Our Speakers

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Medical Informatics Director for AI Clinical Integration, Stanford Health Care
GOALS FOR TODAY’S LECTURE

Over the last year, we have collaborated on two projects implementing AI-enabled solutions at Stanford Health Care.

Our goal today is to:
- share what we have learned thus far from our experiences on these projects
- discuss how those learnings can be applied more broadly
- reflect on what is necessary to increase the capacity for AI development and integration at Stanford
With machine learning situated at the peak of inflated expectations, we can soften a subsequent crash into a “trough of disillusionment” by fostering a stronger appreciation of the technology’s capabilities and limitations.

What are tasks that AI can perform?

Classification  Regression
What is the difference between AI and machine learning?

Artificial Intelligence

Machine Learning

Deep Learning
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.

A subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning.

Any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning).
Machine learning algorithms are used to build models that classify and predict at high accuracy.
Prediction models are not new to medicine

Example:

Model for End Stage Liver Disease (MELD) score developed in 2002 to help prioritize liver transplant recipients:

\[ MELD = 3.8 \times \log_e(\text{serum bilirubin [mg/dL]}) + 11.2 \times \log_e(\text{INR}) + 9.6 \times \log_e(\text{serum creatinine [mg/dL]}) + 6.4 \]
Then why all the hype now?

1. More data and computing power available

2. Learning algorithms enable the creation of more accurate models

3. Hospitals and clinics more “wired” and capable of using advanced analytics in real time
Then, why are we not seeing the impact?

### Papers
- # papers about novel ML implementation
- # papers about novel ML algorithms

### Finance
- $$$ generate by AI in healthcare
- $$$ raised for AI healthcare
Paradigm Shift

From...
Ok, I have a machine learning model...now what?

To...
Ok, I have this problem I need to solve...how could machine learning enable the solution?
Healthcare is a Complex System...

**System**: a set of individual agents interacting with each other and forming **structures, processes, and patterns**

Medication Administration System in Hospital

**Structure**
- Pharmacy
- Nursing units
- Elevators
- Committees
- Info systems
- Individual roles
- Etc.

**Process**
- Ordering
- Transcribing
- Entering
- Dispensing
- Etc.

**Pattern**
- Prescribing practices
- Types of errors
- Feelings & values
- Supportive behavior
- Blaming
- Fear
- # of errors reported
- Etc.

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“To address how AI can be leveraged at scale, we need to both broaden and deepen our thinking around **how AI fits into the complexities of healthcare delivery.**”
Create systems enabled by AI

Machine learning model(s)  →  Intelligent care delivery system
(New work structures and processes for delivering care enabled by ML models)
Building and implementing AI systems require the synthesis of multiple disciplines

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<th>Category</th>
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<tr>
<td>External Rules and Regulations</td>
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<td>Organizational and Business Strategy</td>
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<td>People, Teams, Workflows, and Culture</td>
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<td>Software Applications/Human Computer Interaction</td>
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<td>Analytics</td>
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<td>Data and Knowledge Representation</td>
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<td>Infrastructure</td>
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Adapted from Sittig and Dean et al and Nguyen “Health IT Stack”
How can we create systems enabled by AI?

1. Leverage existing proven methods for complex problem solving and implementation
   - Quality Improvement
   - Human Factors Engineering
   - Quality by Design
   - Design Thinking
   - Implementation Science

2. Add prediction and classification to the current constructs for improving processes
   - Reduce waste
   - Minimize variation
   - Minimize hand-offs
   - One-piece flow
   - Pull systems
   - Work cells
   - Prediction and classification
A tale of two projects

AI Enabled Clinical Deterioration Prevention

What’s the problem?
AI task identified?

How does AI enable the solution?

AI Enabled Advance Care Planning

What’s the problem?
AI task identified?

How does AI enable the solution?
AI Enabled Clinical Deterioration Prevention

What’s the problem?

Unexpected deterioration events (RRT, Code, escalation to ICU) with some leading to death in the inpatient setting.

Early signs of clinical deterioration missed:

Why:
• Information overload
• Continuity > shift change
• No shared definition of severity of illness

Signs identified, but not acted on:

Why:
• Friction amongst team members
  • No shared definition of severity of illness
AI Enabled Clinical Deterioration Prevention

Key Drivers Derived from Root Cause Analysis

- **Continuous** clinical status monitoring
- **Objective** shared mental model for *early* risk of deterioration *detection*
- **Standardized initial response** and intervention
- Agreed upon workflows *after initial response*
- **Role clarity** throughout the process
AI Enabled Clinical Deterioration Prevention

Model is looking at 20+ clinical indicators in EPIC

Risk of Deterioration Column Flag (in production)

Flags patients with a 1/5 chance of ICU Escalation, RRT or Code in the next 6-18 hours.

Automatically updates every 15 minutes
AI can enable a shared definition for risk and standardized workflows, alleviating cognitive burden and friction.
AI Enabled Advanced Care Planning

What’s the problem?

Low and late frequency of documented advance care planning conversations for patients with terminal illnesses in the inpatient setting, contributing to end of life care that is not concordant with patient goals, moral distress for providers, and ineffective and inefficient utilization of health system resources.

Selection of appropriate patients:
Why:
• Difficulties estimating and agreeing on prognosis
• No shared definition of Advance Care Planning

Limited capacity and coordination challenges:
Why:
• Assumption that this is an MD only conversation
• Silo’d documentation
• Little to no outpatient continuity
AI Enabled Advanced Care Planning

Key Drivers Derived from Root Cause Analysis

Consistent identification of patients that need ACP leveraging a shared mental model for prognosis

Shared definition of advance care planning

Decentralization of responsibility to have iterative ACP conversations

Ability to easily share ACP updates/info to and from any member of the team

Providers and have tools and skills to feel confident to ACP with patients/families

Continuity with outpatient primary care providers
AI Enabled Advanced Care Planning

How does AI enable the solution?

Automated list of ACP candidates generated by a ML model predicting 12-month mortality on all admitted patients

Secure: ACP List (Team D) 03-22-20

AI-Enabled Advance Care Planning <ai-acp@cs.stanford.edu>

Sun 3/22/2020 7:05 AM
To: Ron Li

Dear Dr. Li,

Please consider discussing prognosis with the following patients on C3 and M7:

<table>
<thead>
<tr>
<th>Name</th>
<th>MRN Age</th>
<th>Admit Date</th>
<th>Unit</th>
<th>Bed</th>
</tr>
</thead>
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If prognosis is shared, please fill out the "Advance Care Planning Smartform" under the "Goals of Care" tab in Epic. Nursing, Social Work, and PT/OT will be available to help continue an advance care planning discussion.

Thank you,
AI-Enabled ACP Team.

This message was encrypted in transit via the Stanford Secure Email service.
AI can enable new workflows and structures for ACP to be multidisciplinary
How do we build our capacity to create AI enabled systems?

1. Stop thinking of AI as the solution but rather an enabler of an intelligent care delivery system

2. Expand our improvement lens on all quality improvement projects to include prediction and classification

3. Streamline the model selection, validation and integration process so that it can occur iteratively in parallel with problem solving and workflow design activities
THANK YOU

QUESTIONS?

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