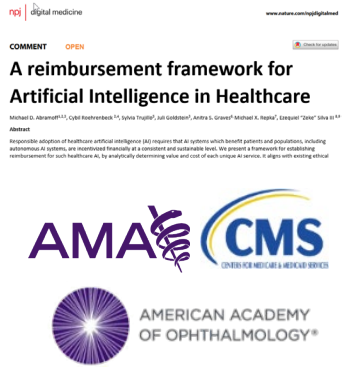
Concept to validation

American Diabetes Association.

Standards of Medical Care in Diabetes (2019)

NCQA

HEDIS-MIPS care gap closure with autonomous AI



AMA CMS

AMERICAN ACADEMY OF OPHTHALMOLOGY

First ever CPT Code 92229 (2019)

Nationwide Medicare Payment

Blended rate ~$79

Randomized Clinical Trials:

- Increase health equity
- Increase in physician productivity
- Lower cost
- Improved clinical outcomes

American Diabetes Association. 11. Microvascular Complications and Foot Care: Standards of Medical Care in Diabetes – 2020. Diabetes Care; 43(Supplement 1): S135-S151, 2020. https://www.ncqa.org/wp-content/uploads/2020/07/20200701_Summary_Table_of_Measures_Product_Lines_and_Changes.pdf
https://www.ama-assn.org/practice-management/digital/ophthalmologist-doing-health-care-ai-right-way
https://www.aaojournal.org/article/S0161-6420(21)00643-6/fulltext