How to Trust, but Verify, in Healthcare

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Patient Journey

ICD codes
Medications
Procedures
Lab tests
Term mentions
Bedside monitors
Wearables
Gene Expression
Phone usage
Browsing history
Social media
Audio recordings
Exposome
Decide who to treat

Based on:
1. Genetic markers
2. Demographics & SES
3. Prior medical record
4. Wearables (digital biomarkers)
5. Behavioral and social data

If \((\text{Risk} > \text{Th.})\)

then \((\text{do} = X)\)

Decide how to treat

Based on:
1. Biomarker measurements
2. Mechanistic understanding of disease
3. Similar patients’ outcomes
4. What’s covered, and available
5. How much time we have on hand
A model

Learning Algorithm

Model \( f(x) \)

\( X_{\text{new}} \)

\( Y_{\text{pred}} \)

features (e.g. patient characteristics)

target (e.g. patient outcome)

observations (e.g. patients)

"Training Data"
A workflow

I might be able to help this patient; what do you think?

Good catch! I agree.
Inpatient Hospital Medicine Initiated Workflow – Goals of Care Workflow

Summary Stats
- Total Steps: 7
- Level 1: 7
- Level 2: 7
- Handoffs: 7
- Total Cycle Time: 40 hours

Reliability Level:
1. Indicators: Feedback, checklists, training, basic standards
2. Procedures: Embedded standard work, reminders, constraints
3. Systems: Fail safes, physical layout, built-in feedback, automated systems, concentration of responsibility

Margaret Smith, MD, Vistual Improvement, SHEC
Definitions and Clarifications

• Trustworthiness: of the model, or the workflow around it, or both?

• Trust = proof over time that a thing does what it claims to do. Trust is earned [over time].

• HOW = interpretability
• WHY = explainability
When predicting 24 hr. mortality ...

- Interpretability is a poor surrogate for trust
  - Knowing ‘how’ does not help you decide what action to take

- Explainability is a poor surrogate for trust
  - Knowing ‘why’ does not help you decide what action to take

- Knowing that the model’s prediction has helped make good decisions in the past 2 years.
Building trustworthy (and useful!) models

**Use case**
- What clinical outcome(s) are you trying to affect?
- Who is the target population?
- What action would you take?
- Who will take that action?

**f: X -> Y subject to...**
- use an existing equation vs. learn a new equation.

**Technical formulation**

**Technical validation**

**Model development**

**Deployment design**

**Running system** = model applied to each case + execution of workflow.
- Evaluate the impact of the running system on the outcomes we care about
- Maintenance is huge liability – who will carry the pager?
- Monitoring is unexplored

**Utility assessment**
- Given the costs of the actions and its benefit, is there net utility?

**Deployment design**
- Do we increase the efficiency of existing workflows
- Do we require entirely new workflows

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**How do we get the best f: X -> Y?**
- Does representation learning help?
- Does multi-task learning help?
- Does using textual content help?
- How do we train fair models?

**Can we use f: X -> Y in the real world?**
- Can we get the data by 5 am, to make prediction by 6 am?

**Running system**
- Model applied to each case + execution of workflow.
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