AI is to Medicine Today
What the X-ray was to Medicine a Century Ago, and Much More...

Jiajie Zhang, PhD
Dean & Professor
Glassell Family Foundation Distinguished Chair in Informatics Excellence
School of Biomedical Informatics
University of Texas Health Science Center at Houston

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Outline

Medical AI is the X-ray of the 21st Century.

Medical AI is real, finally.

Medical AI is easy.

Medical AI is hard.

Medical AI requires deep clinical integration.
Medical AI is the X-ray of the 21st Century.
A century ago, X-ray enabled doctors to see invisible structures inside the body.
Today, AI is enabling doctors to not only see, but predict, previously unidentified patterns within massive medical and biological data.
Medical AI is real, finally.
The Age of Acceleration

- **Data**
- **EHR Adoption**
- **Cost of Genome Sequencing**
- **Cell Phone Adoption**
- **5G Speed**
- **Computing Speed**

### Ages and Revolutions

- **Old Stone Age**
- **New Stone Age**
- **Bronze Age**
- **Iron Age**
- **Middle Ages**
- **Modern Age**
- **Industrial Revolution**
- **Agricultural Revolution**
- **Cognitive Revolution (Today)**

### World Population

- **1+ million BC**
- **8000 BC**
- **7000 BC**
- **6000 BC**
- **5000 BC**
- **4000 BC**
- **3000 BC**
- **2000 BC**
- **1000 BC**
- **AD 1**
- **AD 1000**
- **AD 2000**
- **AD 3000**

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"The past 20 or 30 years, and the next 20 or 30 years—really is historically unique. It is arguably the largest economic disruption in recorded human history."
(Ben Sasse, US Senator, WSJ, April 21, 2017)
Examples of Medical AI Applications

- Read images (X-Ray, CT, skin, retina, etc.)
- Predict which COVID patients need ventilators
- Predict sepsis onset before detection
- Use Natural Language Processing (NLP) to process notes, reports, etc.
- Make diagnosis for common and rare diseases
- Calculate risks (MI, heart failure, readmission, etc.)
- Predict disease progression (e.g., diabetes to retinopathy to kidney failure)
- Detect Parkinson’s from keyboard typing or smartphone touching
- Discover new functions of existing drugs
- Discover genetic mutations of cancers
- Take medical license exams
- Discover and predict insurance claims
- Optimize coding for billing
- More, more, more...
Drug Repurposing: Metformin for Cancer Treatment

Heart Failure
- the heart can't pump enough blood to meet the body's needs.
- 5 million US patients in 2016
- $30 billion cost

Cerner Healthfacts Database
- 600 hospitals/clinics
- 50 million unique patients
- > 10 years of records
- 110 million patient visits
Detect Parkinson’s Disease from Typing or Touching

Luca Giancardo

Sepsis Prediction Before Onset

• The leading cause of death in U.S. hospitals. 1 patient dies every 2 minutes in the US—more than breast cancer, prostate cancer and HIV combined.

• Mortality increases 8% for every hour that treatment is delayed

• 80% sepsis deaths preventable

UTHealth Project:
4 Hour Prediction of Severe Sepsis:

Model: Deep LSTM

Performance (AUC)
• AUC = 0.92
• Status Quo 0.85

Bella Patel, MD  
Xiaoqian Jiang, PhD  
Robert Murphy, MD
The Eyes Are The Windows Of Health

Luca Giancardo, PhD, an expert in machine learning, collaborates with neurologists like Sunil A. Sheth, MD, and other health care professionals to develop artificial intelligence techniques for evaluating patients who suffer a stroke to help them receive timely care regardless of where they live. (Photo by Terry Vine Photography)
Medical AI is easy.
Predict Sudden Unexpected Death in Epilepsy (SUDEP)

- 35 students from Rice, UTHealth, TAMU, University of Houston, etc.
- Detect the onset of slow activity after seizures based on messy EEG signals
- AUC 0.84 from the best model
- Published 5 papers in a BMC special issue
• Predict COVID-19 hospitalization and mortality in Houston Metro Area

• Data available:
  • historical hospitalization and mortality rates;
  • infection, recovery, active, and test cases (9 counties)
  • population mobility, demographics, and mask usage

• 34 students from Rice, UTHealth, U. of Houston, etc.

• Best model performance:
  • Mean Squared Logarithmic Error (MSLE) for 8 counties is 16.5
In 2017, 7.8 million US adults survived a stroke. Stroke remains a leading cause of morbidity and disability.

- Develop algorithms to predict changes in cognitive and Functional Independence Measure (FIM) scores
- 27 students from Rice, UTHealth, TAMU, University of Houston, etc.
- Best model performance: 
  - L1 (Manhattan) distance = 14.36 on 18 FIM scores
Medical AI is hard.
Most academic (and industrial) medical AI products never get deployed.
A Case Study: CT Imaging for Stroke
• Ischemic Stroke: 87% of all strokes
• Endovascular Stroke Therapy (EST) significantly improves stroke outcomes
• CT Perfusion (CTP) is not widely available
• CT Angiogram (CTA) can help determine eligibility
Imaging sent to PACS

Patient with possible AIS arrives in the ER

Rapid clinical exam and CT imaging performed

Imaging sent to PACS

Radiologist

Radiologist Report

Neurologist/ER Physician

Treatment Decision

Brain images automatically analyzed by DeepSymNet, a machine learning based algorithm

Alerts indicating the most likely stroke type

1 minute

Patient with possible AIS arrives in the ER

Rapid clinical exam and CT imaging performed

Imaging sent to PACS

Radiologist

Radiologist Report

Neurologist/ER Physician

DeepSymNet reduces the time to treatment decision
Current Status

- The algorithm works well as stroke alert generation
- 1,985 unique subjects from 1/15/2020 to 1/10/2021.
- Pipeline running time < 1 min
- Pipeline integrated in 4 hospitals at Memorial Hermann System

- Record FAST time of “bench-to-bedside”. It took a year to go from idea to implementation in the hospital
- First “in-house” multisite live imaging / machine learning pipeline in the UTHealth-Memorial Hermann
- This framework can be expanded to many other projects
Medical AI requires deep clinical integration.