Artificial Intelligence: Impact on Technology Transfer

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Transforming Ideas into Opportunities

Moderator

Anna Solowiej is Senior Licensing and Patenting Manager at the National Institutes of Health (NIH), advising NIH scientists about patenting their inventions and negotiating licenses as well as diverse collaboration agreements.

Previous experience:

- Patent attorney, specializing in prosecution in the biotechnology and medical devices areas.

Education and training:

- Ph.D., Yale University, Cellular and Molecular Physiology.
- J.D., The George Washington University School of Law.
- Admitted to practice in MA, DC, and before the USPTO.

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Introduction

- The term **AI** was coined in 1955/56 by John McCarthy at a Dartmouth conference, and some of the first AI patents have been filed in the early 1980s in Japan, we are experiencing a rapid growth of AI and related technologies.
- For example, over 50% of all AI-related patents have been filed since 2013.
- See WIPO's AI Trends from January 2019 for interesting and comprehensive statistics. https://www.wipo.int/publications/en/details.jsp?id=4386

Panelists/Thought Leaders

Cindy Chepanoske is a Senior Manager, Business Development and Licensing at Carnegie Mellon University. Since 2012, she supports licensing and patent management activities for departments in the school of computer science, including human computer interaction, computational biology, and machine learning.

Previous experience:

- Program Manager and Director of Informatics Services at Ceiba Solutions (acquired by Perkin Elmer).
- Senior Application Scientist at Rosetta Biosoftware (acquired by Microsoft)

Education and training:

- Postdoctoral appointment, Lawrence Livermore National Lab
- Ph.D., University of Utah, Chemistry
- B.S., Carnegie Mellon University, Chemistry

Panelists/Thought Leaders

Jackson Ho is Of Counsel at the law firm of Innovation Counsel LLP, where his practice is focused on patent prosecution. Jackson has broad patent experience including working in patent prosecution, litigation, licensing, due-diligence, and *inter partes* reviews.

Previous experience:

- Partner at K&L Gates LLP.

Education and training:

- B.E., Cooper Union, Chemical Engineering.
- Ph.D., Cornell University, Cellular and Molecular Biology.
- J.D., University of Chicago.
- Admitted to practice in CA and before the USPTO.

Panelists/Thought Leaders

Tracy Harrison is the lead commercial counsel for the Google Health as well as the Google Accelerated Science team.

Previous experience:
Verily Life Sciences (f/k/a Google[x] Life Sciences)
Cooley LLP
Gilead Sciences, Inc.
Yale University, Office of Cooperative Research
M.I.T., Technology Licensing Office

Education and training:
B.S. (Biology), M.I.T.
M.S. (Experimental Pathology), Yale University
J.D., Certificate in Intellectual Property, University of Connecticut School of Law
Admitted to practice in CA

AI: Impact on Technology Transfer

Cindy Chepanoske

Carnegie Mellon University
Center for Technology Transfer and Enterprise Creation

AI- A beginning for the END

- What is AI and why do we care?
- AI from a technology transfer perspective
  - Some terminology and platforms
  - New opportunities for licensing

What is Artificial Intelligence?

- Understand the world, make smart decisions
- Build using multiple types of technologies, across disciplines



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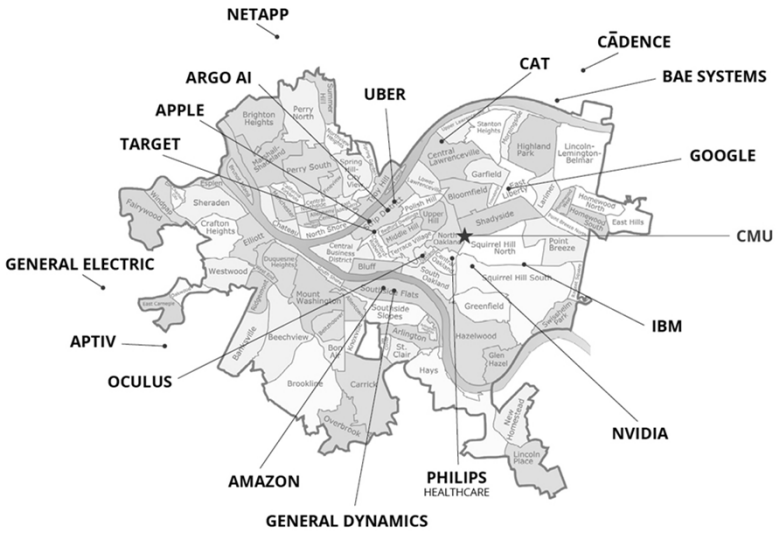
Why is AI important to Universities?

- Enable next generation of workforce
- CMU was the first university to offer a bachelor's degree in AI (Fall 2018)
- Create new industries
- Reinvigorate and re-imagine "old" or commodity industries
- (Value in the buzzwords)

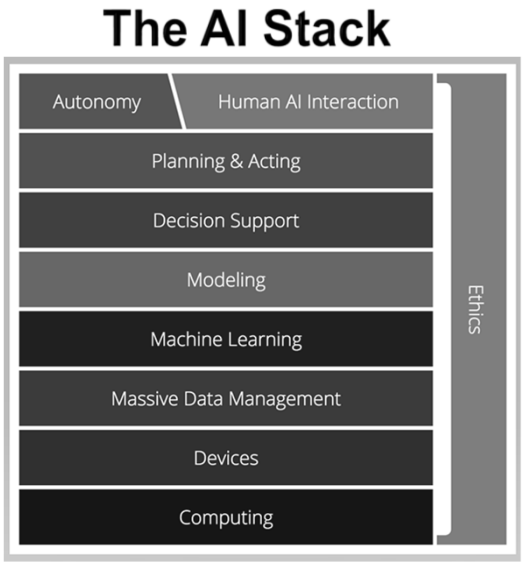

Transform Your Neighborhood



AI From a Tech Transfer Perspective

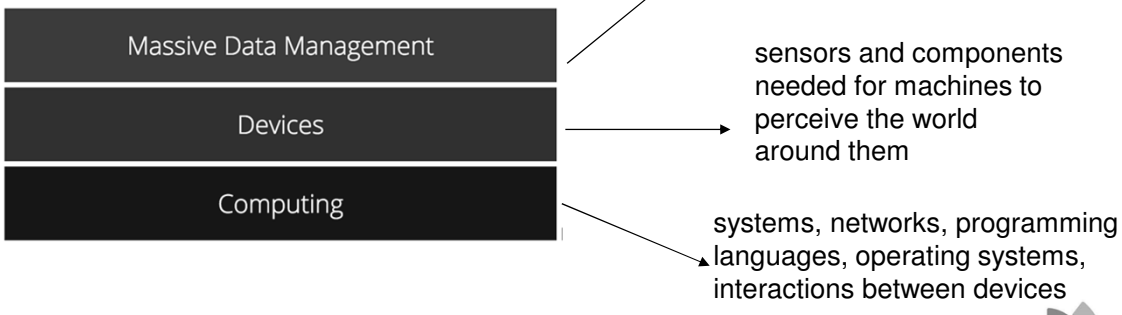
- Leverage the AI Stack
- Terminology and platforms- What does it all mean?
- Agreements- How are they changing?

AI: A View From the Top

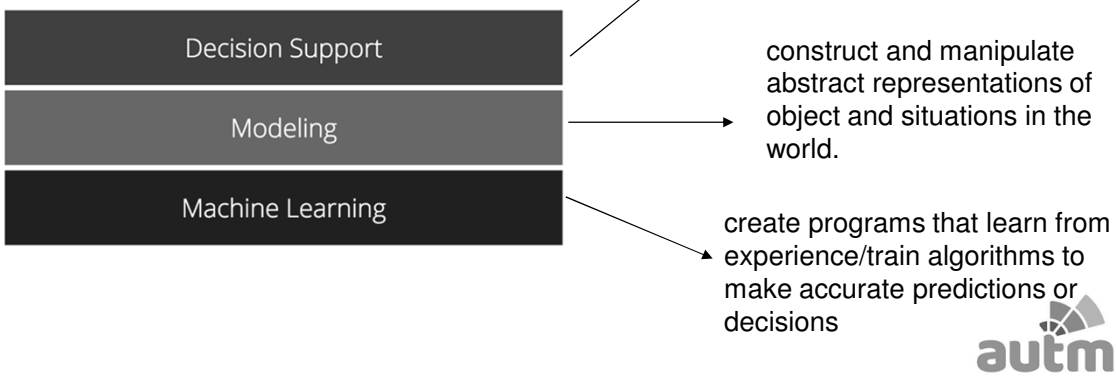


https://ai.cs.cmu.edu/

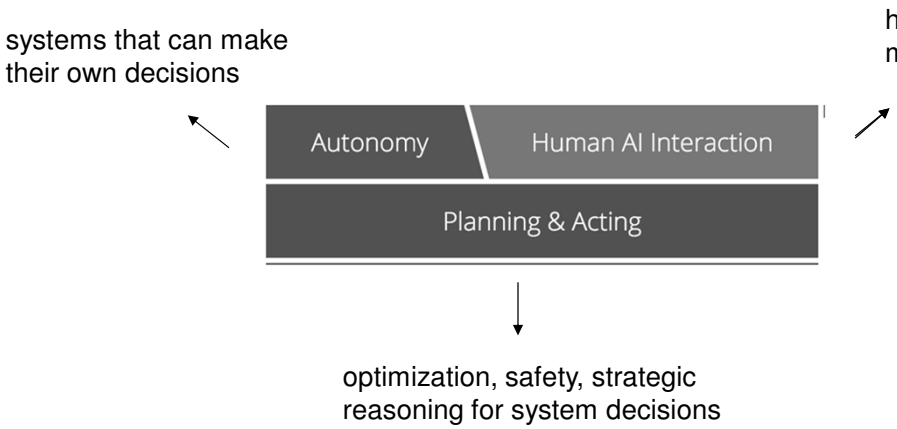
The AI Stack from the Ground Up



The AI Stack from the Ground Up



The AI Stack from the Ground Up



ETHICS surround it all

Terminology and Platforms

- Machine Learning (ML) and Deep Learning (DL)
- Three types of ML include supervised, unsupervised, reinforcement learning
- Supervised learning- classification
  - *Requires labeled data*
  - *Learn the rules to correctly classify the "future case"*
- Unsupervised learning- clustering (eg k-means, gaussian mixture models)
  - *Data is not labeled*
  - *Find interesting clusters*

Terminology and Platforms

- DL is a subset of ML
  - Automatically discover features to be used for classification; draw conclusions
    - discover underlying structure, semantic relationships constraints, or invariances from data.
  - Models are composed of several layers of nonlinear processing
  - Great YouTube tutorial from 3Blue1Brown series "what is a neural network"

Terminology and Platforms

Common frameworks – Open Source

- TensorFlow (Google) Keras API
- Caffe PyTorch

Everyday examples of ML and DL

- Information retrieval (Google, Apple)
- Automatic speech recognition (ASR), text and image retrieval image tagging (YouTube, Facebook)
- Facial recognition (Apple, Facebook)
- Product recommendations (Netflix, Amazon)
- Autonomous Vehicles (Uber, Google, BMW)

Licensing Considerations

- What's the valuable IP- the algorithm, its implementation, a data set?
- Are there constraints on the dataset used and/or collected?
  - Model files accompanying software will be dependent on the datasets
- Explore commercialization for software code, libraries, and/or annotated data sets with non-traditional models

Express Licenses- Annotated Data Sets and Software

Motivation

Monetization opportunity: software available on GitHub under a noncommercial academic use license

Streamlining opportunity:

- Negotiating license terms for smaller value licenses ($5K-$25K) is time consuming
- Can execution and payment process be improved?

Success using Flintbox for distribution

- Includes support for payment, click-through licenses, etc.

Flintbox Example : Annotated Databases

- PIE and FIA: Seminal databases used in facial recognition research
  - developed in 2010
- Large format (>300Gb) required* distribution on a dedicated hard drive
- Click-through license
- License income (to date) = $>400K

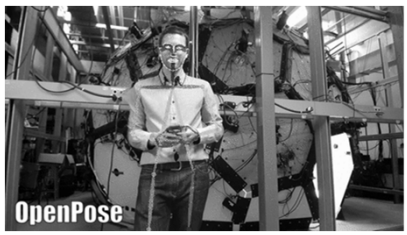
*In 2010

Toward a Standard Express License

- Create a model license template for a non-exclusive license for software code to make derivatives, dispose or incorporate into a commercial product
  - Renewable, annual fee
  - What are the absolute minimum terms required?
- Create site to convey expectations for non-negotiable terms

OpenPose and OpenFace

- First offerings for an “express” NE software license
- OpenPose library for real-time multi-person keypoint detection
  - Annual fee= $25K
  - Offered Sept 2017
  - License income generated to date = $875K



OpenPose and OpenFace

- OpenFace
  - toolkit for building interactive applications based on facial behavior analysis
  - Annual fee= $10K-$18K
  - Offered April 2018
  - License income $135K

- Plans for other libraries coming soon!

Key Points from License Requirements

- **Subject and conditioned upon receipt of annual minimum license fee**, license to use the software and to create derivatives for the sole purpose of making licensed products
- License is null/void if not paid in 10 days
- Licensee cannot assert derivatives against CMU
- Termination section fully contemplates non-renewal of Annual Term, bankruptcy/closing of Licensee
- CMU has a right to terminate with notice
- Standard no warranty, indemnification provisions

Summary

- AI brings together many technologies
- Find new ways to generate value
  - >1.5M in licensing revenue without patents filed
- Opportunities to explore license models
  - Dual licensing

Artificial Intelligence: Impact on Technology Transfer

Jackson Ho
Innovation Counsel LLP
San Jose, CA

Artificial Intelligence & Patent Subject Matter Eligibility

USPTO 2019 Revised Patent Subject Matter Eligibility Guidance (Jan 2019)

USPTO October 2019 Update: Subject Matter Eligibility

Step 1: Statutory categories

Process, machine, manufacture, or composition of matter

Steps 2A and 2B: *Alice/Mayo* judicial exceptions

Artificial Intelligence & Patent Subject Matter Eligibility

Step 2A:

Prong One: whether the claim recites a judicial exception

- law of nature
- natural phenomenon
- abstract ideas
  - mathematical concepts / mathematical relationships, mathematical formulas or equations, mathematical calculations
  - certain methods of organizing human activity
  - mental processes / concepts performed in the human mind.

Artificial Intelligence & Patent Subject Matter Eligibility

Mental Processes

- A claim with limitations that cannot practically be performed in the human mind does not recite a mental process
- A claim that requires a computer may still recite a mental process
- A claim that encompasses a human performing the steps mentally with the aid of pen and paper recites a mental process

Artificial Intelligence & Patent Subject Matter Eligibility

Step 2A:

Prong Two: whether the claim recites additional elements that integrate the exception into a practical application of that exception.

- important consideration: whether claimed invention improves the functioning of a computer or other technology

Step 2B: Evaluate whether additional elements in the claim provides an inventive concept

Artificial Intelligence & Patent Subject Matter Eligibility

Gottschalk v. Benson

409 U.S. 63 (1972)

- Claims for method of converting binary code decimal numbers to equivalent pure binary numbers.
- Application rejected by PTO.
- CCPA reversed; pointed to the claimed “signals” and “reentrant shift registers” to show that claim did not cover a mental process.
- Supreme Court characterized claim as an “algorithm”.

Artificial Intelligence & Patent Subject Matter Eligibility

Gottschalk v. Benson

"It is conceded that one may not patent an idea. But in practical effect that would be the result if the formula [claimed] were patented in this case. The mathematical formula involved here has no substantial practical application except in connection with a digital computer, which means … the patent would wholly pre-empt the mathematical formula and in practical effect would be a patent on the algorithm itself."

Artificial Intelligence & Patent Subject Matter Eligibility

In re Meyer, 688 F.2d 789 (CCPA 1982)

- An expert system designed to help neurologist diagnose the which neurological pathways in a patient may be malfunctioning.
- "their invention is concerned with replacing, in part, the thinking processes of a neurologist with a computer"
- "the claims recite a mathematical algorithm, which represents a mental process that a neurologist should follow"
- Not patentable because the claims are directed to an "algorithm representing a mental process that has not been applied to physical elements"

Artificial Intelligence & Patent Subject Matter Eligibility

Blue Spike v. Google

14-cv-01650 (N.D. Cal. 2015)

- Patent sought to model on a computer "the highly effective ability of humans to identify and recognize a signal."
- Claims recited creating "an abstract" from a reference signal and comparing the abstract with a query signal.
- Claims cover a "general purpose computer implementation of an abstract idea long undertaken within the human mind."

Artificial Intelligence & Patent Subject Matter Eligibility

Purepredictive, Inc. v. H2O.AI, Inc.

17-cv-03049 (N.D. Cal. 2017)

- Claimed a method of performing predictive analytics using machine learning.

A method for a predictive analysis factory, the method comprising:
pseudo-randomly generating a plurality of learned functions based on training data without prior knowledge regarding suitability of the generated learned functions for the training data, the training data received for forming a predictive ensemble customized for the training data;
evaluating the plurality of learned functions using test data to generate evaluation metadata indicating an effectiveness of different learned functions at making predictions based on different subsets of test data; and
forming the predictive ensemble comprising a subset of multiple learned functions from the plurality of learned functions, the subset of multiple learned functions selected and combined based on the evaluation metadata, the predictive ensemble comprising a rule set synthesized from the evaluation metadata to direct different subsets of the workload data through different learned functions of the multiple learned functions based on the evaluation metadata.

Artificial Intelligence & Patent Subject Matter Eligibility

Purepredictive, Inc. v. H2O.AI, Inc.

- Claims directed to a mental process and the abstract concept of using mathematical algorithms to perform predictive analytics

USPTO analysis

- Step 2A (Prong one): mathematical concept?
  mental process?
- (Prong Two): Integration into practical application?

Fed. Cir. Q: “Isn’t this an algorithm?”

AI: Impact on Technology Transfer

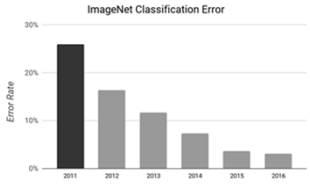
Tracy Huang Harrison
Google LLC
Mountain View, CA

What I'll Cover Today

- Why AI and healthcare?
- Some things that Google's working on.
- Top of mind issues for tech transfer.

Why AI and Healthcare?

- Major progress in ML / AI: leaps in fundamental machine learning capabilities, e.g., image recognition and computational power



TPU

- Availability of massive datasets

Why AI and Healthcare?

ML worked really well in Google technologies:

Photos

Gmail

Translate

Why AI and Healthcare?

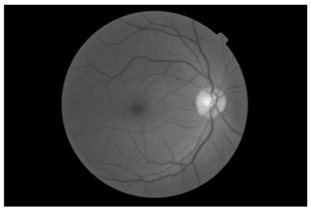
So, four to five years ago we began to ask: Where might ML help in new fields, and have the most impact?

Healthcare seemed liked an obvious answer.

Things We're Working On

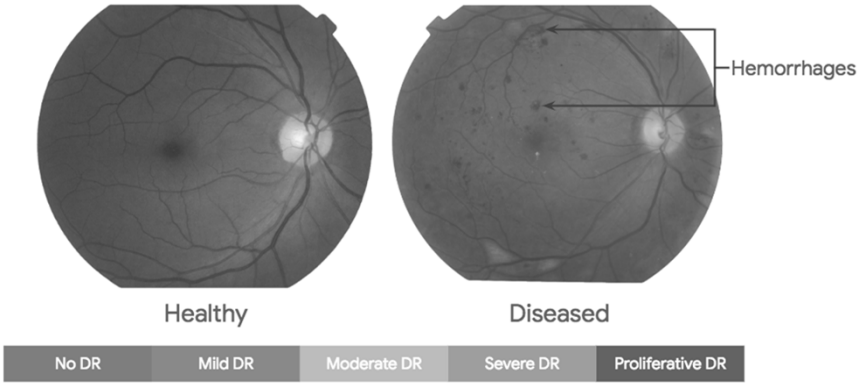
Retinal Disease: Diabetic Retinopathy

- Fastest growing cause of preventable blindness
- Screening prevents blindness
- Screening is very specialized … most MDs can't do it
- Impact of this shortage is significant
- For example, in India:
  - Shortage of 127,000 eye doctors
  - 45% of patients lose vision before diagnosis



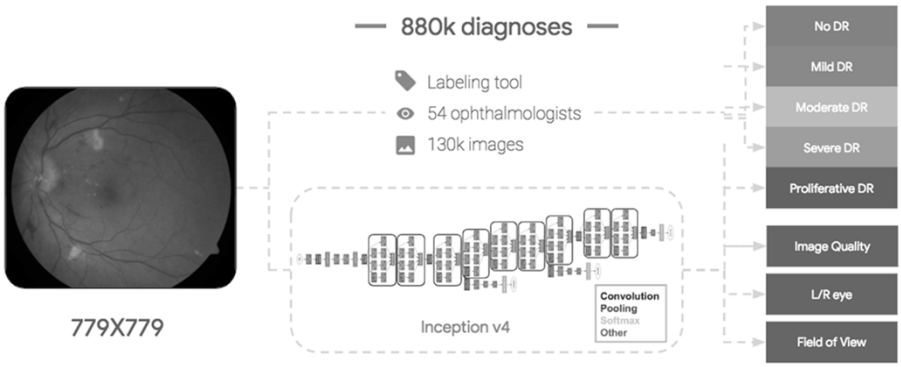
Things We're Working On

How DR is Diagnosed: Retinal Fundus Images



Things We're Working On

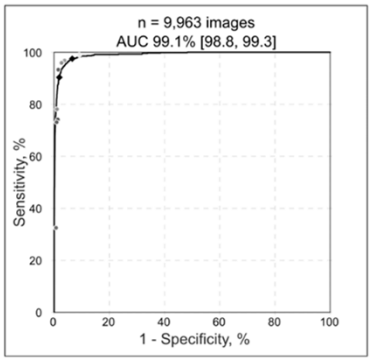
Adapt deep neural network to read fundus images:



Things We're Working On

JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs



F-score

0.95	0.91
Algorithm	Ophthalmologist (median)

"The study by Gulshan and colleagues **truly represents the brave new world in medicine.**"

Dr. Andrew Beam, Dr. Isaac Kohane
Harvard Medical School

"Google just published this paper in JAMA (impact factor 37) [...] **It actually lives up to the hype.**"

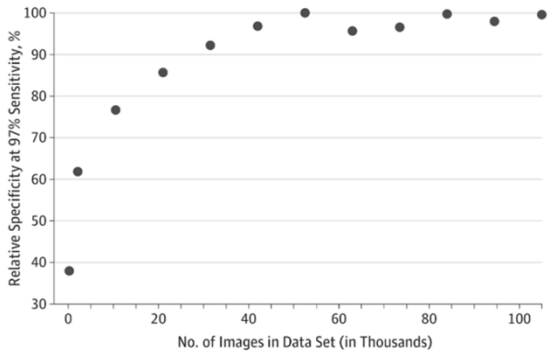
Dr. Luke Oakden-Rayner
University of Adelaide

Things We're Working On

Learning: Amount of data matters

Data gains >> Model gains

Noisy labels are okay for training



Things We're Working On

In addition… a bunch of other things

Applying AI to EHRs

Rajkomar *et al.* Scalable and accurate deep learning with electronic health records. *Nature Digital Medicine* (2018)

Applying AI to pathology

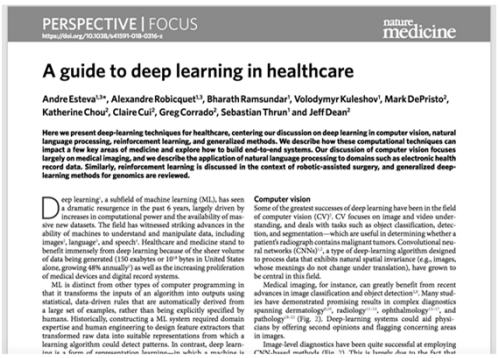
Liu *et al.* Artificial Intelligence-Based Breast Cancer Nodal Metastasis Detection. *Archives of Pathology & Laboratory Medicine* (2018)

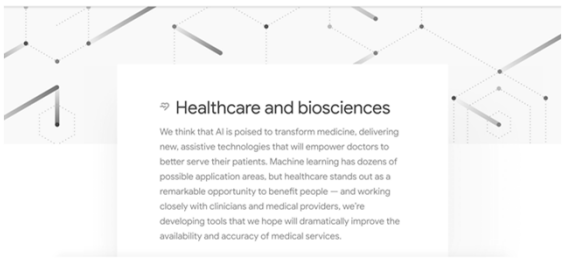
Applying AI to microscope imaging

Yang *et al.* Assessing microscope image focus quality with deep learning. *BMC Bioinformatics* (2018)

Things We're Working On

More Resources:





https://ai.google/healthcare/

https://health.google/

Top of Mind Issues

Patentable subject matter (35 U.S.C. §101): whether ML as diagnostics can be patentable

- Will be more like software patents than traditional pharma patents, in part because using *known* machine learning techniques
- This changes dynamics about what universities are out-licensing
  - IP and "valuation": not just patents (which are likely be much lower value); value comes from access to *data* and *technical solutions/prototypes*
  - Exclusivity and "field of use": exclusivity has limited value so tech companies aren't likely to pay for that; care more about FTO

Top of Mind Issues

Collaborations in ML / AI: not traditional pharma or med device deals. Or even sponsored research deals.

- IP and business terms (valuation)
- Data: lots and lots, different sources, need ability to pool / aggregate
- Sensitivities around **health data** (it is highly regulated!)
  - PHI and de-identified data; research vs. commercial activities
  - May need to contract differently

Top of Mind Issues

Export control

- Seeing some university red flags around export control: i.e., requiring university collaborators not be exposed to *anything* that is subject to export control
- What this means in practice:
  - No encryption (since any encryption system is export controlled) **but** encryption is so ubiquitous at tech companies, making it impossible / onerous to screen from that
- Quantum computing is covered under Commerce Department's proposals on export control

Thank you!