Intro to Machine Learning for Health

CRTP Fall Term, Week 1

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Introductions!

your name

+ a brief note on your background and role

+ which topic interests you most

  (intro to ML, model learning, measuring performance, computer vision, NLP, sequential data)

Course Overview

We will learn about state-of-the-art machine learning techniques that are now beginning to impact clinical practice.

- How are these techniques different from what has come before?
- How are they the same?
- And what do you need to know to take advantage of this tech?

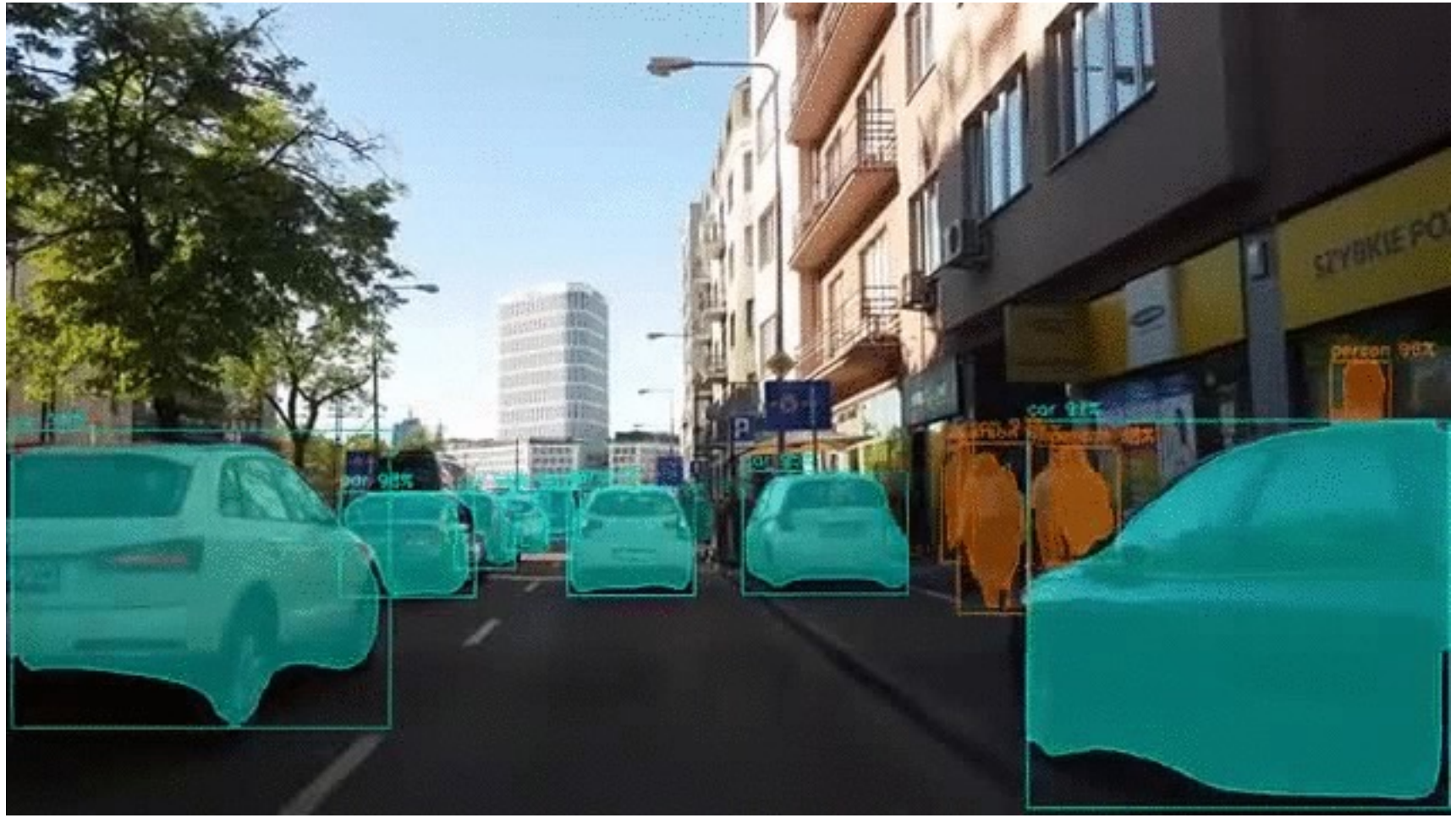
I know that most of you are NOT going to be machine learning researchers.

But you *will* work with data scientists, and you *will* have to make decisions about what models to use and how to use them. It is important to know enough to get in the weeds with the data scientists, because if applied/evaluated incorrectly, these models are certain to be unhelpful and *likely to be harmful*.

A Brief Tour of ML in 2021

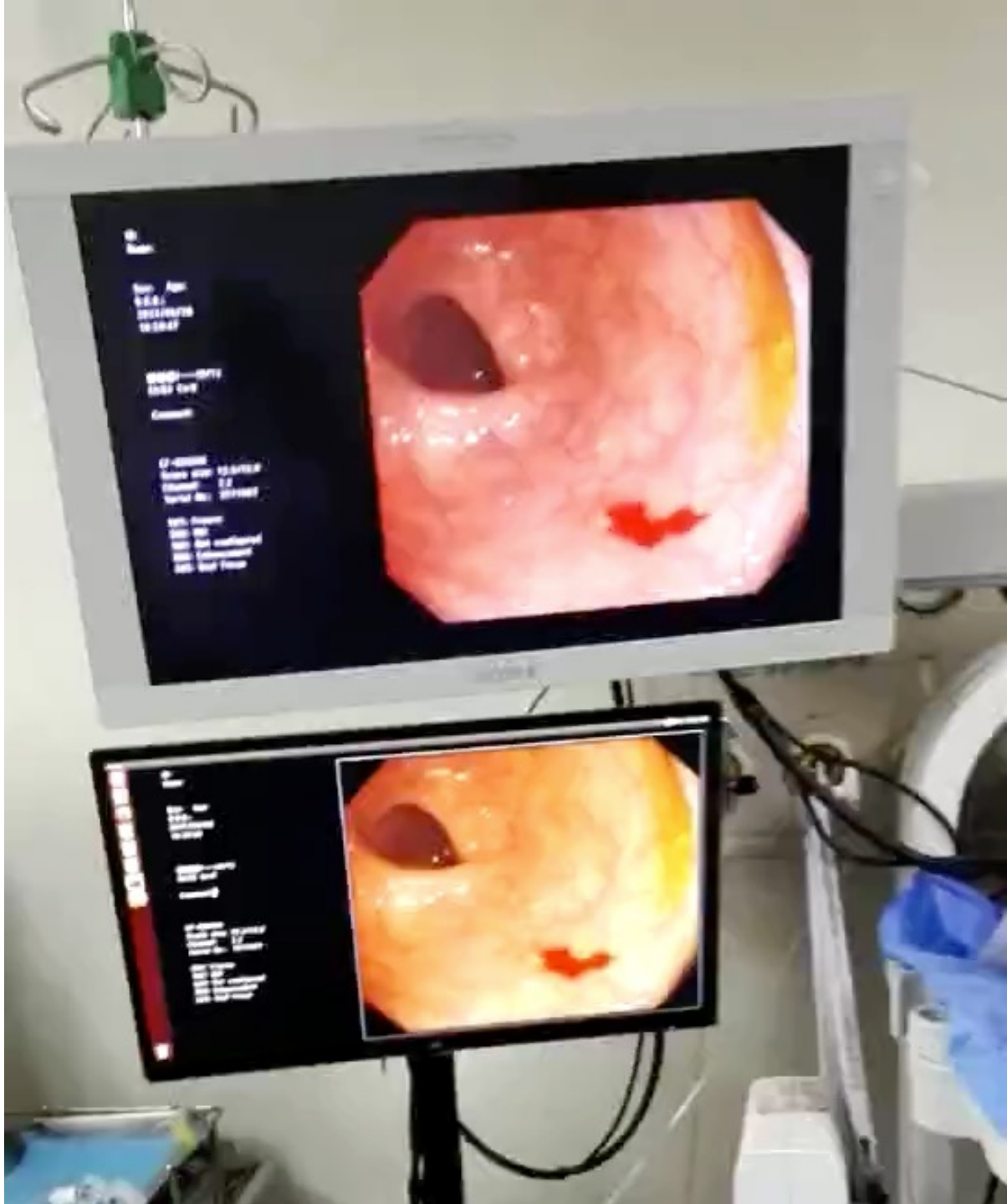
General Application -> Biomedical Application

Computer Vision:
Real-Time Object Detection (& segmentation)



Real-time polyp detection:

a second set of eyes during colonoscopy



Natural Language Processing: Text Generation

SYSTEM PROMPT (HUMAN-WRITTEN)

A train carriage containing controlled nuclear materials was stolen in Cincinnati today. Its whereabouts are unknown.

MODEL COMPLETION (MACHINE-WRITTEN, FIRST TRY)

The incident occurred on the downtown train line, which runs from Covington and Ashland stations.

In an email to Ohio news outlets, the U.S. Department of Energy said it is working with the Federal Railroad Administration to find the thief.

“The theft of this nuclear material will have significant negative consequences on public and environmental health, our workforce and the economy of our nation,” said Tom Hicks, the U.S. Energy Secretary, in a statement. “Our top priority is to secure the theft and ensure it doesn’t happen again.”

The stolen material was taken from the University of Cincinnati’s Research Triangle Park nuclear research site, according to a news release from Department officials. The Nuclear Regulatory Commission did not immediately release any information.

According to the release, the U.S. Department of Energy’s Office of Nuclear Material Safety and Security is leading that team’s investigation.

“The safety of people, the environment and the nation’s nuclear stockpile is our highest priority,” Hicks said. “We will get to the bottom of this and make no excuses.

“Better Language Models and Their Implications”
2/14/19
OPENAI

Natural Language Processing: Find Predictive Text in Notes

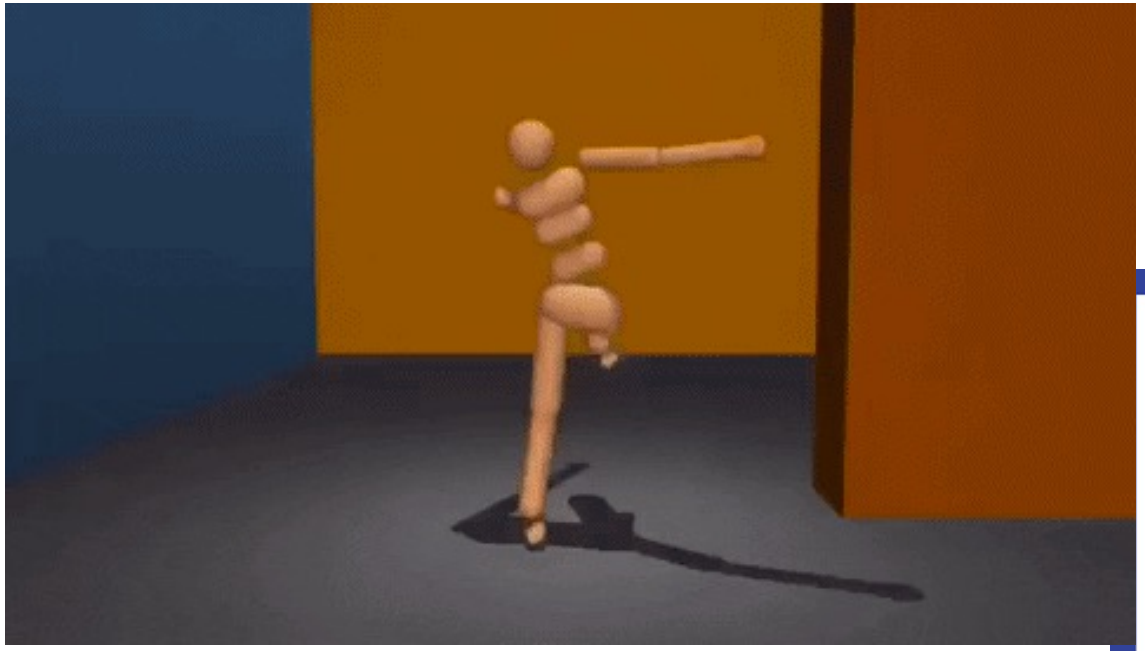
Passage (from note)	Change in predicted autism dx log-odds
subjective intake chief complaint problems with sleep, inattention, and behavioral concerns both in the home and school setting. DATE, recently more anger and recent tic like behavior	+6.95
psychologist presenting problem NAME is a 3 year, 4 month old female who was referred for a neurodevelopmental assessment due to concerns regarding her overall development, behavior, and social emotional functioning and to assess for autism spectrum disorder	+6.82
problem list diagnosis • disruptive behavior disorder • impaired speech articulation • daytime enuresis • other subjective visual disturbances • hypermetropia of both eyes • adhd attention deficit	+6.81
problem list diagnosis • anemia of prematurity • history of colitis • meconium tox for thc • extreme immaturity of newborn, 27 completed weeks • nasal congestion of newborn • presumed	+6.78
motor delay DATE • hypotonia DATE • clasped thumb DATE • polydactyly DATE • developmental	+6.74
therapy NAME was seen for developmental support during rop eye exam today. the	+6.65

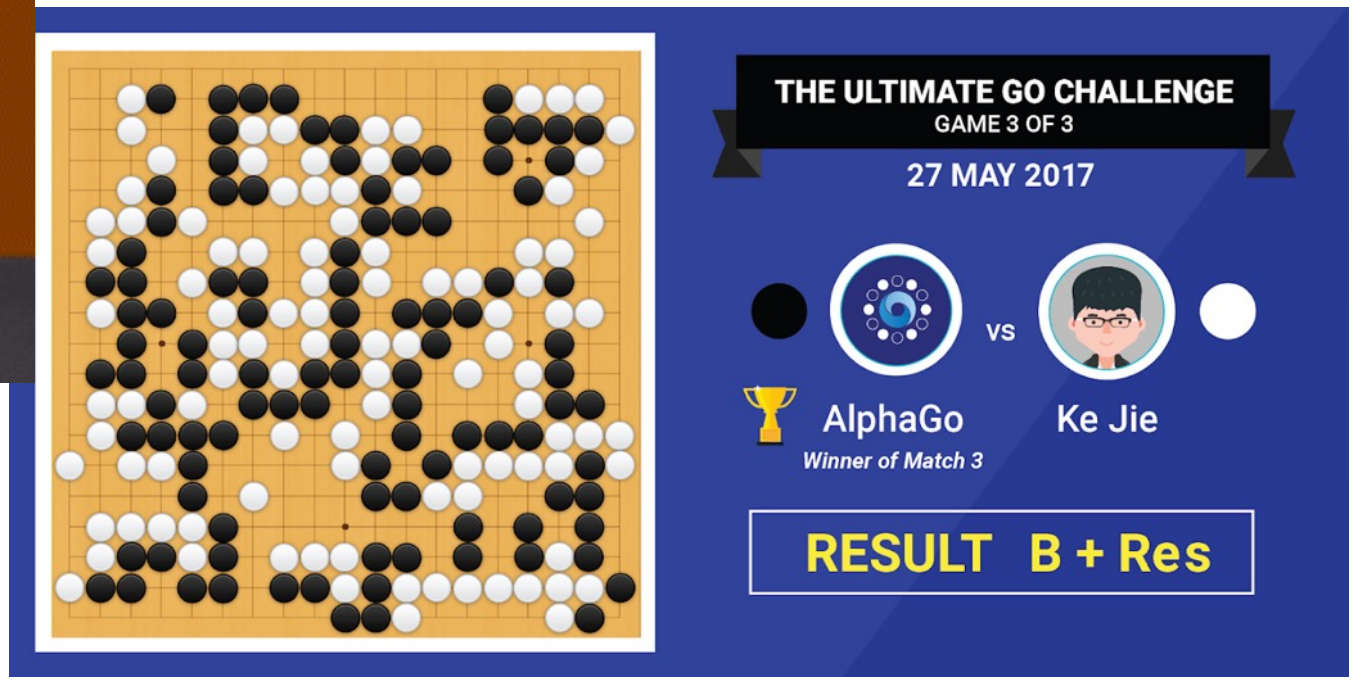
Developmental and behavioral concerns are highly predictive

Premature birth and perinatal complications are also highly predictive

Subramanian V, Engelhard MM, Berchuck SI, Chen L, Carin L. SpanPredict: Extraction of Predictive Document Spans with Neural Attention. Submitted to NAACL.

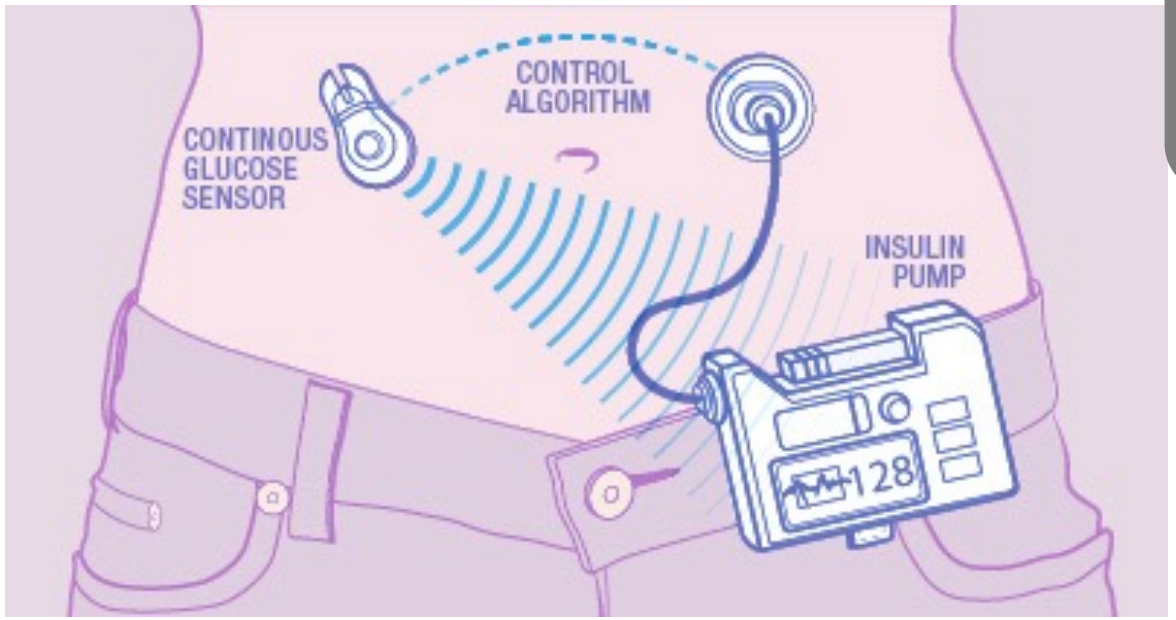
Reinforcement Learning:
goal-directed sequential decision-making



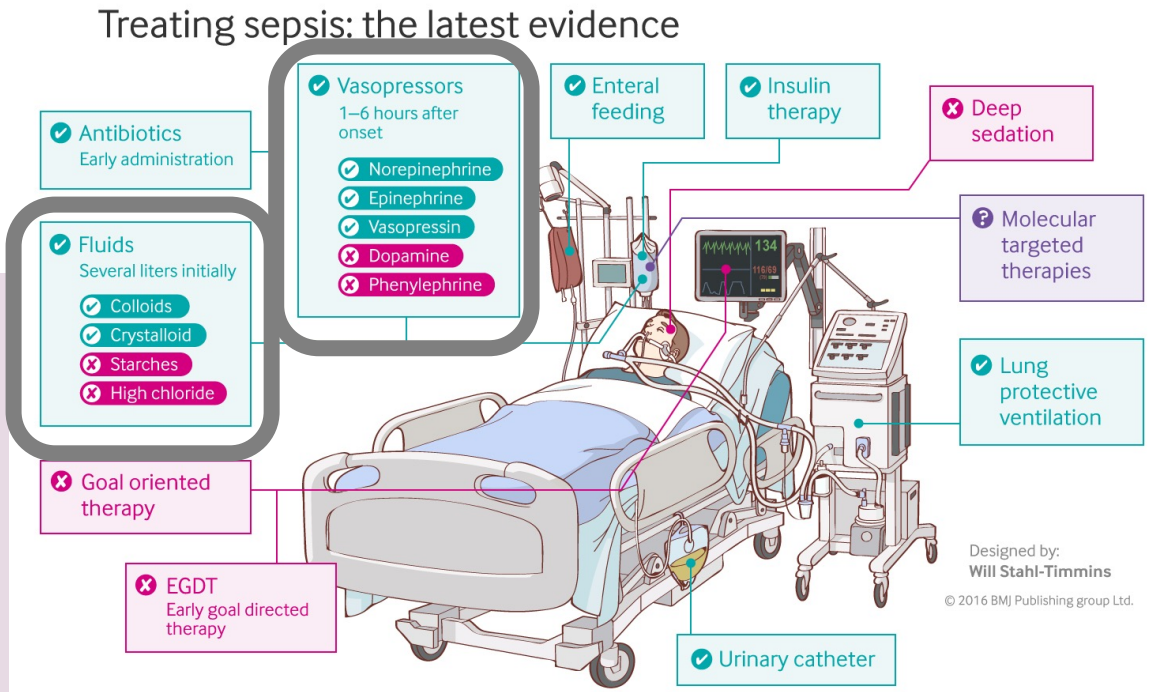


Reinforcement Learning in Medicine

Closed-loop blood glucose control ("artificial pancreas")



https://www.mayo.edu/research/labs/artificial-pancreas/overview



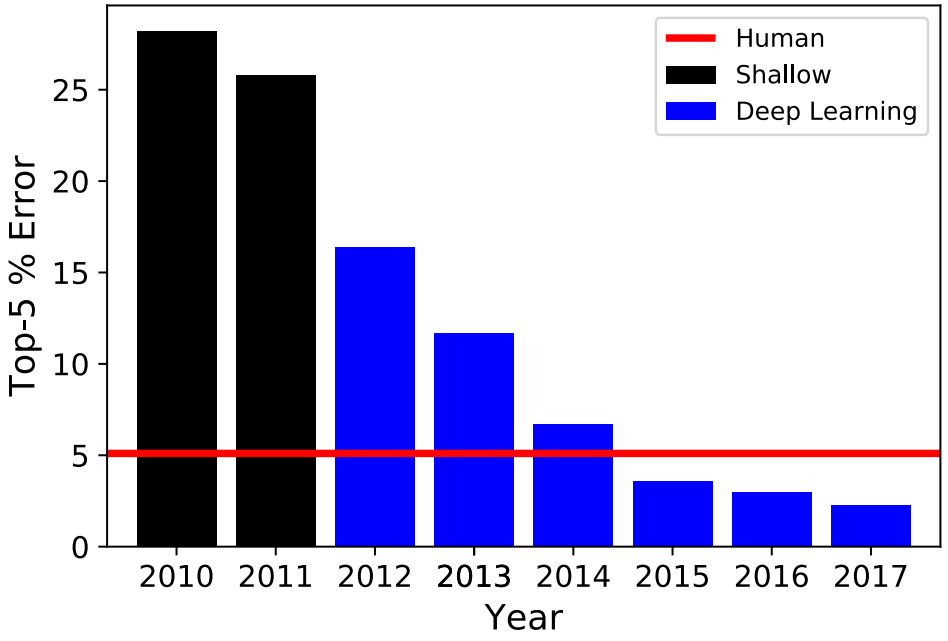
Fluid and vasopressor administration for sepsis treatment

Gotts JE, Matthay MA. Sepsis: pathophysiology and clinical management. bmj. 2016 May 23;353(i1585).

The Current ML Moment

Looking back to 2012…

Deep learning leapt forward in ‘12 and beat humans in ‘15



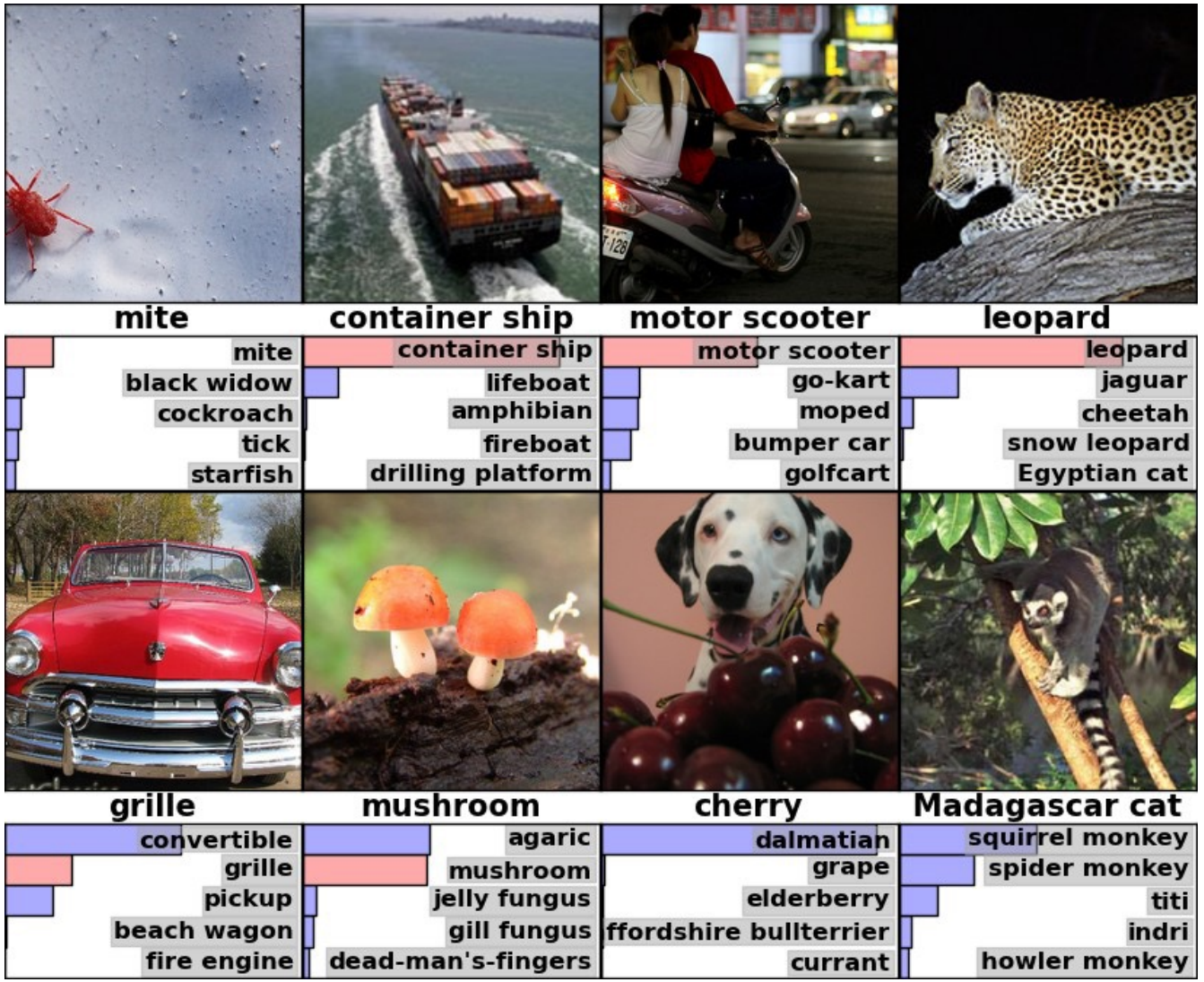
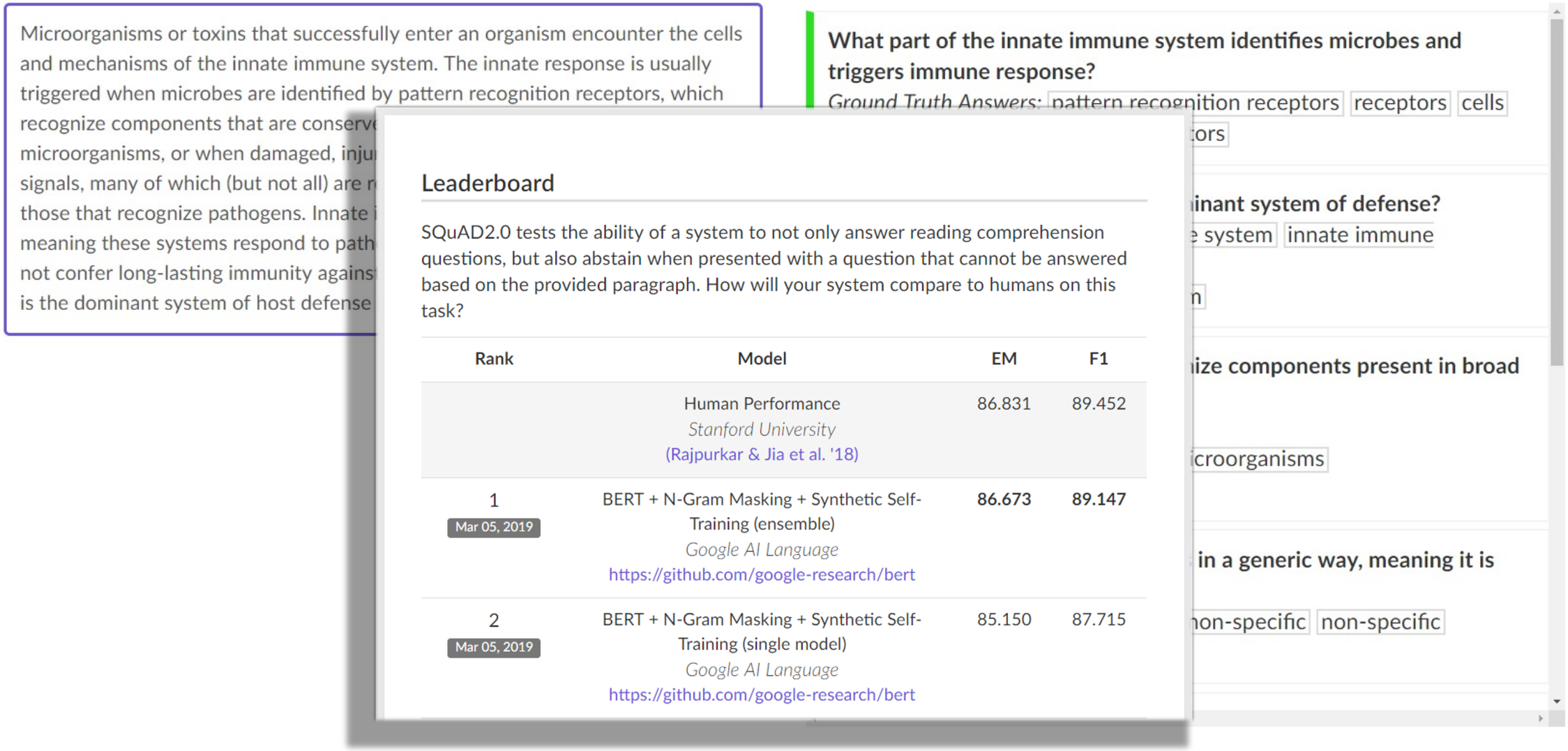


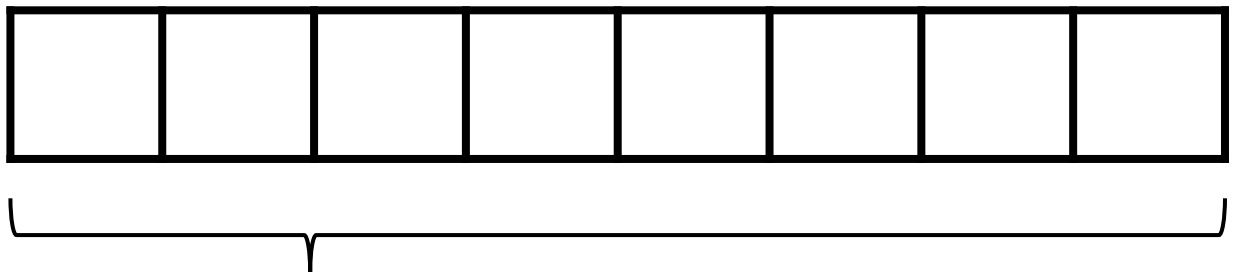
Figure from Krizhevsky et al 2012

Deep Learning now surpasses humans in a variety of tasks

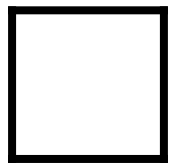
Most recently, DL has surpassed humans in language tasks



All of these have, at their core, a predictive model



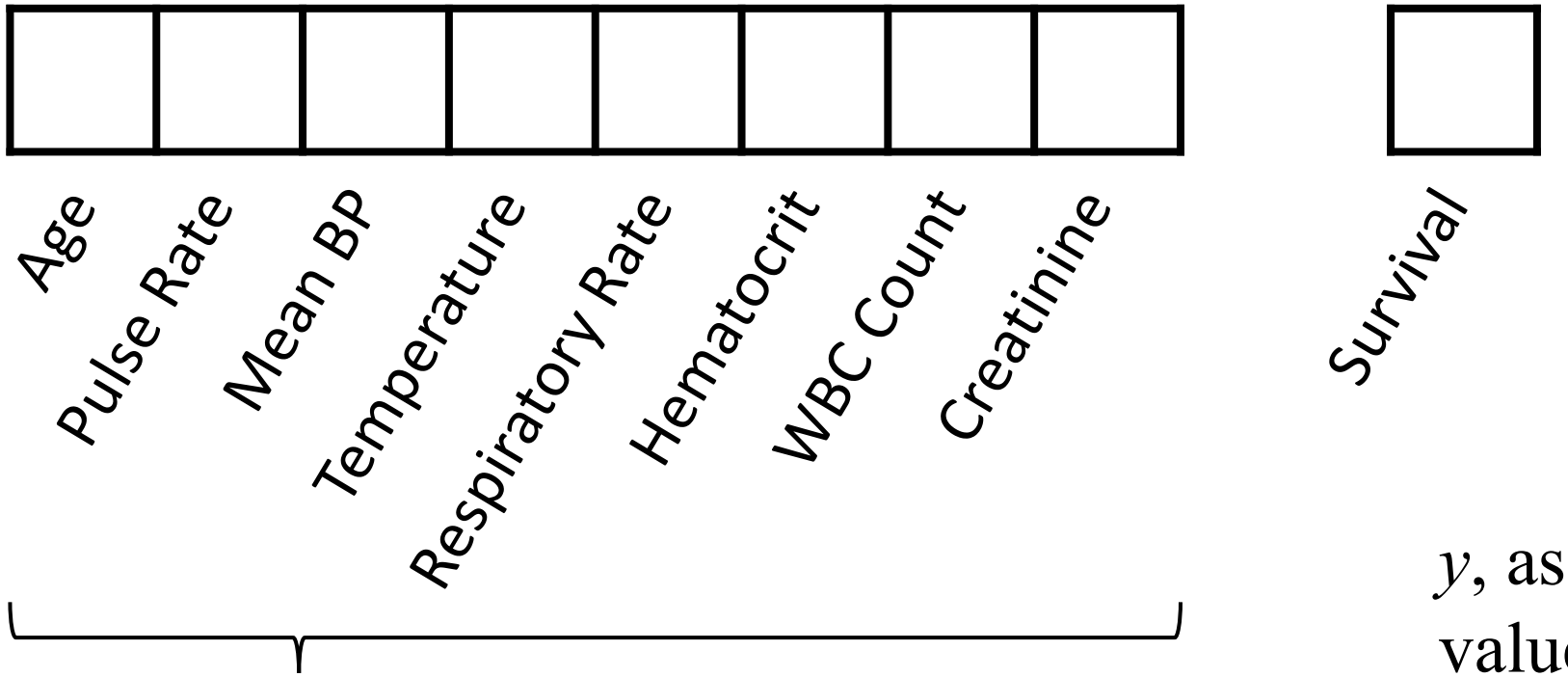
x, data/features for
a subject or patient



y, associated
value or label

End goal: predict y from x

Simple models often work well for clinical data!



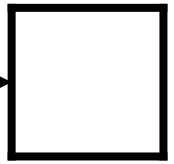
x, data/features for a subject or patient

y, associated value or label

End goal: predict odds of hospital mortality

For complex data, more complex models are needed.

x, retinal image



y, referrable diabetic retinopathy

End goal: predict y from x

Course Objectives

Understand the capabilities and limitations of ML in healthcare.

(a) design and manage ML research and/or QA/QI projects

(b) gain hands on experience with all components of the model development pipeline

(c) collaborate and communicate effectively with machine learning researchers / data scientists

(d) critically evaluate machine learning models and methods, with an emphasis on rigorous model validation

Course Requirements and Materials

- Let's take a look at the website
- Questions & discussion about course requirements, materials, or activities
- Contact me: m.engelhard@duke.edu