Agenda

- Background on AI: a primer
- Separating Hype from Reality
- Examples & Use-cases
- Roadmap & Next Steps
- Q & A

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Background on AI: De-mystification

- **Artificial Intelligence (AI):** Activity that resembles human capabilities of association, learning, and insight.
- **Machine Learning (ML):** Math and Software that replicate & extend human capabilities of pattern recognition & learning.
- **ML applies statistics & modeling in software to:**
  - Represent essential features of the world
  - Allow software to update its performance in response to training
  - Allow software to identify new patterns of association in data
- **Uses:**
  - **Classification:** assigning something to a meaningful category
  - **Data Mining:** finding patterns of association in data (clustering)
  - **Dimensionality Reduction:** mapping many to few, assigning topics
Background on AI: De-mystification

- **Supervised Learning**: ML that employs training examples (reference data) provided by people.
  - Example: handwriting interpretation (US Postal service)—classify inputs based on meaningful categories (alphabet letters) & training cases

- **Unsupervised Learning**: ML that groups data based on mathematical & statistical properties of the data
  - Example: data mining. Finding potentially new associations in data. Software scans large data, but can’t assign meaningful categories (classification)
Separating Hype from Reality

• There’s no escaping statistics
  • Performance inversely relates to complexity, capture & volume of data
  • Engineering features (abstraction) is expensive
  • Training Data is expensive

• Healthcare is a human endeavor
  • Policy, Policing, & Payment are based on human exercise of independent clinical judgement and action
  • Technology moves much faster than regulation & the law
  • Humans don’t trust ‘black boxes’: be skeptical of magic & panaceas

• A worthy goal: AI supports humane care
  • Reduce hassle of necessary administrative oversight
  • Elucidate what treatments are most effective & efficient
  • Help people contend with a rising tide of data
  • Prioritize & support meaningful human interactions
Evidence Based Guidelines are very complicated (branching trees)

Reconciling a patient’s record (EHR) with guidelines is laborious

Yet: appropriateness improves with evidence-based practice

Distillation: how do we make guidelines ergonomic & useful in practice?

**Approach:**

Leverage Natural Language Processing (NLP) to expedite information retrieval from EHR, organized by *clinical logic*

Employ Data Science to prune guidelines complexity as appropriate

Operationalize all of this in browser-based, HIPAA-compliant software

**Implementation:** At Massachusetts General Hospital (MGH) and Partners Healthcare as part of order work-flow (PrOE)

Key collaborators: Tim Ferris MD, Creigh Milford MD, Mitch Harris PhD, Sid Govindan MD, Jim Zawisa Msc

Illustrative Use Cases: Improved Utilization Management
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Appropriateness Scores for Diagnostic Catheterization for Suspected CAD at MGH* vs. NY Cardiac Database**

- MGH Data reflect the time period 8/2013-8/2014.
Illustrative Use Cases: Improved Utilization Management

<table>
<thead>
<tr>
<th>Member</th>
<th>Member Id</th>
<th>Age</th>
<th>Health Plan</th>
<th>Referring Physician</th>
<th>Specialty</th>
<th>CPT</th>
<th>ICD</th>
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</thead>
<tbody>
<tr>
<td>Bobby Hill</td>
<td>XYZ001</td>
<td>52</td>
<td>MSI Program</td>
<td>Uy, Levin</td>
<td>All</td>
<td>74177</td>
<td>R10.31</td>
</tr>
</tbody>
</table>

This application is designed to streamline the prior authorization process. Please provide only information that is truthful and up-to-date according your knowledge. By pressing the "Submit" button, you attest to the accuracy of the provided information.

### Indications

<table>
<thead>
<tr>
<th>COMMON INDICATIONS</th>
<th>ANSWER QUESTION(S)</th>
<th>FINAL STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverticulitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendicitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generalized abdominal pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal wall hernia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowel obstruction</td>
<td></td>
<td></td>
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<tr>
<td>Inflammatory bowel disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Concerning Symptoms

Following conditions present in the medical record?
- Pain that persists for more than 4 weeks?
- History of cancer?
- Signs of infection, such as fever or WBC > 10,000?
- Abdominal mass?
- GI bleeding?
- Peritoneal signs, such as abdominal pain, abdominal tenderness, or abdominal guarding, exacerbated by movement of the peritoneum?

- YES
- NO
- UNKNOWN

#### CPT 74177

CT abdomen and pelvis with IV contrast

It looks like your patient has a concerning symptom. Your case will be immediately approved.

- Submit Approval

#### Withdraw Case
Improved Utilization Management: Implementation and scaling issues

• Lessons Learned:
  • Innovation *can satisfy* multiple stakeholders (patient, clinician, payer)
  • EHR interoperability (free flow of data, open workflow) remains *poor*
  • Market dynamics *complex* for utilization management

• Problems:
  • NLP ability to answer questions using unstructured EHR data is *limited*
  • Challenge to acquire enough *training data* for models & NLP
  • Business case challenge: who really benefits from improved workflow?
    • Key stakeholders do not necessarily value workflow & experience innovation
  • Workflow challenge: integrating *fully functional software* in EHR
Outpatient Examples:

- Machine Learning for IoT
  - Patient facing self-management applications (Diabetes, Depression)
  - Home monitoring devices (Home activity monitoring)

- Patient Micro-segmentation for Population Health
  - Mass customization of outreach efforts
  - Constant optimization of best ways to promote change

- Provider Documentation Workflow Optimization
  - Ability to adapt to how a provider uses the EMR
  - Voice analytics augment dictation to ambient “scribe” functions

- Key Activities
  - Monitoring daily volume of streaming monitoring data from devices
  - Detect baseline and changes from baseline (Filter signal from noise)
  - Customize alerts appropriately for patient/provider/situation
Outpatient Examples:

- Population Health:
  - Behavior patterns
  - Continuous looped learning
  - Individualized plan
  - Customized action

- ML active population surveillance fits cyclic nature of chronic condition management.

- Can optimizes provider and patient time and efforts and reduce empirical trial/error.
Roadmap & What’s ahead

• **Matching modeling (ML) to problems**
  • Appropriateness determination
  • Feature recognition (radiology)
  • Clinical trial recruitment
  • Genomic mapping, disease & drug response prediction

• **Improve & clarify the interaction between AI & people**
  • Regulation & software ethics: defining who is taking responsibility
  • Technical evolution: AI that can explain its rationale to a human

• **Bringing models to the data (and staying HIPAA compliant)**
Conclusions:

- AI has the potential to help us re-think healthcare delivery
- Despite technical challenges, there are real use cases today
- Policies and regulations need to mature around use of patient data (AI training) and advanced decision support (AI augmented automation) to safely accelerate development
- Resist hype: AI is not magic, and it’s not a panacea
- AI can extend, but not replace human insight & judgement