Applied Artificial Intelligence at Mayo Clinic

Atul Dhanorker, Adam Resnick
Mayo Clinic

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Presentation Outline

- The Opportunity Space
- Artificial Intelligence (AI) Capability
- **Case Study 1:** Emergency Department Transfer
- **Case Study 2:** Breast Cancer Risk Prediction
- Discussion

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Mayo Clinic – United States

TOTAL CLINIC EMPLOYEES – 63,078*

4,590 Physicians and scientists	58,488 Administrative and allied health staff
Rochester	34,660**
Health System	16,413
Arizona	6,448
Florida	5,557

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2030 Bold. Forward. Strategic Plan

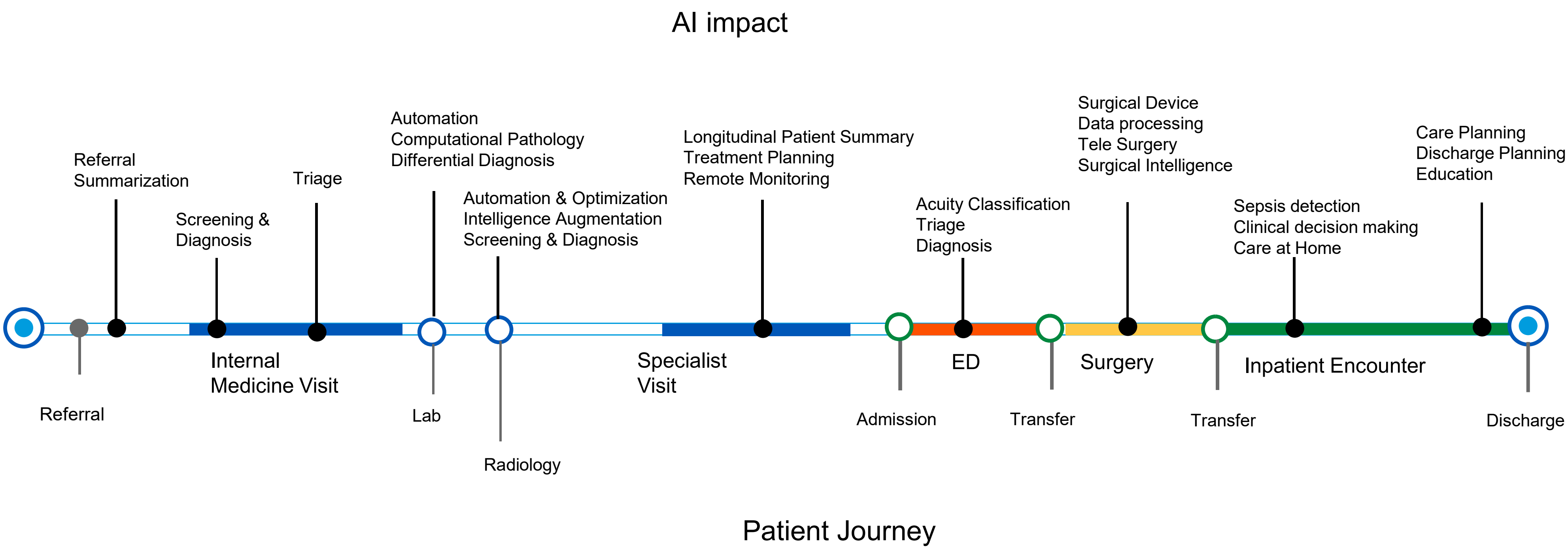
Cure

Connect

Transform

People, Innovation and Environment

Patient Journey Map and AI Impact



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Capability Model: Ideas Based on Maturity

Idea	Proof of Concept (POC)*	Prototype*	Minimum Viable Product*	Vended Product / Applied IA
A hypothesis to solve a problem	"Identifies operational feasibility of the concept and is for internal use"	"Offers the first look and feel of the project and can be presented to stakeholders"	"Gives a basic working model that can be implemented and deployed into"	Available in the marketplace

* Definitions for Proof of Concept, Prototype and Minimum Viable Product were sourced from Hacker Noon, a hub for technologists and Software Developers

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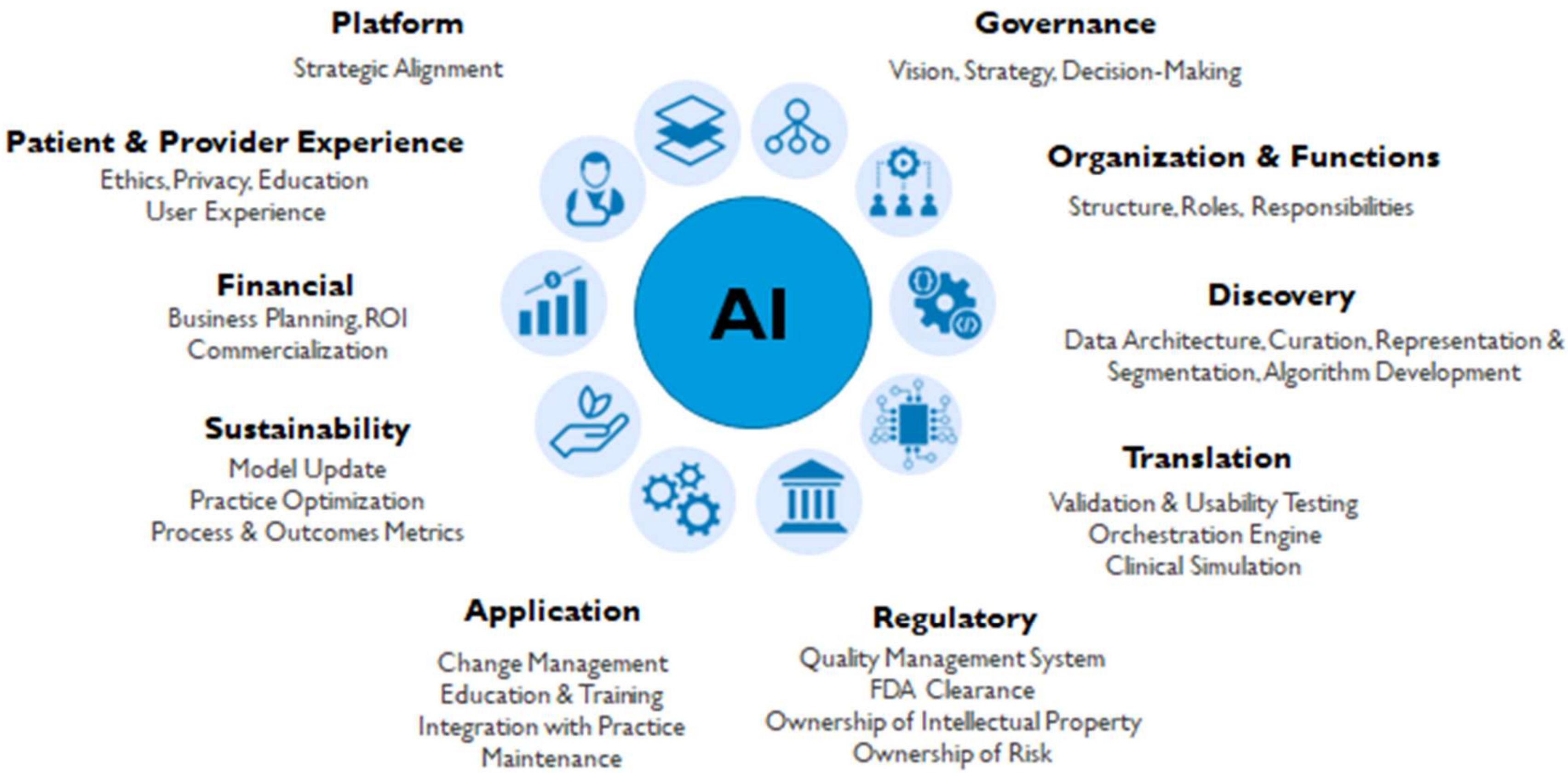
Pillars of Clinical AI



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Case Studies

Emergency Department Case Study

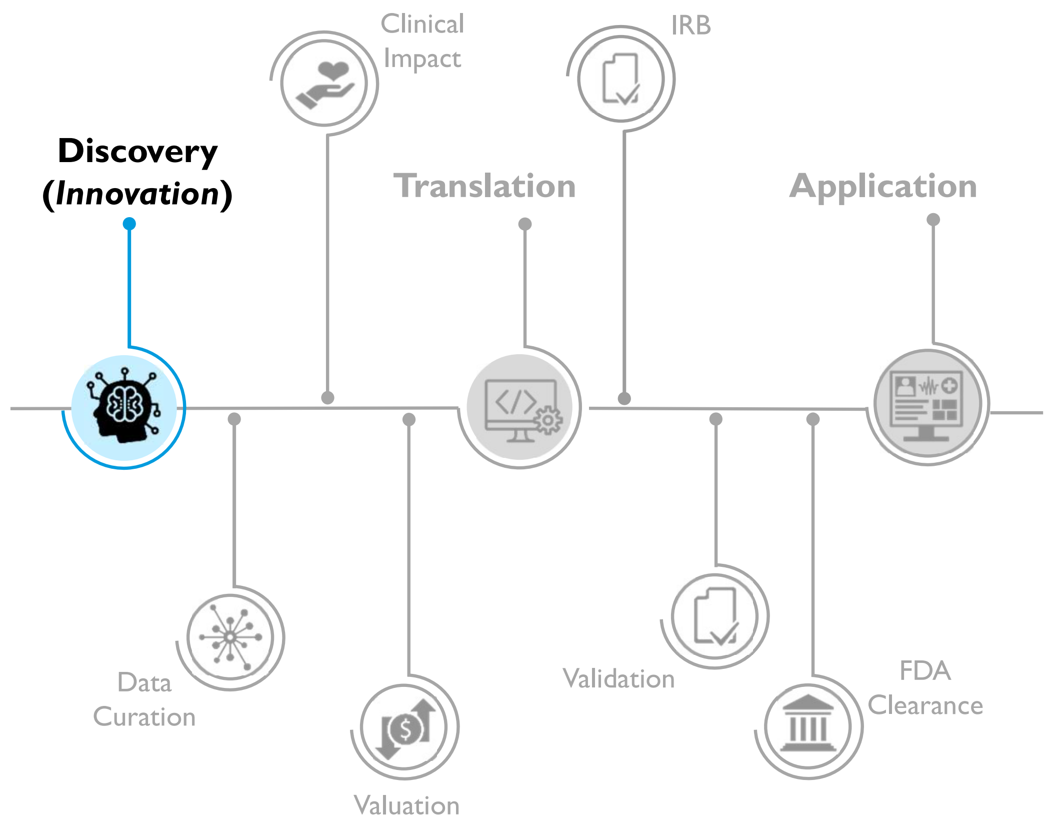
Product Pipelines

Clinical, Research and Education

Business Intelligence & Administrative

Direct-to-Consumer

Process



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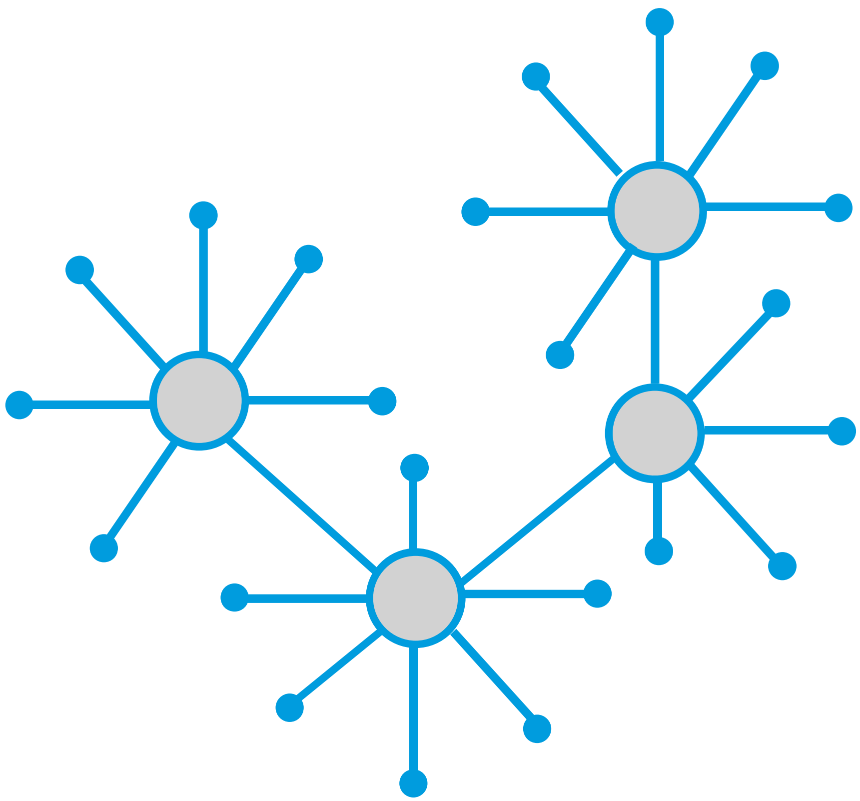
Mayo Clinic Midwest

- **Hub-and-spoke model**
  - "Hubs" can manage complex patients
  - "Spokes" have fewer resources
- **Goals:**
  - Manage patients locally as much as possible
  - Reduce unnecessary healthcare utilization



Purpose

Objective

To leverage machine learning to **predict which patients would require hospital transfer** to enable early preventative intervention

Benefits

- Earlier readiness of hospital transport
- Ability to intervene with telemedicine to prevent transfer
- Enable research to better understand trends in patient transfers

Purpose

Proactively Prepare Transport

Identify Telemedicine Candidates

Detect Biases and Trend

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Approach

Input Data

- Demographics
- Triage status at arrival
- Problem list
- Vital signs
- Diagnosis
- Orders
- Medications
- Used data from 160,000 patients treated between July 2017-October 2020 from non-hub Mayo Midwestern sites

Neural Network

trained in Google AutoML

Risk Score

Score 1-10 indicating risk of transfer to hub site

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Results

	Model Type	Accuracy	Percent of Flagged Patients Who Were Truly Transferred	Percent of Transferred Patients Who Were Flagged
Full Visit Data	Neural Network	95.5%	77.4%	63.4%
Data at Triage	Neural Network	92%	68.8%	8.1%

Null model: 92% accuracy

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Conclusions

Feasibility

- It is **possible to accurately predict ED transfers** using machine learning
- Model accuracy is less clear with data only available at triage

Implementation

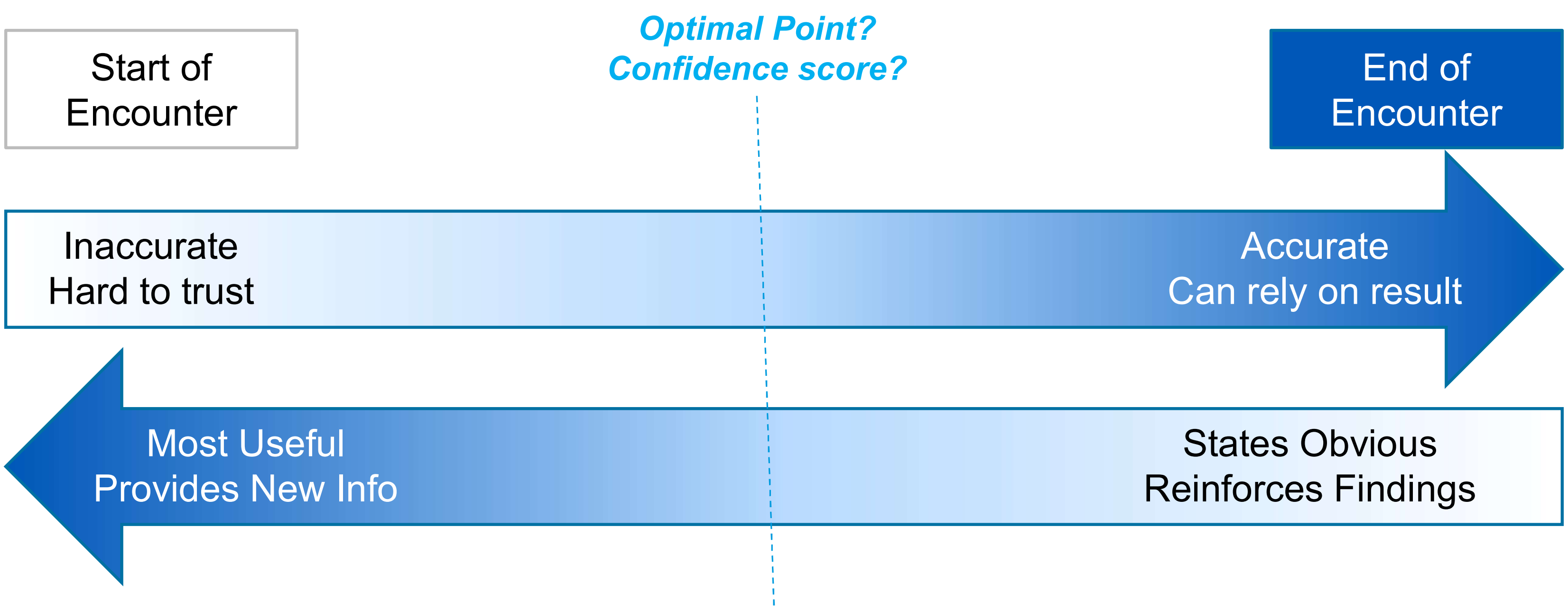
- The model **use case must be refined** for further development
- Minimum acceptable predictive performance must be established
- **Incorporation into clinical workflows** must be considered

Items for Further Study

- The use **of additional predictive variables** may improve accuracy
- Other criteria for optimization may better meet the model use case

Possible Follow-Up Research Question

- **At which point of the patient journey is input from a model-based risk score most valuable?**



Automation of Breast Cancer Risk Assessment Case Study

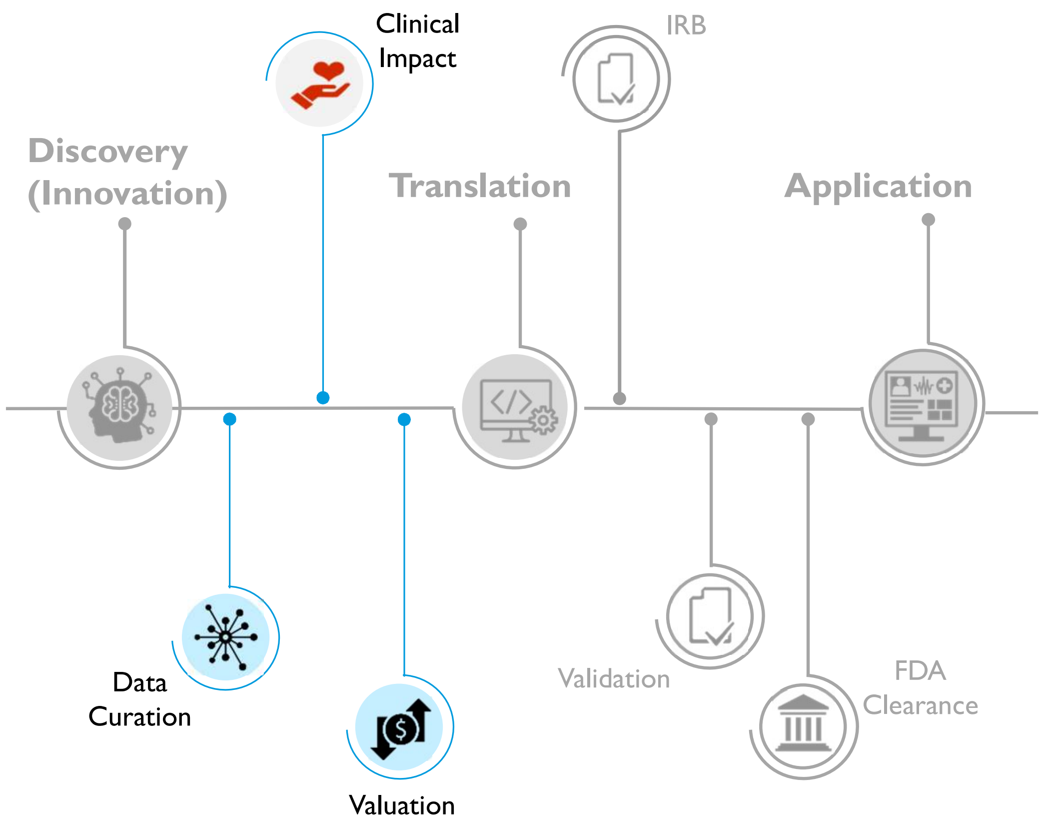
Product Pipelines

Clinical, Research and Education

Business Intelligence & Administrative

Direct-to-Consumer

Process



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Background

Risk Assessment

- Tyrer-Cuzick model calculates patient's 10 year and lifetime risk of developing breast cancer
- It uses demographic, family history, radiology, breast biopsy, genetic etc data to calculate the risk

Point of Care use Challenges

- Physicians are spending 30-35% of their time documenting and retrieving information with EHR
- Data is scattered throughout electronic health record(EHR)
- Most of the data elements are stored in unstructured clinical notes.

Patient and Physician satisfaction

- Physician EHR usage present a challenge in developing meaningful relationship with patient
- Physician are under increasing time pressure resulting in stress and burnouts

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Purpose

Objective

To leverage NLP and deep learning to **extract structured and unstructured data** element needed to prepopulate the TC risk prediction model

Benefits

- Improve patient provider interaction
- Reduce cognitive burden and stress
- Human in the loop design to enable physician to modify the data elements

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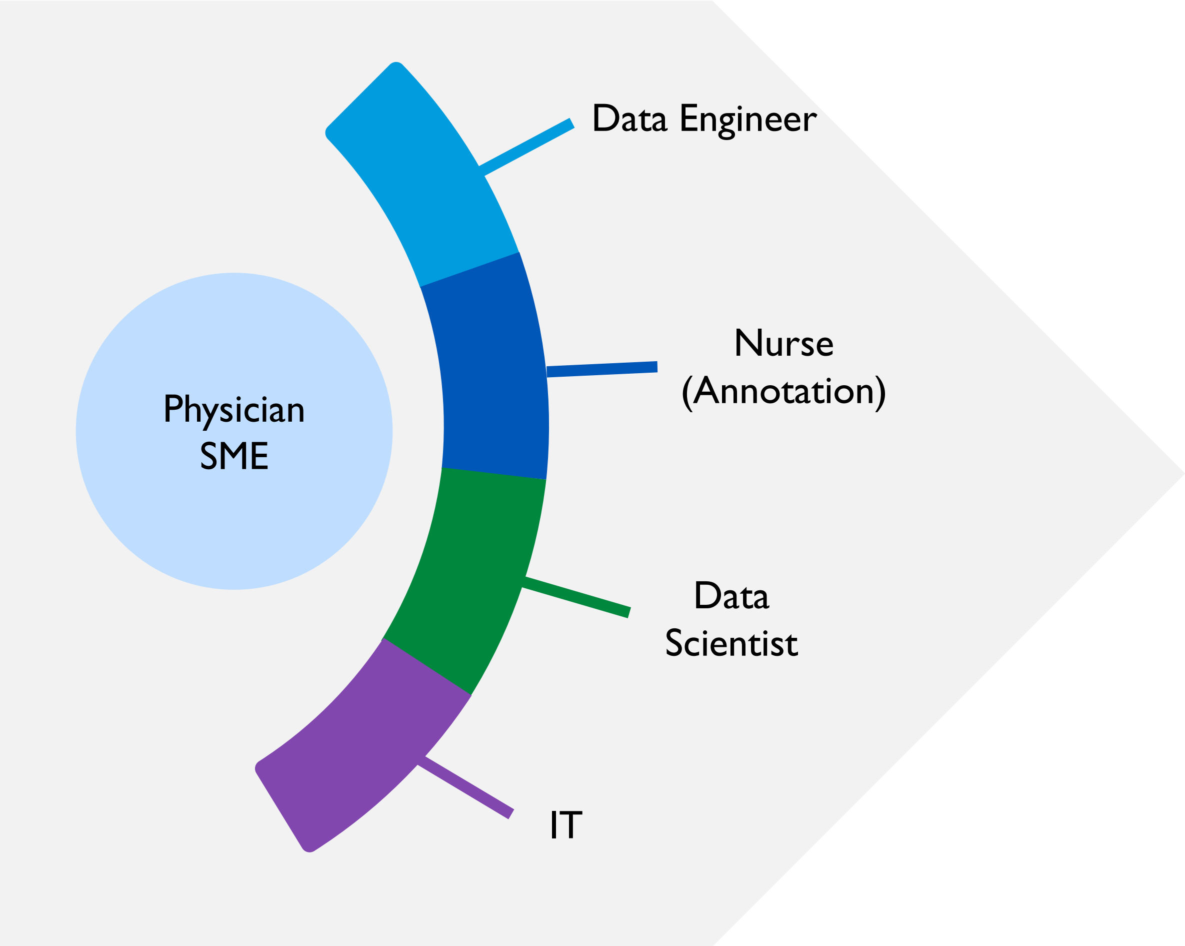
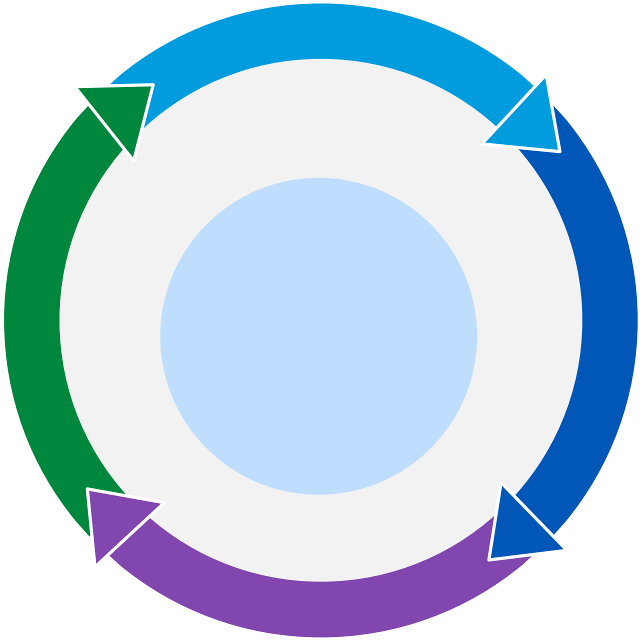
Team


Physician
SME
Data Engineer
Nurse
(Annotation)
Data
Scientist
IT



Challenges

Data

- 70% of data element present in clinical notes.
- Complex inclusion and exclusion criteria.
- Need specialized trained nurses for annotation.
- 80% of project effort in annotation.
- Coverage of data elements.

Process Engineering

- Human in loop design: augment not automate the physician's workflow.
- Ethical, technical and quality standards

Agile Translation and Collaboration

- **Technical collaboration** between team members with different domain expertise

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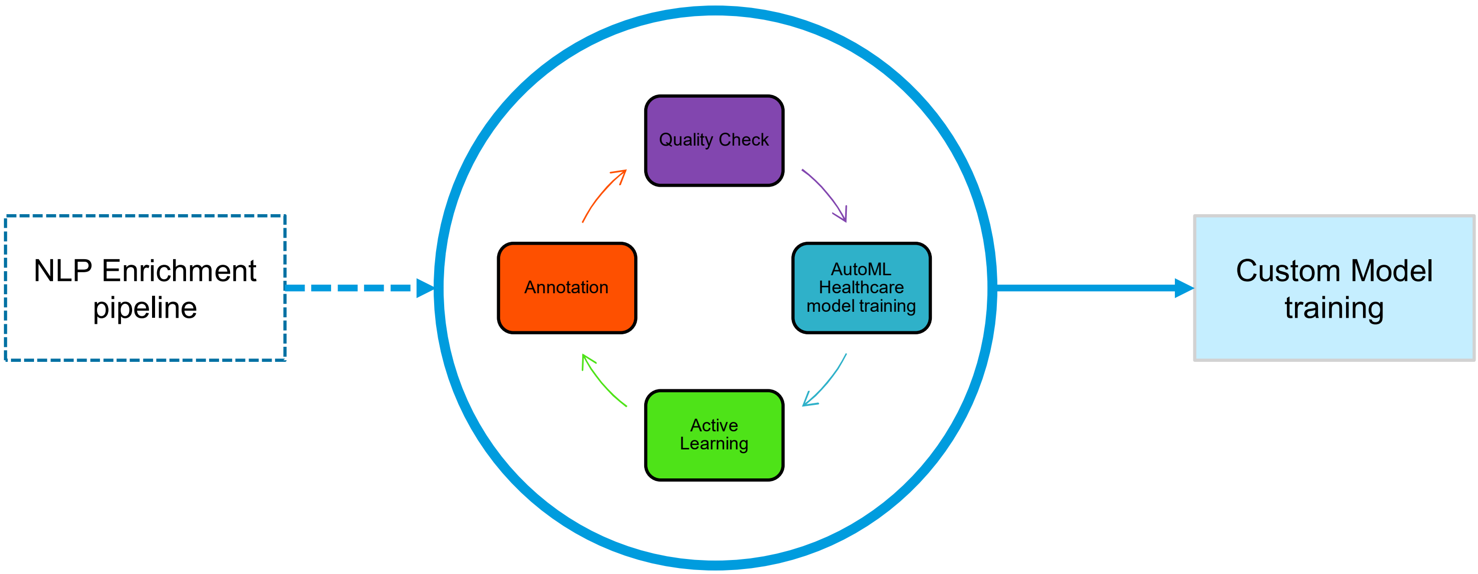
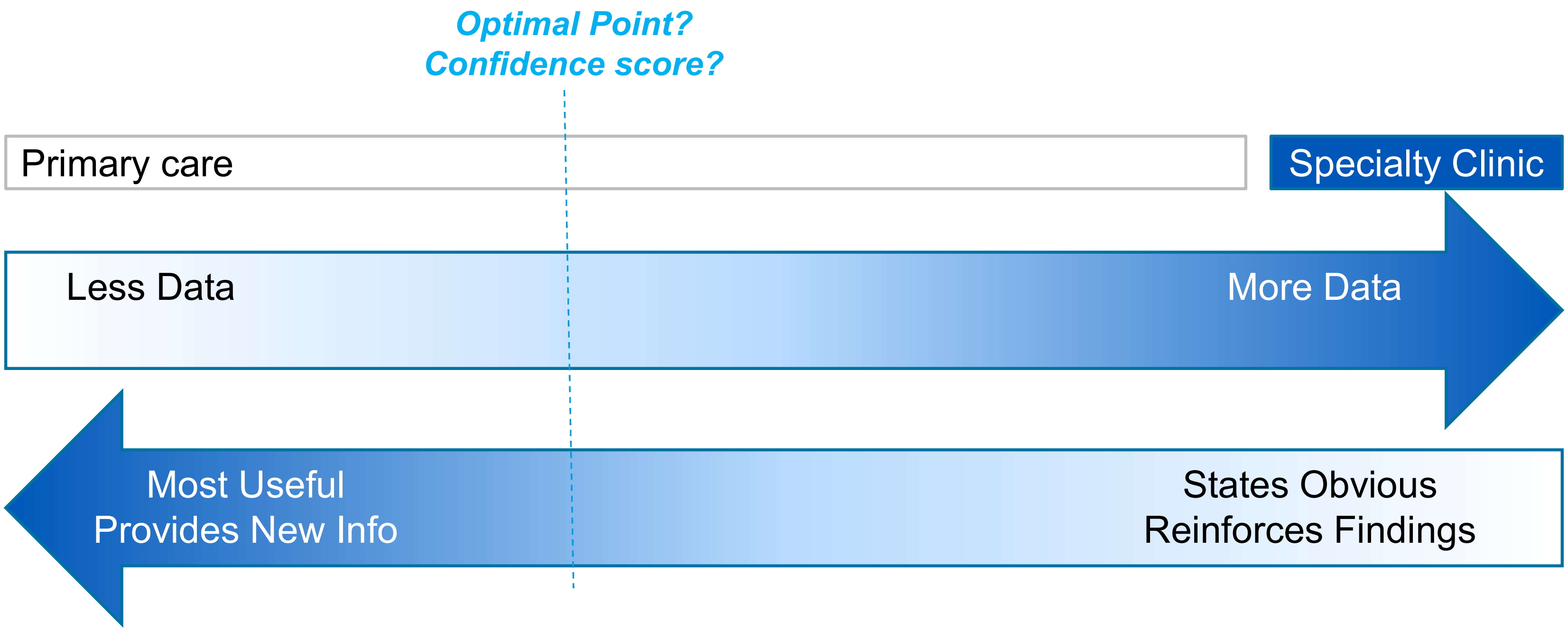
Approach



NLP Enrichment pipeline
Quality Check
Annotation
AutoML Healthcare model training
Active Learning
Custom Model training

Possible Follow-Up Research Question

- **At which point of the patient journey is input from Risk model most valuable?**



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Discussion

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