ML & Advanced Analytics For Biomedicine

Ishanu Chattopadhyay
Department of Medicine
University of Chicago

CCTS 40500 / CCTS 20500 / BIOS 29208

Winter 2020

Today

- Introductions
- Course Expectations, Goals and Syllabus
- Computing Resources
- Conceptual Introduction to ML
- Problem Examples

What Is Machine Learning?

- Learning from machines?
- Learning with help of computers?
- Modeling data?
- Regression?

- Learning from machines?
- Learning with help of computers?
- Modeling data?
- Regression?

How Is ML Different From ···

- Artificial Intelligence
- Statistics
- Data Mining
- Deep Learning

How Is ML Different From · · ·

- Artificial Intelligence
- Statistics
- Data Mining
- Deep Learning

- *“Machine learning is essentially a form of applied statistics”*
- *“Machine learning is glorified statistics”*
- *“Machine learning is statistics scaled up to big data”*
- *“The short answer is that there is no difference”*
- *“Machine learning is for Computer Science majors who couldn’t pass a Statistics course.”*
- *“Machine learning is Statistics minus any checking of models and assumptions.”*
- *“I don’t know what Machine Learning will look like in ten years, but whatever it is I’m sure Statisticians will be whining that they did it earlier and better.”*

https://www.svds.com/machine-learning-vs-statistics/

How Is ML Different From · · ·

- Data Science
- Big Data Analytics

How Do We Teach Machines?

ML Categories

Machine Learning

Supervised

Unsupervised

ML Categories

Machine Learning

Classification

Prediction

Modeling

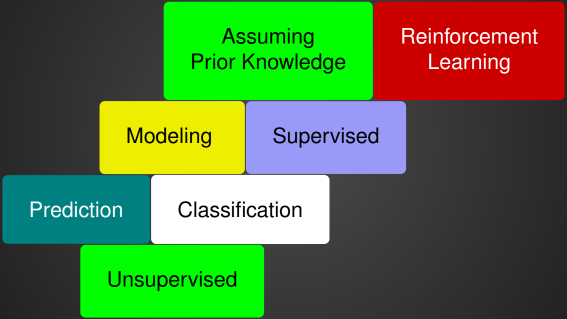
ML Categories

Machine Learning

Assuming
Prior Knowledge

Zero Knowledge
Learning

ML Categories



- Introduction to ML

http://www.r2d3.us/visual-intro-to-machine-learning-part-1/

- Bias Variance Tradeoff

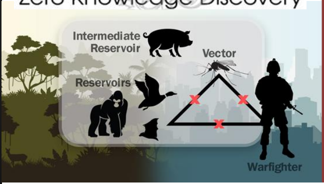
http://www.r2d3.us/visual-intro-to-machine-learning-part-2/

ML: Breaking The Status Quo

Taking On The Grand Challenges

Funded Projects

Zero Knowledge Discovery



Data Driven Discovery of Models (D3M)
Defense Advanced Research Proj. Agency (DARPA I2O)

- 2017-2021

Preventing Emerging Pathogenic Threats (PREEMPT)
Defense Advanced Research Proj. Agency (DARPA DSO)

- 2018-2021

Physics Augmented AI (PAI)
Defense Advanced Research Proj. Agency (DARPA DSO)

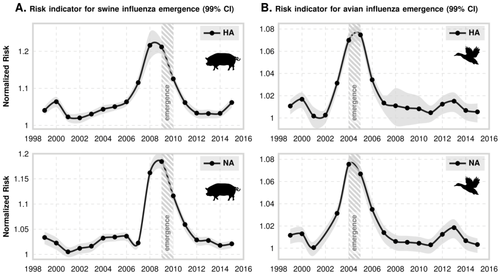
- 2018-2020

Crimes of Prediction
Neubauer Collegium for Culture & Society

- 2017-2019

Biosurveillance For Predicting Zoonotic Emergence

J.Dhanoa, B. Manicassamy and I. Chattopadhyay , ***"Algorithmic Bio-surveillance For Precise Spatio-temporal Prediction of Zoonotic Emergence"***, https://arxiv.org/abs/1801.07807

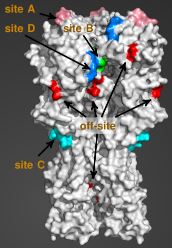


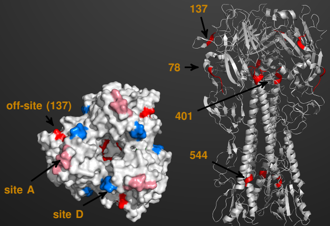
Predicting
the
next pandemic:

Where
When
Who

ML: Breaking The Status Quo

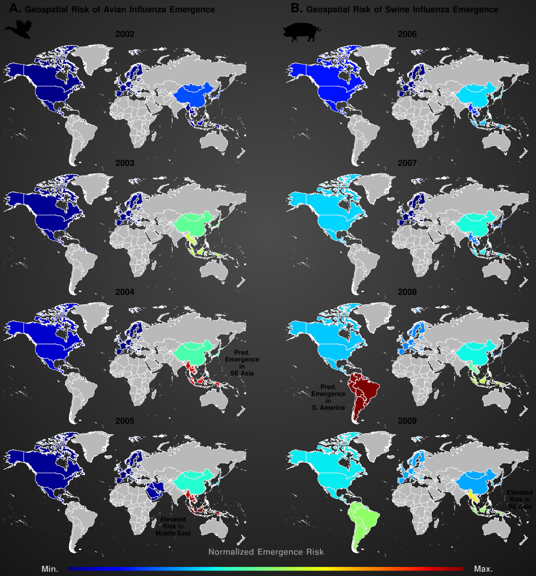
Taking On The Grand Challenges





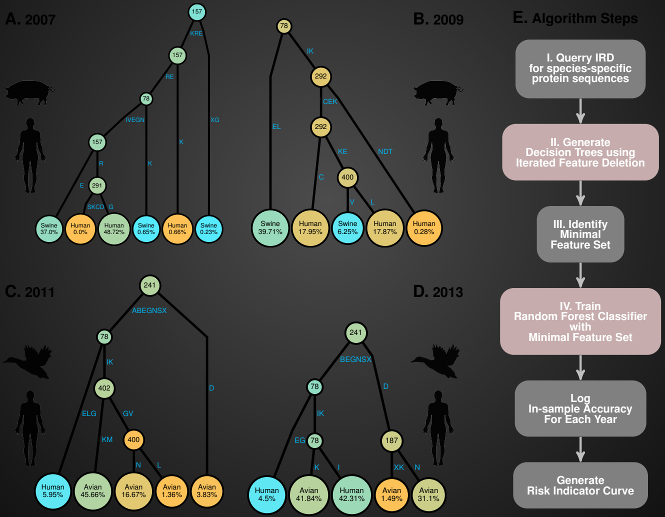
ML: Breaking The Status Quo

Taking On The Grand Challenges



ML: Breaking The Status Quo

Taking On The Grand Challenges

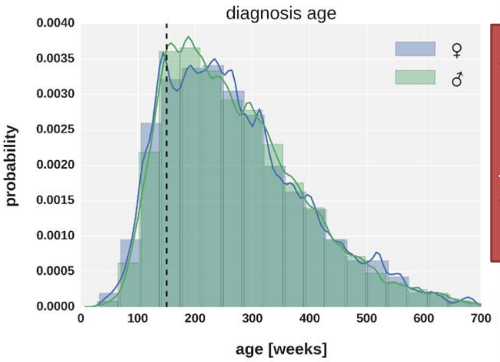


Predicting Neuropsychiatric Diagnoses From Sparse Electronic Health Records

Truven Health Analytics MarketScan® Commercial Claims and Encounters Database for the years 2003 to 2012

- **4.6 billion inpatient and outpatient service claims**
- **150 Million individuals**

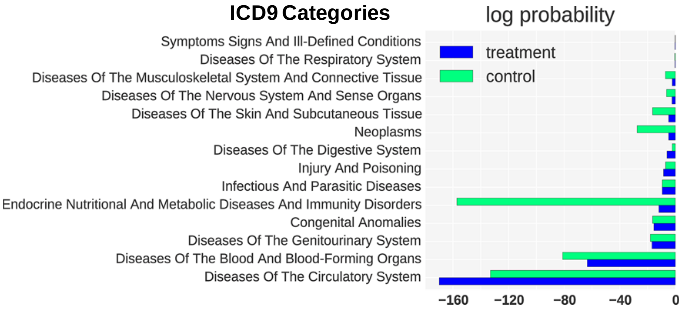
Autism Diagnoses Age Distribution



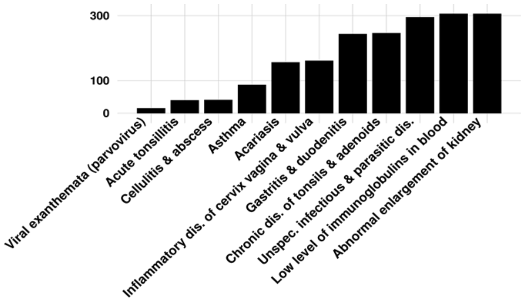
- ❿ **Can we predict ASD or CDD diagnoses from sparse medical history?**

- ❿ **Can we get etiological insights?**

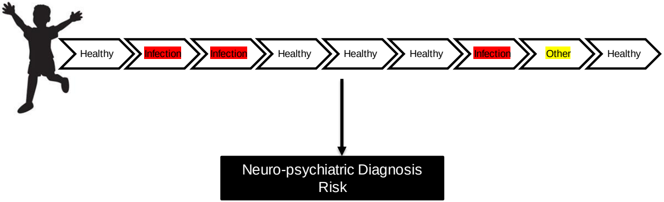
Specific Disease Groups are Overrepresented



Log-Odds Ratio Specific Disease Groups are Overrepresented



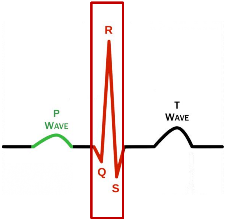
Models from Population Data
Predictions at the Individual Level



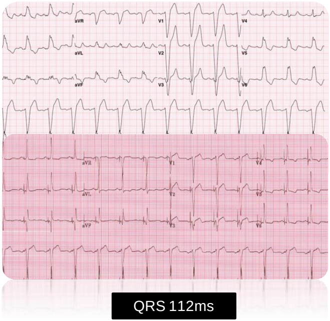
ML: Breaking The Status Quo

Taking On The Grand Challenges

Accurate Prediction
Of
Left Bundle Branch Blocks
From Surface EKG



QRS 200ms

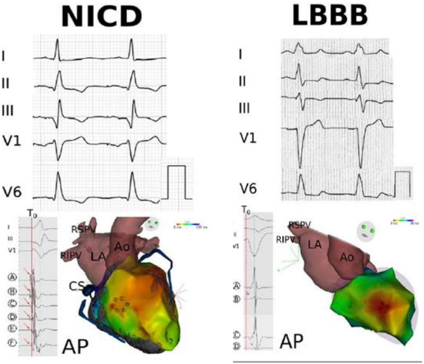


QRS 112ms

ML: Breaking The Status Quo

Taking On The Grand Challenges

What's a left bundle?

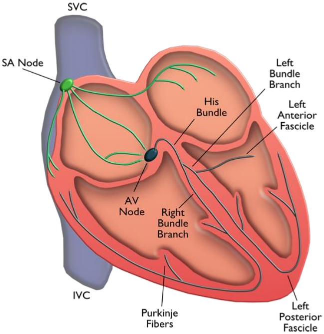


ACC/AHA/HRS Criteria for LBBB (2009)

- QRS ≥ 120 ms
- Notched or slurred R-wave in leads I, aVL, V5, and V6
- Absent q wave in I, V5, V6
- R peak time > 60 ms in V5 and V6
- ST and T waves usually opposite to QRS

In LBBB: Passive Activation of the Left Bundle

Objectives



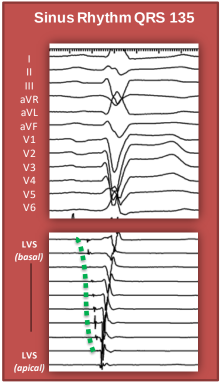
- ❑ His Bundle Pacing in Lieu of LV Lead for CRT
- ❑ Determine which cases will correct with HBP
- ❑ Determine level and extent of conduction system block
- ❑ Make this determination with surface leads instead of invasive EP studies

ML: Breaking The Status Quo

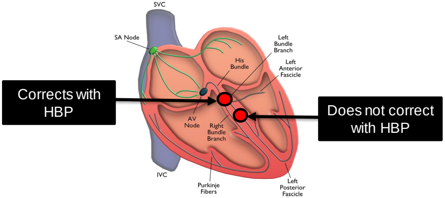
Taking On The Grand Challenges

CRT Lab UChicago

Normal His-Purkinje Activation



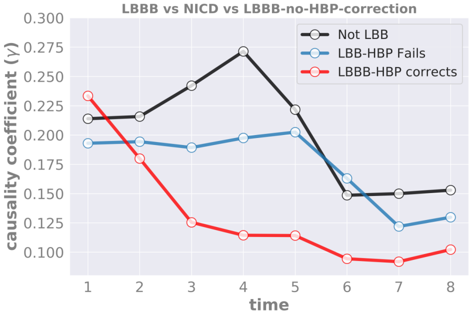
- ❑ **No surface ECG criteria could predict QRS correction.**
- ❑ **Wide QRS with intact Purkinje activation cannot be corrected.**



	Intact Purkinje Activation	Delta LV His to Mid-Septum (ms)	Latest LV to QRS end (ms)	Mid-Septal QLV (%)
Correction	0%	47±21	58±13	67%
No Correction	75%	-19±34	74±17	51%
p-value	0.0001	<0.0001	0.0132	0.0001

Deep Granger Nets: Identifying Phenotype From Surface EKG

- **I. Chattopadhyay, Causality Networks. CoRR abs/1406.6651 (2014)**



- ~96% accuracy in identifying three classes
- Etiological insight

- Small cohort tested. Larger samples being prepared