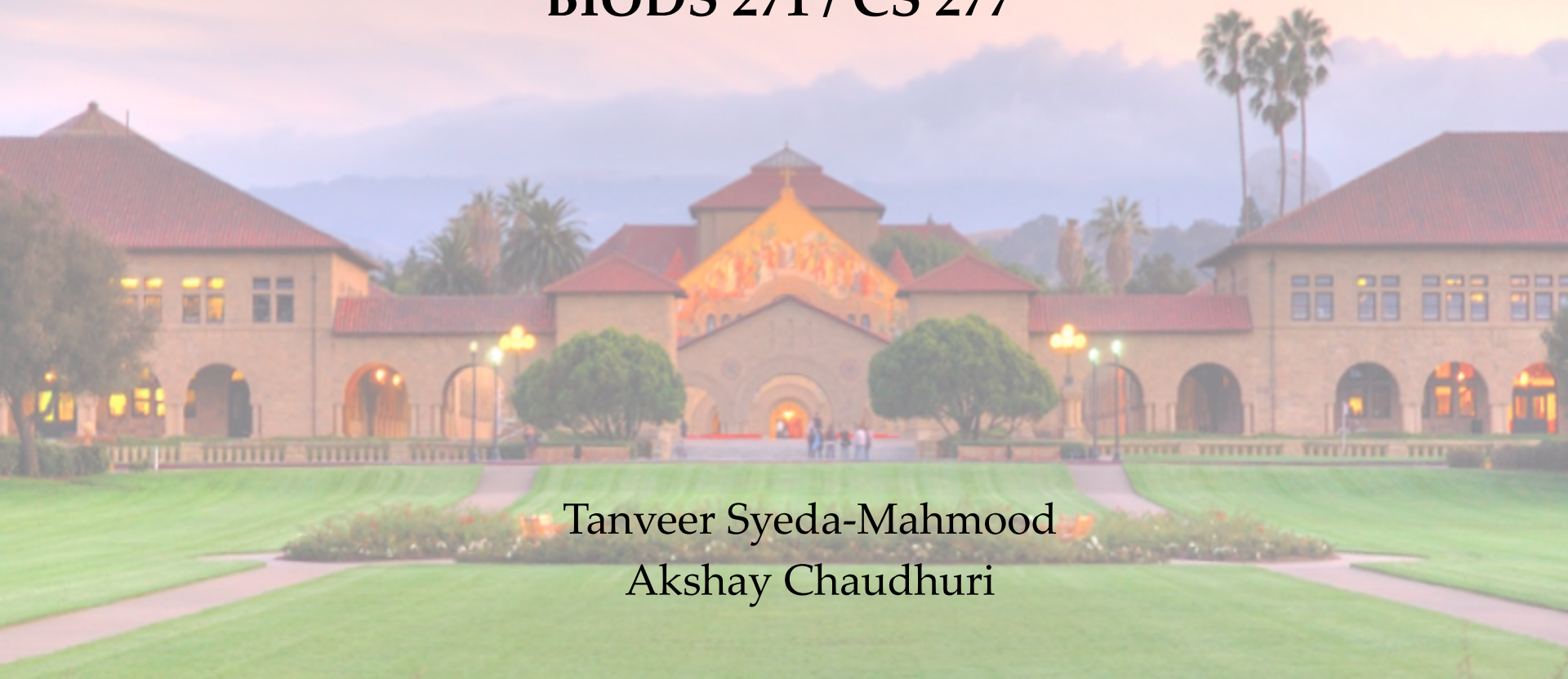# Clinical Needs for Foundational Models

BIODS 271 / CS 277

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Akshay Chaudhuri

Healthcare-specific Foundation Models

- Some target tasks addressed by foundational models may not be as useful for healthcare-specific use cases:

  - *Sentiment analysis*

  - *Masked language prediction*

  - *Question answering*

  - *Captioning*

  - Language translation

  - Summarization

  - Language generation

  - Classification

  - Segmentation

  - Speech to text

User base for Healthcare FM

- Providers/Staff/Technicians
  - Clinicians: : Primary care, PCP, Radiologists, Cardiologists, Oncologists, Radiation oncologists, Interventional cardiologists, radiologists, …
  - Nursing and other hospital staff
  - Technicians
- Payers/Backoffice
  - Insurance, payer-provider networks, Medicare
  - Backoffice staff
- CIO/IT Staff
  - IT/Data warehousing, CRO
  - Training
- Clinical researchers/Academics
  - Clinical study research
  - Clinical education & training
- Patients

Clinical Needs for FMs

Imaging

- Technical assessment during imaging
- Worklist prioritization
- Referral routing, Telemedicine
- **Preliminary read – disruptive technology to expedite a dictation-driven workflow**
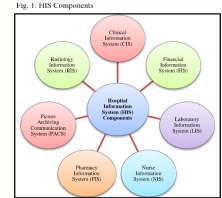
EMR

PACS

X-ray Read Service

Preliminary report

Imaging study

Radiology Read

Radiologist-corrected report

What are the clinical needs of providers?

- Technical assessments of imaging exams

- Screening and triage (first reader)

- Disease segmentation and tracking

- Measurement quantification

- Patient summaries, KPI

- Diagnostic decision support (second reader)

  - Recommendations for diagnosis, treatment or outcome

  - Normal/abnormal discrimination

  - Anomaly detection & classification

- Automated reporting

- Foundational Models
  - ✓ DNN
  - ✓ LM
  - ✓ LLM
  - ✓ VLM
- FM Workflows
  - ✓ Applications using multiple FM

Clinical text analysis

```
MR #: XXXXXXXX                    Sonographer: X
Patient Location: OP
Blood Pressure: /
Age:86            Gender:M              HT:

Referring MD: XXXXXX
Indica...

M—Mode

RVID

LVID

LA

AO

IVS

LVPW

EPSS

FS

LV EF
```

Clinical text
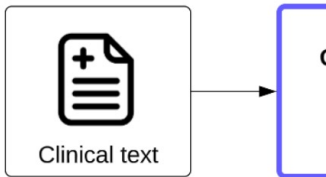
```
Study (
Rhythm
HR: bpm

Left V
cular
grossl
n. Ove
fraction is estimated to be 65 to 70%. There is mi
eft ventricular hypertrophy. No regional
wall motion abnormalities are seen.

Right Atrium: Right atrial size is mildly dilated.
Right Ventricle: Right ventricular cavity size is
ickness is normal, and the free wall
contraction
Aortic Valve  The aortic valve is restricted, thic
ified. Sever  aortic stenosis is present.
The aortic valve peak velocity is 4.49 m/s, the pe
80.6 mmHg, and the mean gradient is
46.0 mmHg. The aortic valve area is estimated to b
d to moderate aortic valve
insufficiency.
```

Input: The patient takes coumadin 5 mg daily for a TIA and she has an aspirin allergy.

Zero-shot prompt:

```
Input: The patient takes coumadin 5 mg […].
Prompt: Create a list of medications.
She takes 5 mg of Coumadin and Aspirin
```

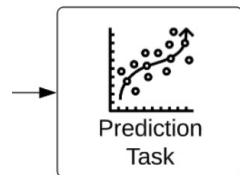Complex post-processing (resolver) of LM output → [coumadin, aspirin]

One-shot example + guidance:

```
Input: He is on a statin now and we think […].
Prompt: Create a list of medications.
-"statin"
Input: The patient takes coumadin 5 mg […].
Prompt: Create a list of medications.
-"coumadin"
-"aspirin"
```

Minimal post-processing (resolver) of LM output → [coumadin, aspirin]

Prediction Task

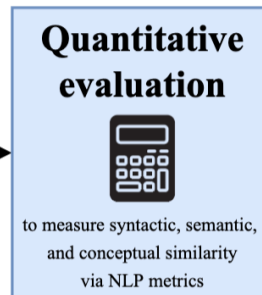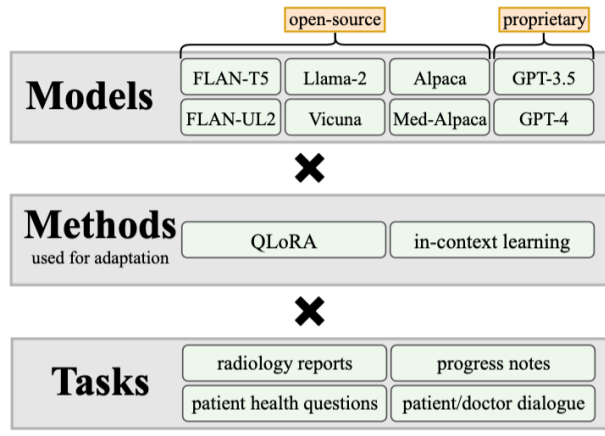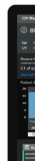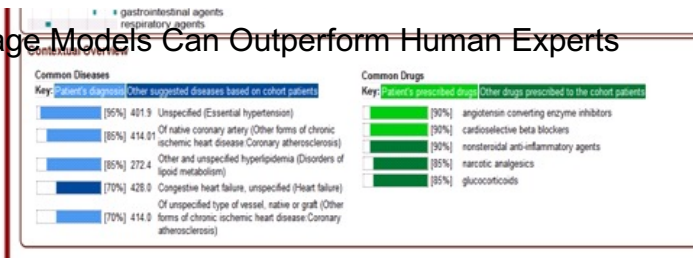| e of	Precision	Recall
	46.7%	79.6%
	72.6%	90.4%
Echocardiogram collection	753 echo reports	cTakes	34.0%	59.6%
		WHIA	78.2%	79.3%

Large Language Models are Few-Shot Clinical Information Extractors, EMLP2022

Patient summaries
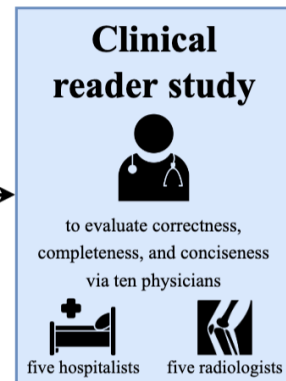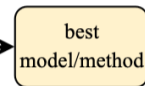
Clinical Text Summarization: Adapting Large Language Models Can Outperform Human Experts

- Indications from diagnostic reports
- Social and family history
- Demographics
- Vitals
- Allergies
- Labs

Clinical Decision Support

What are the clinical needs of payers/back office/CIO/IT?

- Pre-authorization

- Revenue cycle management

- Risk identification

  - 30-day Readmission prediction

- Auditing and compliance

- EMR/Healthcare informatics

- Peer review

- Clinical trial search

- Foundational Models
  - ✓ Statistical ML models
  - ✓ DNN
  - LM
  - LLM
  - VLM
  - ✓ LLM for Search
- ✓ FM Workflow applications
- ✓ Data science tools

Peer Review - Aortic Stenosis study

Study 1 – at Kaiser hospitals

- Total Patients: 1,129
- Patients with AS: 547
- Diagnosed by Provider 421
- Undiagnosed or Tracked: 126
  - Reports: 97
  - Images: 29

Study 2: At Sentara Hospitals

- Total Patients: 3090
- Patients with AS: 664
- Diagnosed by Provider 581
- Discrepancies found: 83

Nearly 30% discrepancies found by ML models!

Identifying Patients at Risk for Aortic Stenosis Through Learning from Multimodal Data, MICCAI 2016
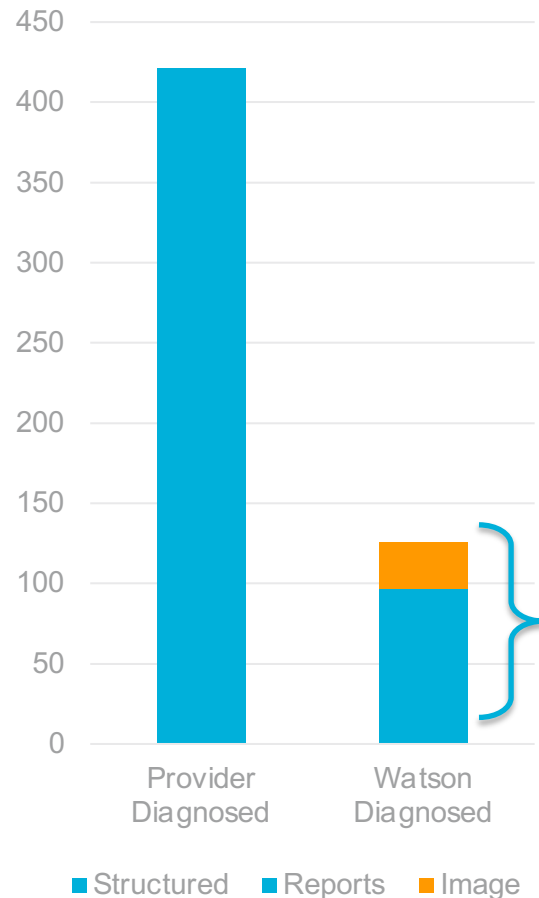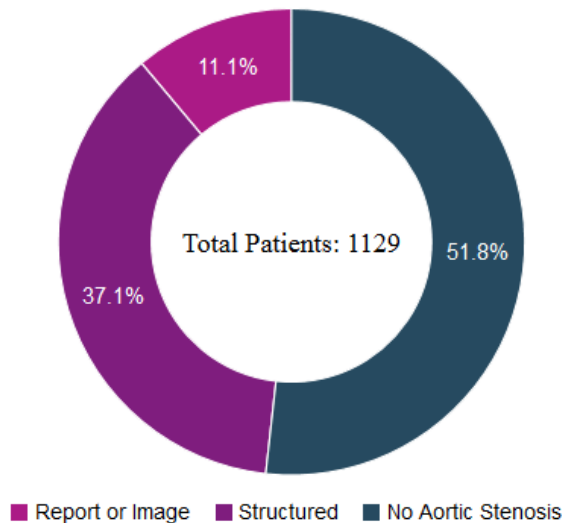
Clinical needs of FM for researchers

- Clinical Research and Education

  - Compare effectiveness of treatments

  - Predictive analytics

  - Developing new guidelines for treatment

  - Enhance medical curriculums

  - Clinical trials research

  - Accelerated discovery research (major area)

- Foundational Models
  - ✓ Statistical ML models
  - ✓ DNN
  - ✓ LM
  - ✓ LLM
  - ✓ VLM
  - ✓ FM for search
  - ✓ Multimodal fusion models
- ✓ FM Workflow applications
- ✓ Data science tools

Searching patients for clinical trials

for
m

- Deployed for 4 years at
  1M
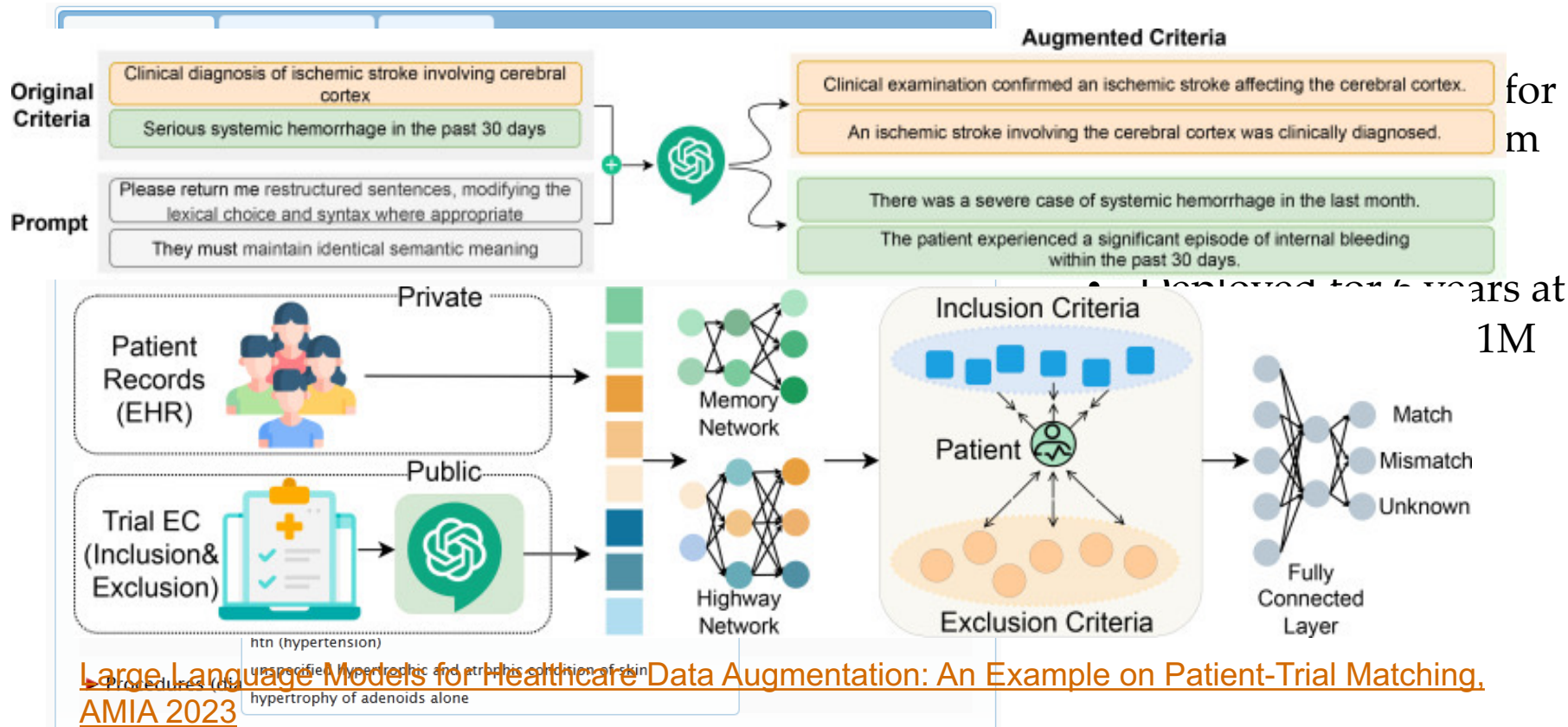
Clinical needs for patients

- Remote monitoring alerts

- Mobile tracking

- Triage and referral routing

- Patients-like-me

- Foundational Models
  - ✓ Statistical ML models
  - DNN
  - LM
  - LLM
  - VLM
  - FM for search
- FM Workflow applications
- ✓ Data science tools
- ✓ Anomaly detection

Most relevant use case of FM

- Automated report generation

  - From dictation to report

  - From image to report

- How good are the current automated report generation using LLM?

  - XrayGPT, GPT4,..

  - Hallucinations

- A case study of automated reporting

  - Turing study on chest X-ray preliminary reads (preview)

A Turing Test for Radiology AI

Chest X-ray
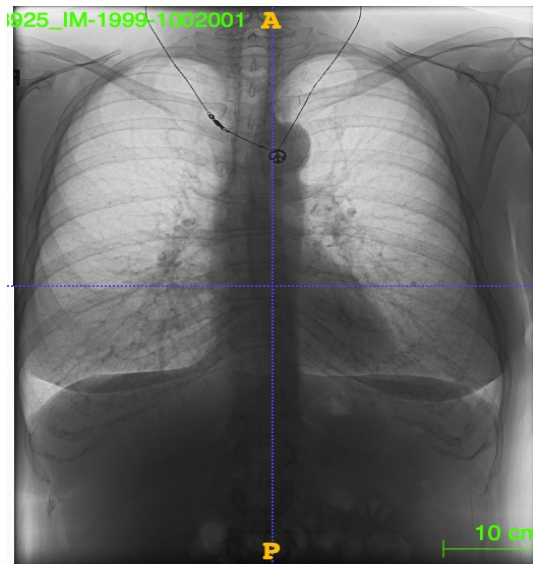
Automated Preliminary Read

There are atherosclerotic changes of the aorta.
There are calcified right hilar and mediastinal lymph nodes.
Arthritic changes of the skeletal structures are noted.