



Opportunities to leverage Machine Learning in Oncology

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Clinical Research Scientist

Disclosures: I am an employee of Google and own Alphabet stock.

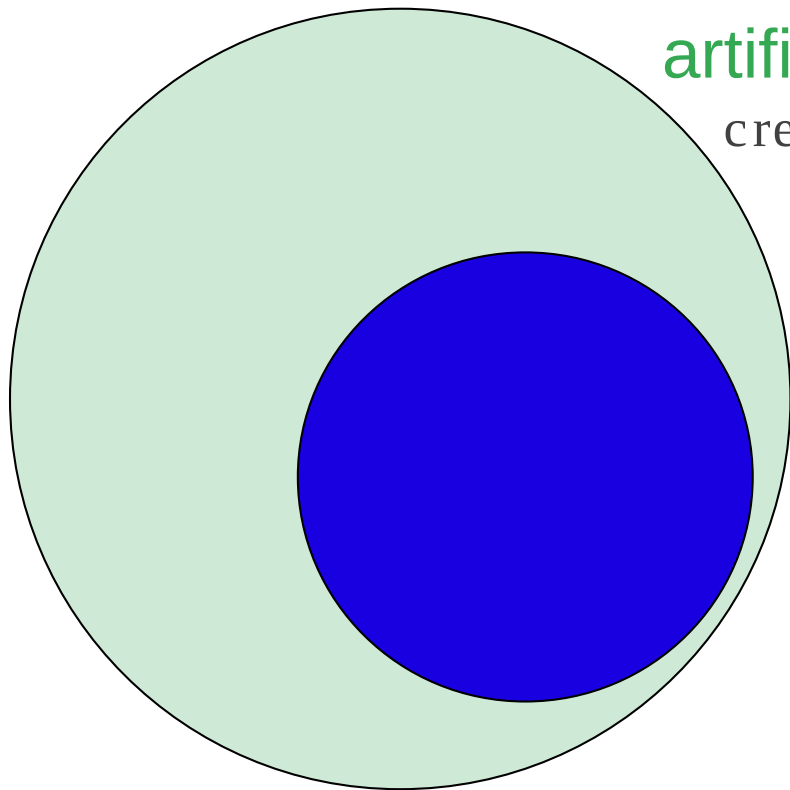
Machine learning in healthcare

- Methods
- Opportunities and examples
- Shared Vision

Analytical methods

artificial intelligence

creating smart systems

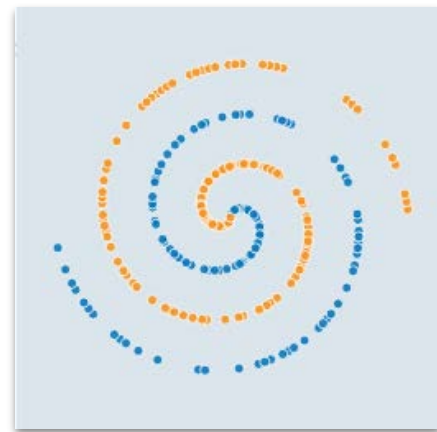
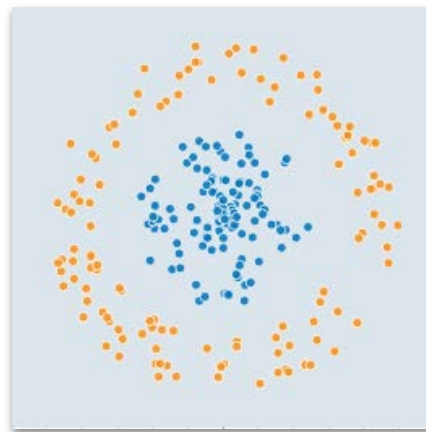
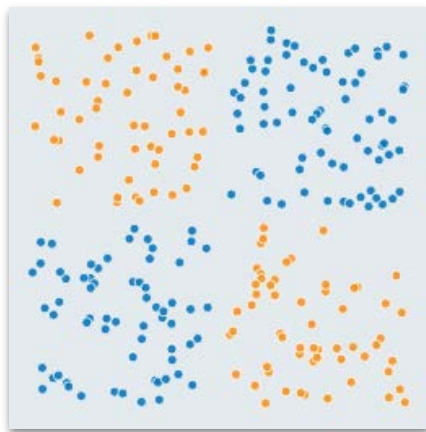
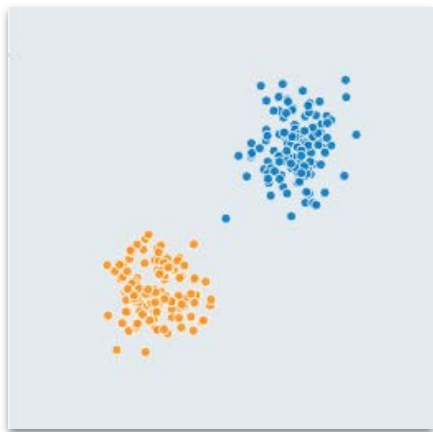


machine learning

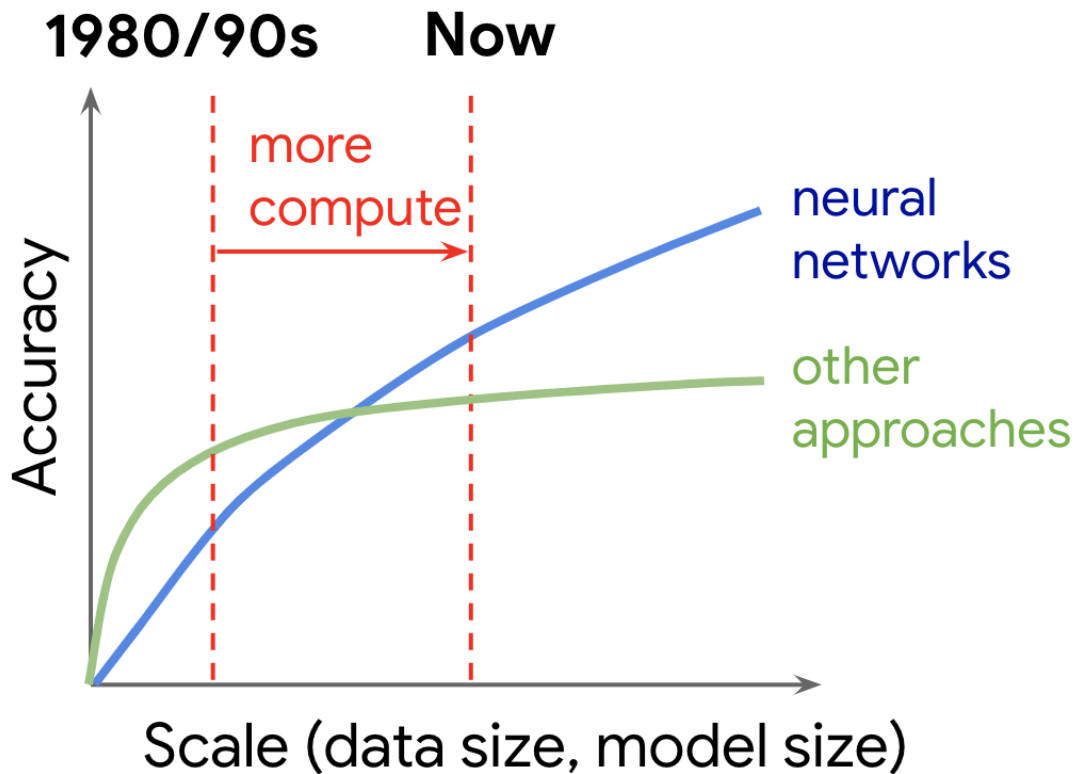
techniques to learn from data to develop
smarter and more adaptable systems

Analytical methods

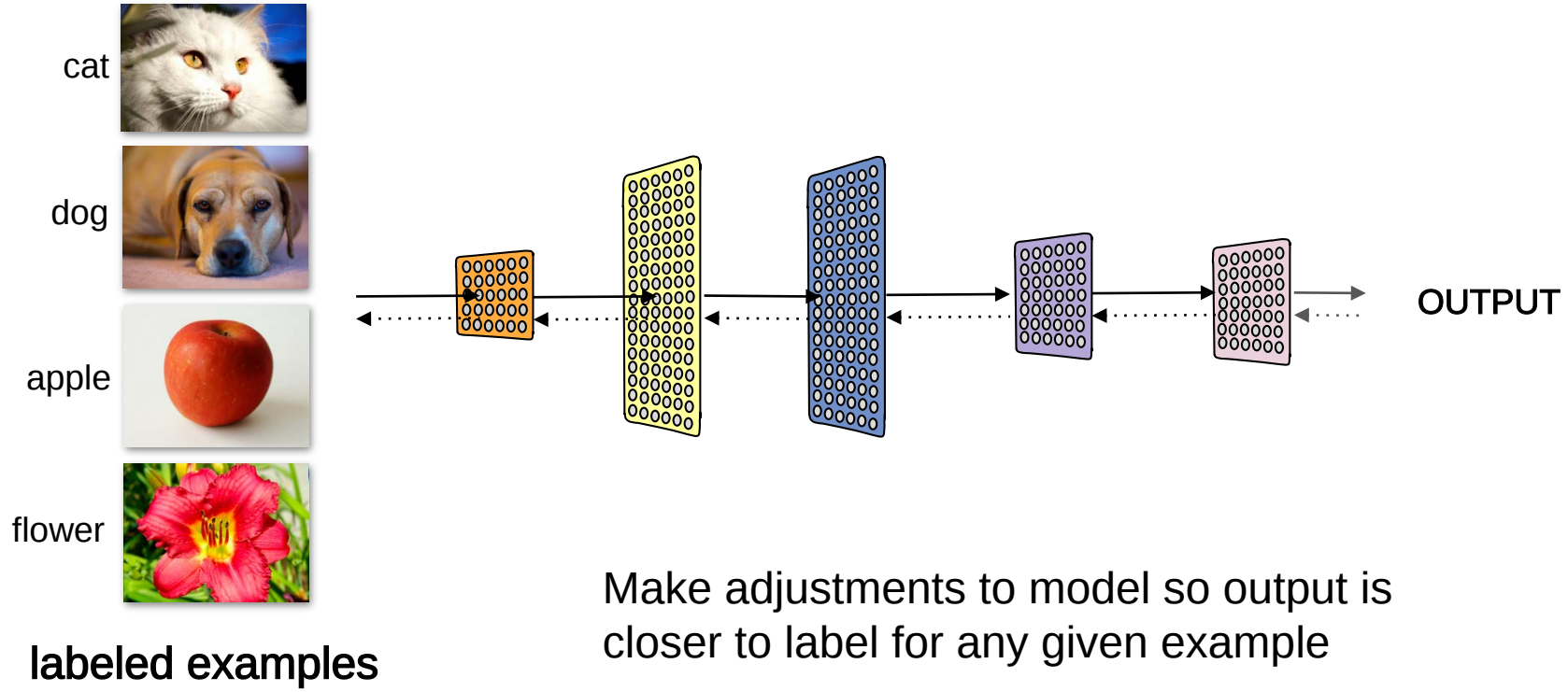
Capacity to learn complex relationships



AI and neural networks - why now?



Neural networks learn from examples

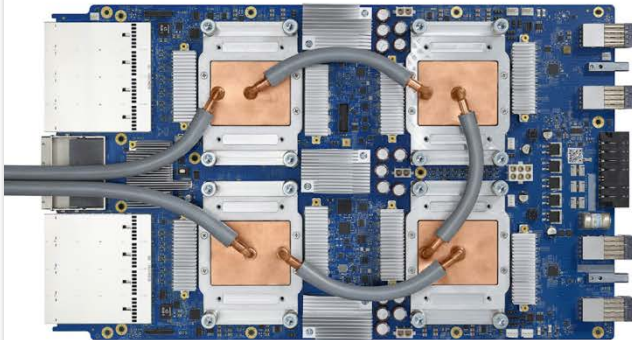
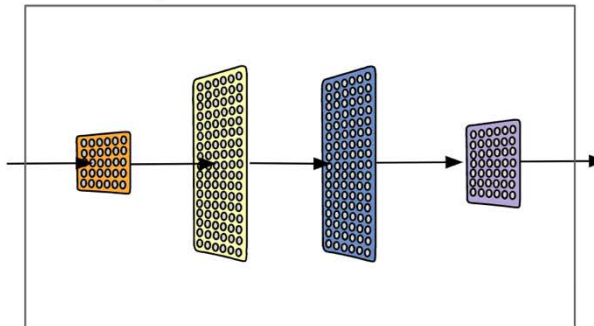


Supervised Machine Learning requires:

training examples



algorithms and tools

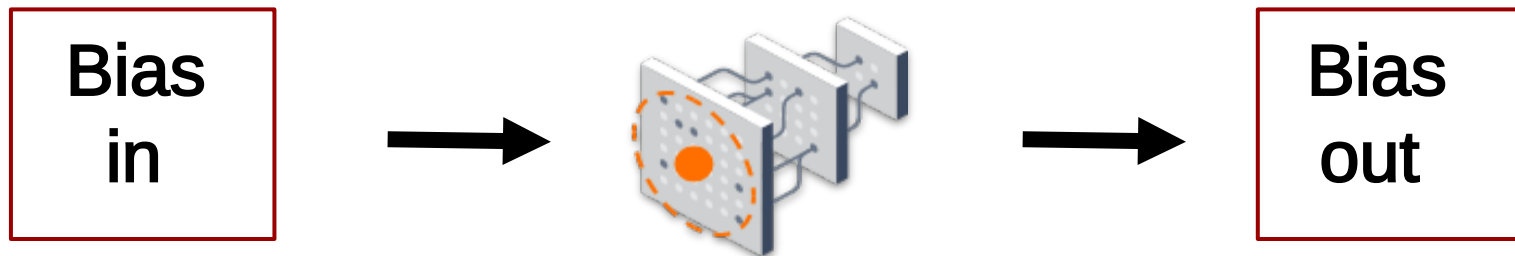


computational resources



creativity and ingenuity

Potential to perpetuate bias...



System is able to learn, improving at a task with experience
...but it only learns what it sees.

Potential to address bias too...

SPECIAL ARTICLE

Annals of Internal Medicine

Ensuring Fairness in Machine Learning to Advance Health Equity

Alvin Rajkomar, MD*; Michaela Hardt, PhD*; Michael D. Howell, MD, MPH; Greg Corrado, PhD; and Marshall H. Chin, MD, MPH

“Consideration of fairness in machine learning allows us to reexamine historical bias and proactively promote a more equitable future.”

Correct bias in the data

*Ensure proper representation of minority groups in training **and** validation*

Correct bias in the model design

*Labels should be adjudicated truths
(i.e. using the delphi method)*

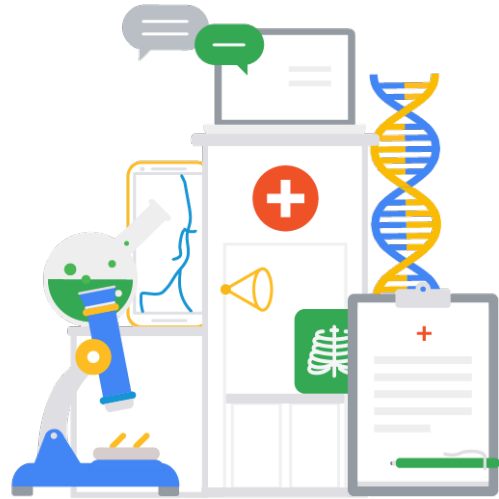
Ensure equal outcomes & resource allocations when using AI

Developing and validating **healthcare** models

Many unique challenges

1. Ground Truth and benchmarks
2. Validation and generalizability
3. Understanding context
4. Integration and actionability
5. Transparency - understanding and learning from the models

Google Health



150

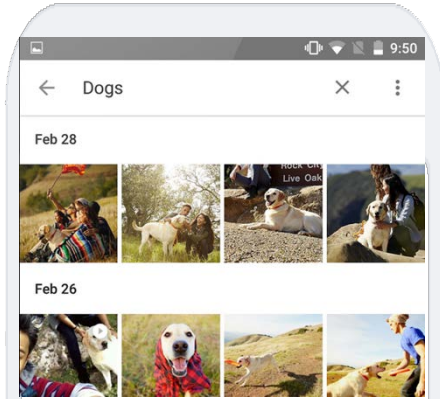
exabytes of healthcare data

1000x all data we've indexed on the internet

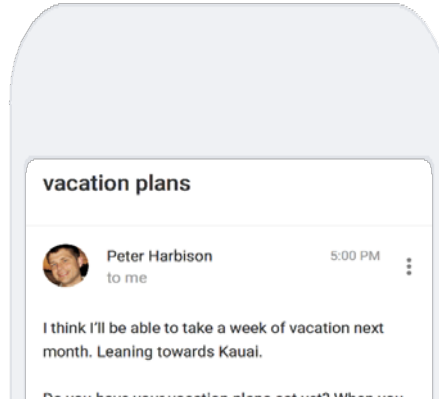
AI research and development is a cornerstone of our work



Photos



Gmail



Translate



Google AI Principles: for responsible development

AI should:

- 1 be socially beneficial
- 2 avoid creating or reinforcing unfair bias
- 3 be built and tested for safety
- 4 be accountable to people
- 5 incorporate privacy design principles
- 6 uphold high standards of scientific excellence
- 7 be made available for uses that accord with these principles

applications we will not pursue:

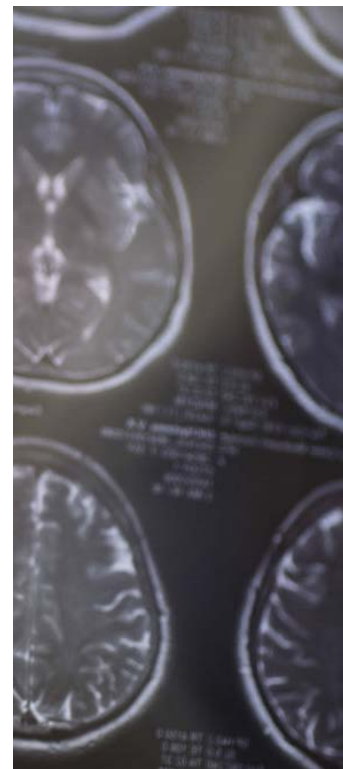
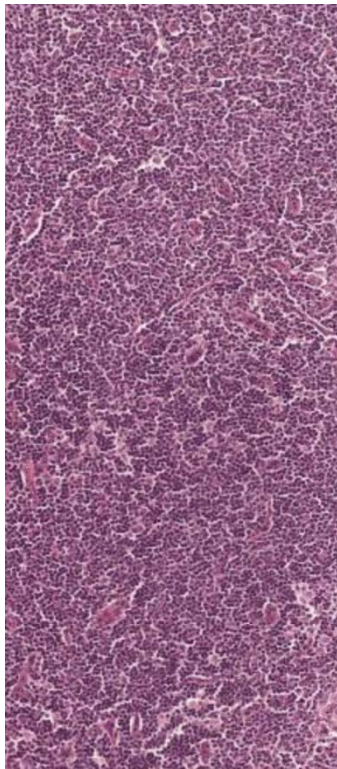
- 1 likely to cause overall harm
- 2 principal purpose to direct
- 3 ~~injury~~ surveillance violating internationally accepted norms
- 4 purpose contravenes international law and human rights

Opportunities in oncology

Democratizing Expertise

Actionable Information

Discovery and Translation

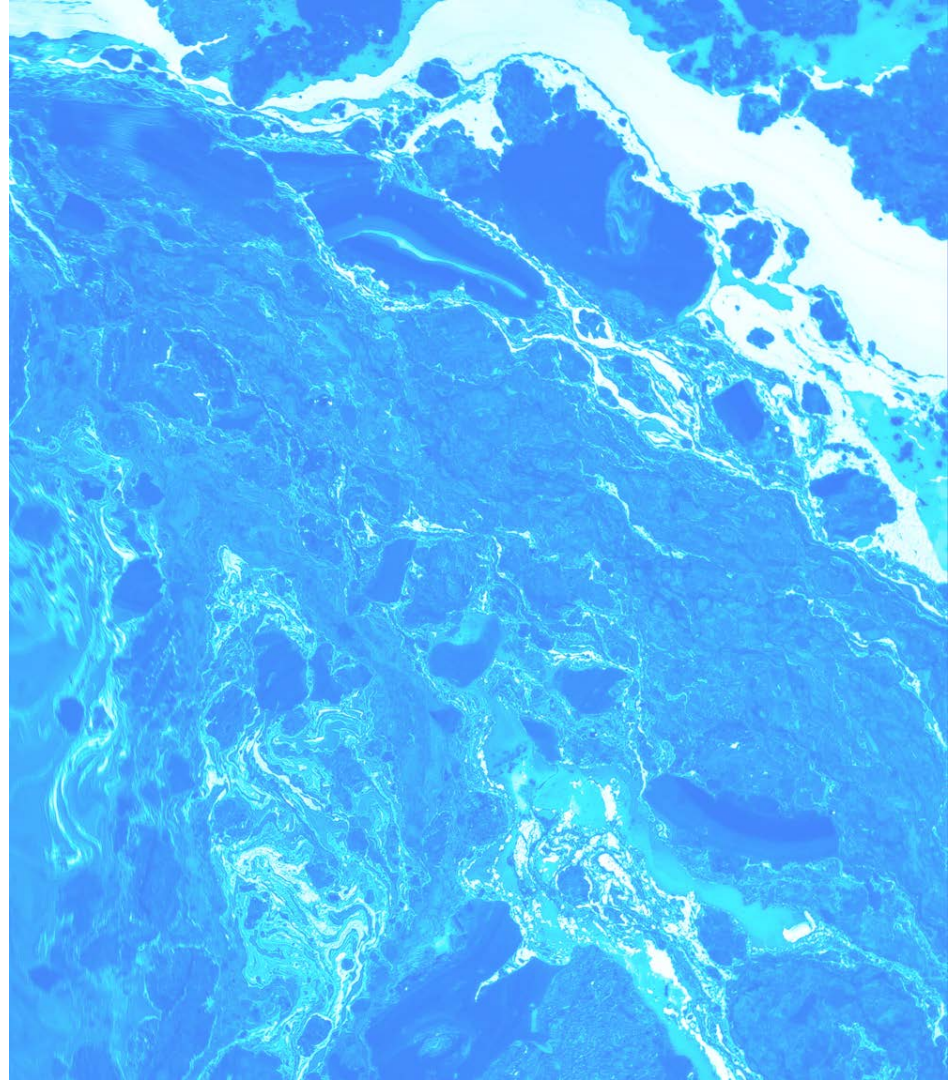




Democratizing Expertise

Access to expert care everywhere

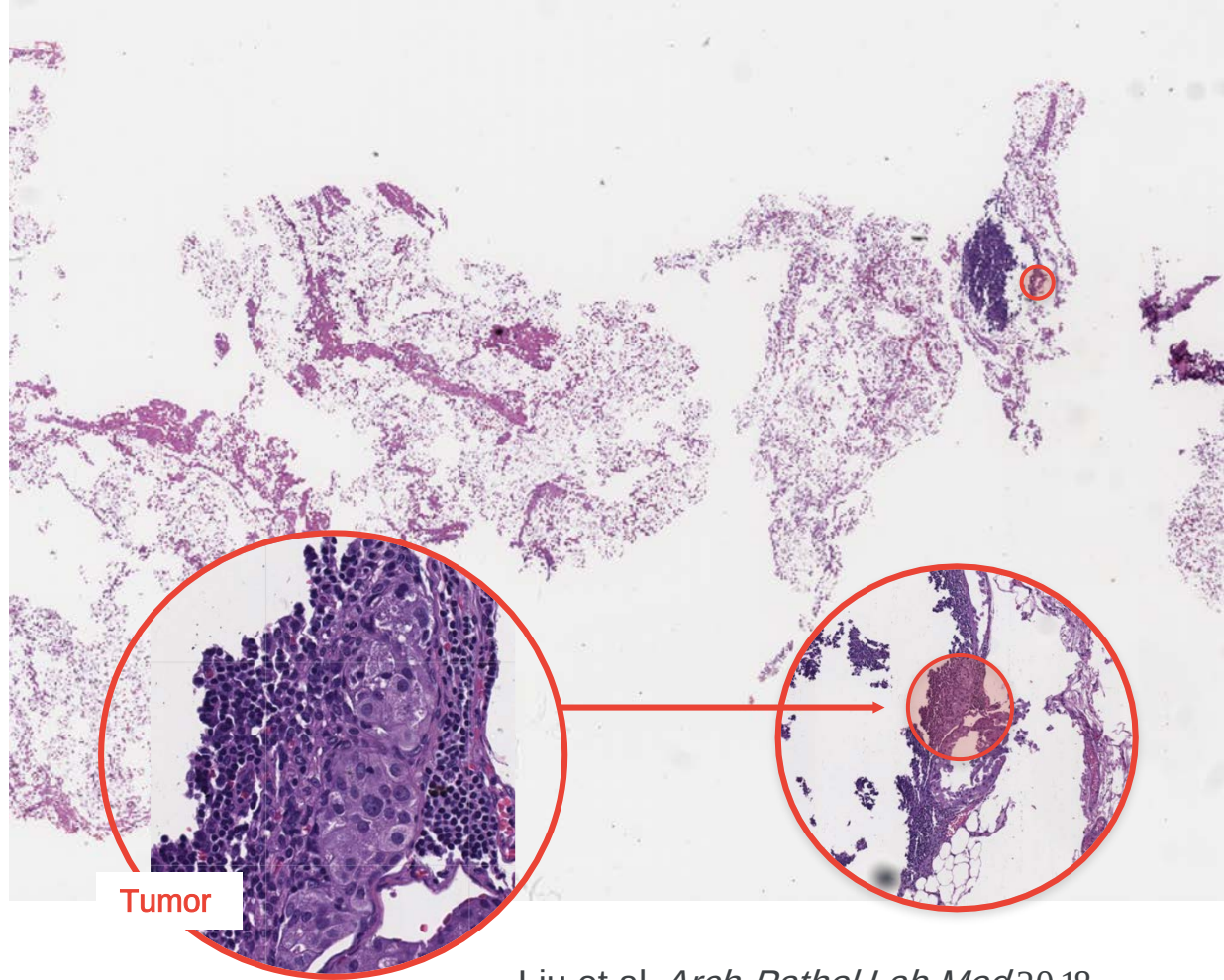
Pathology



Detection can be a needle in a haystack problem

10 gigapixel whole slide images

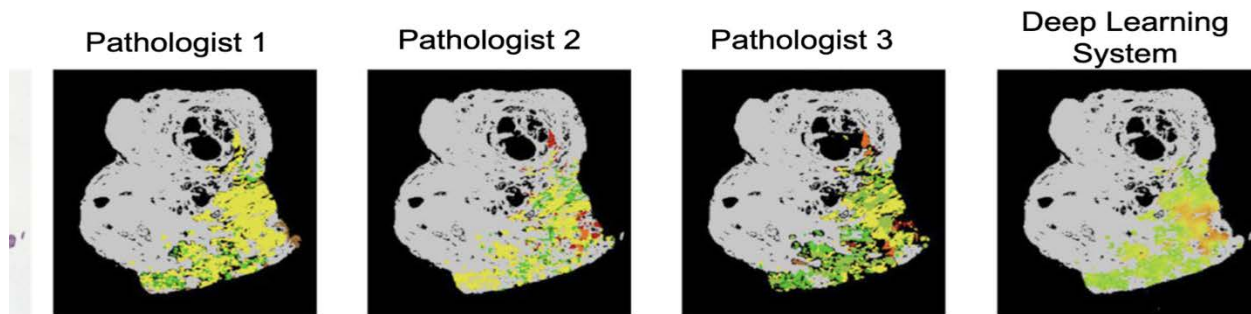
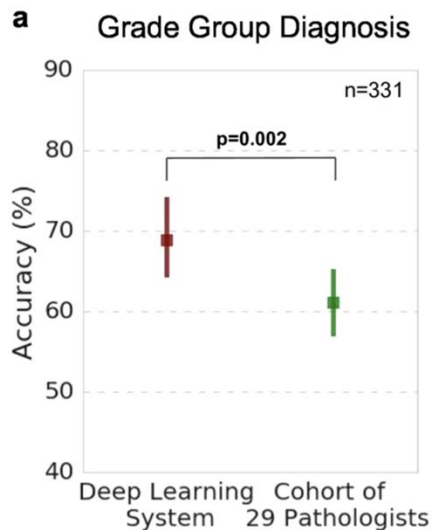
Combination of
pathologist + model
more accurate than
either alone



Liu et al. *Arch Pathol Lab Med* 2018
Steiner et al. *AJSP* 2018

Deep learning to identify and grade prostate cancer

Deep Learning System similar to pathologist interpretation



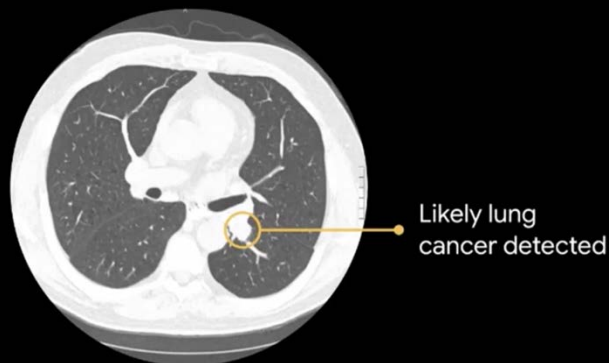
Radiology



End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest computed tomography

Diego Ardila^{1,5}, Atilla P. Kiraly^{1,5}, Sujeeth Bharadwaj^{1,5}, Bokyung Choi^{1,5}, Joshua J. Reicher², Lily Peng¹, Daniel Tse^{1*}, Mozziyar Etemadi³, Wenxing Ye¹, Greg Corrado¹, David P. Naidich⁴ and Shravya Shetty¹

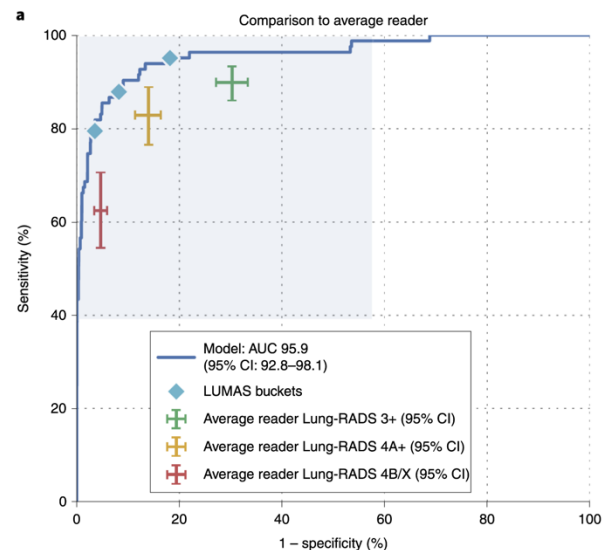
(Nature Medicine 2019)



Initial scan with AI detection

Compared to 6 radiologists, the model had an absolute **reduction** of

- ↓**11%** in false positives
- ↓**5%** in false negatives



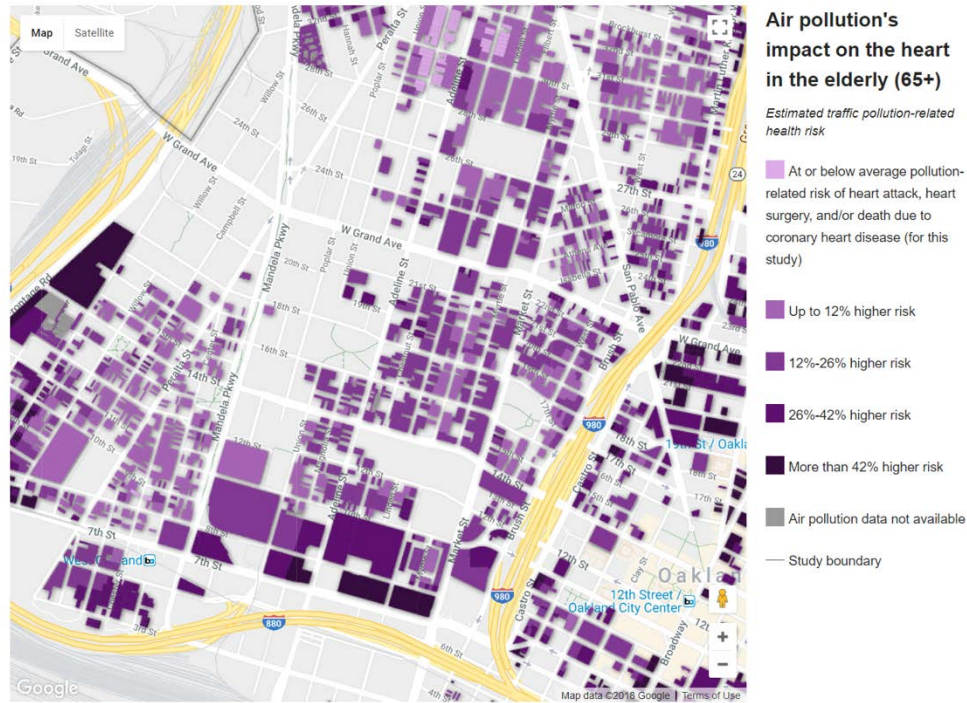


Actionable Information

Elevating public health

2018: Health Impact study

West/Downtown Oakland Study Area



East Oakland Study Area



Health Impacts in Oakland, CA (from diesel trucks and other sources)

www.edf.org/airqualitymaps/how-pollution-impacts-human-health





easternhealth

Analyzing records from ambulances
to uncover trends and potential
points of intervention around suicide

Discovery and Translation

Understanding health and disease.
Translating from code to care.

Shared vision:

Cooperatively exploring the complex data landscape...

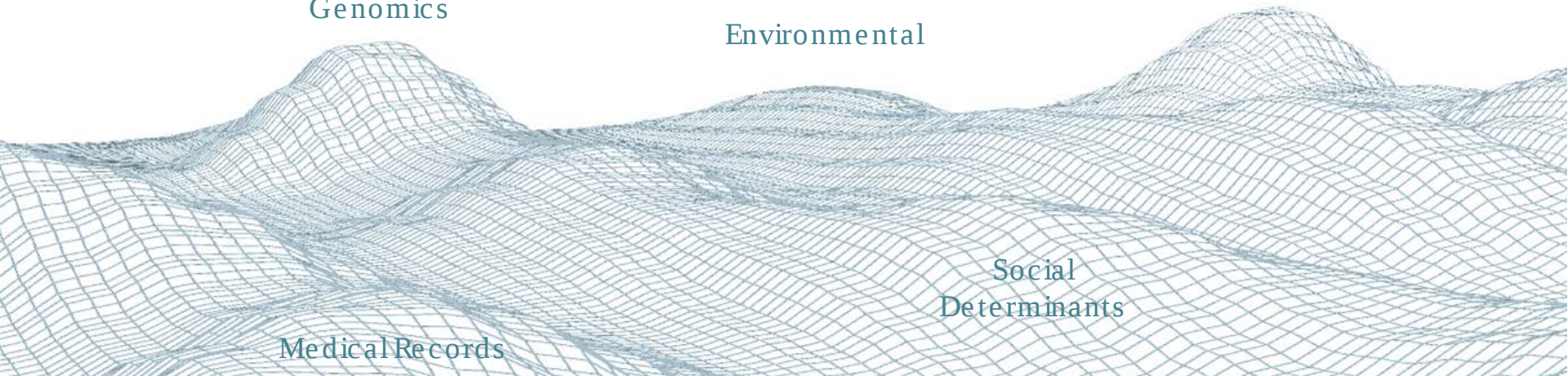
Genomics

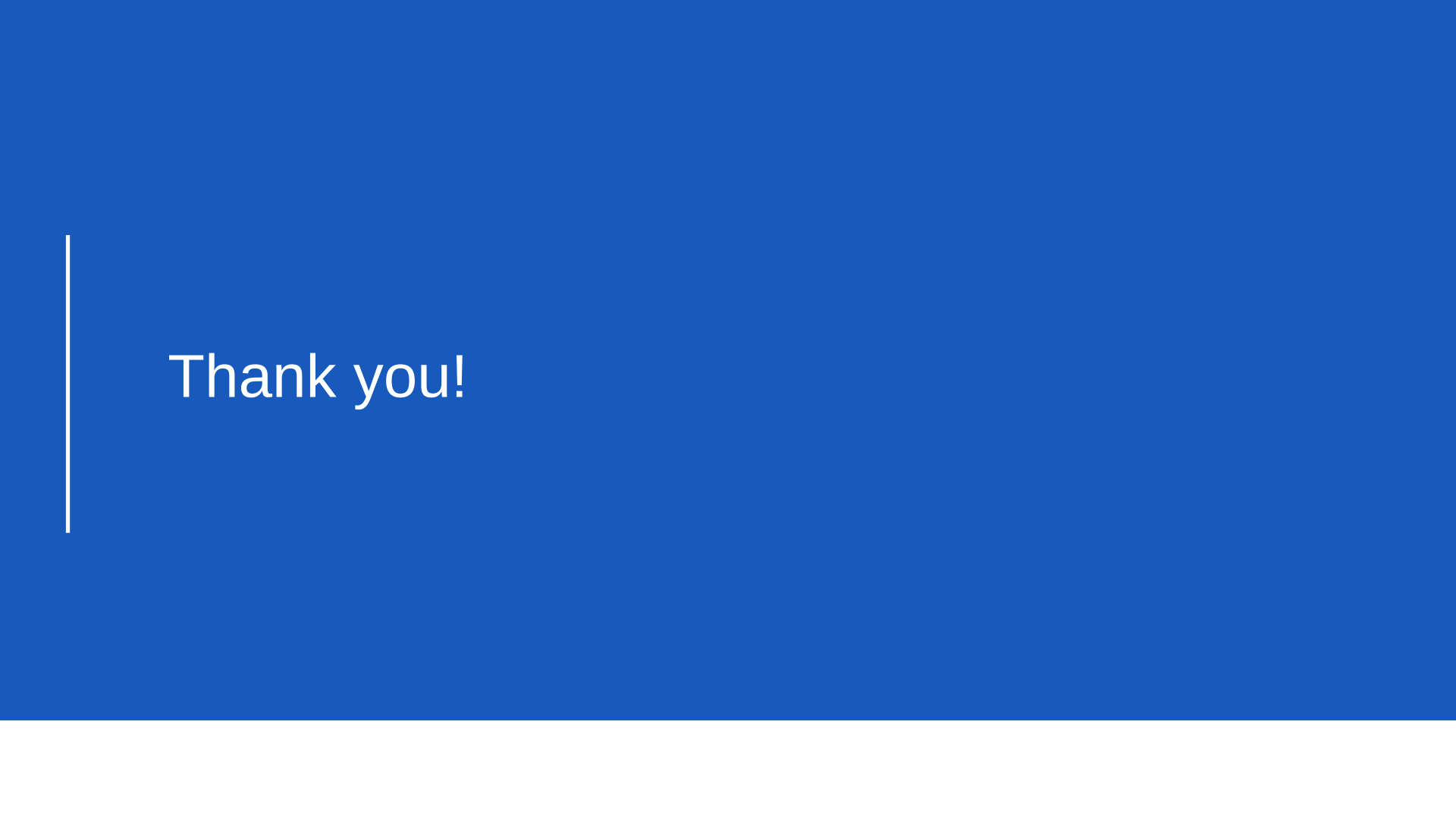
Environmental

Medical Images

Social
Determinants

Medical Records





Thank you!

