

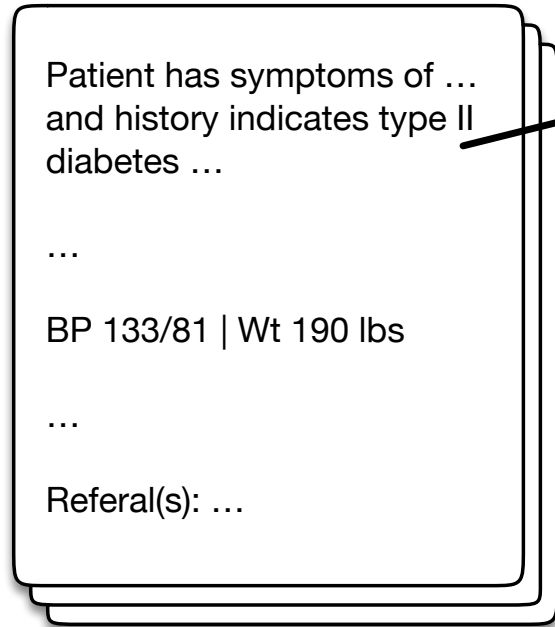


# CHiLL: Zero-shot Custom Interpretable Feature Extraction from Clinical Notes with Large Language Models

Denis Jered McInerney<sup>1</sup>, Geoffrey Young<sup>2</sup>, Jan-Willem van de Meent<sup>3</sup>, Byron C. Wallace<sup>1</sup>  
<sup>1</sup>Northeastern University, <sup>2</sup>Brigham and Women's Hospital, <sup>3</sup>University of Amsterdam

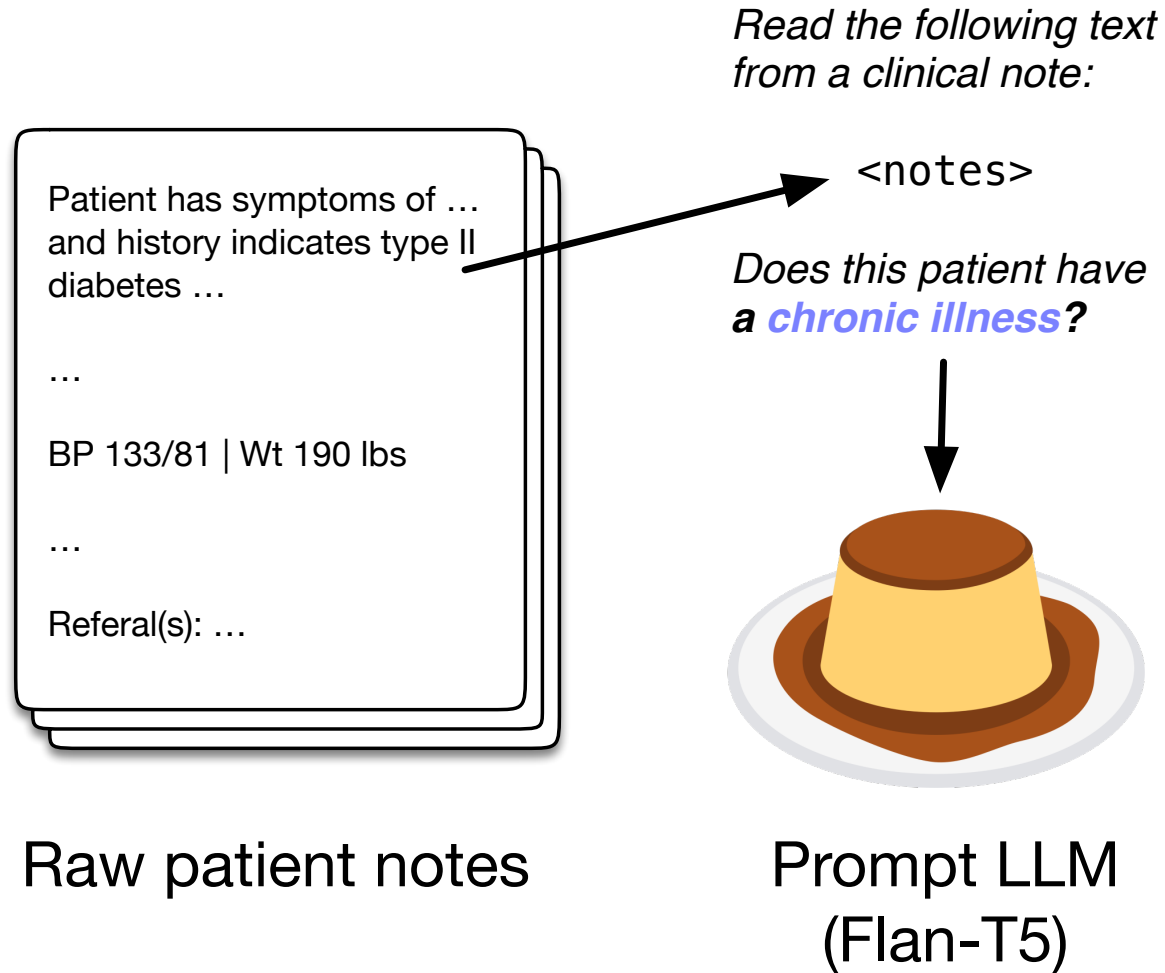
Presented by  
Denis Jered McInerney

# Craft **H**igh-**L**evel **L**atents (**CHiLL**)

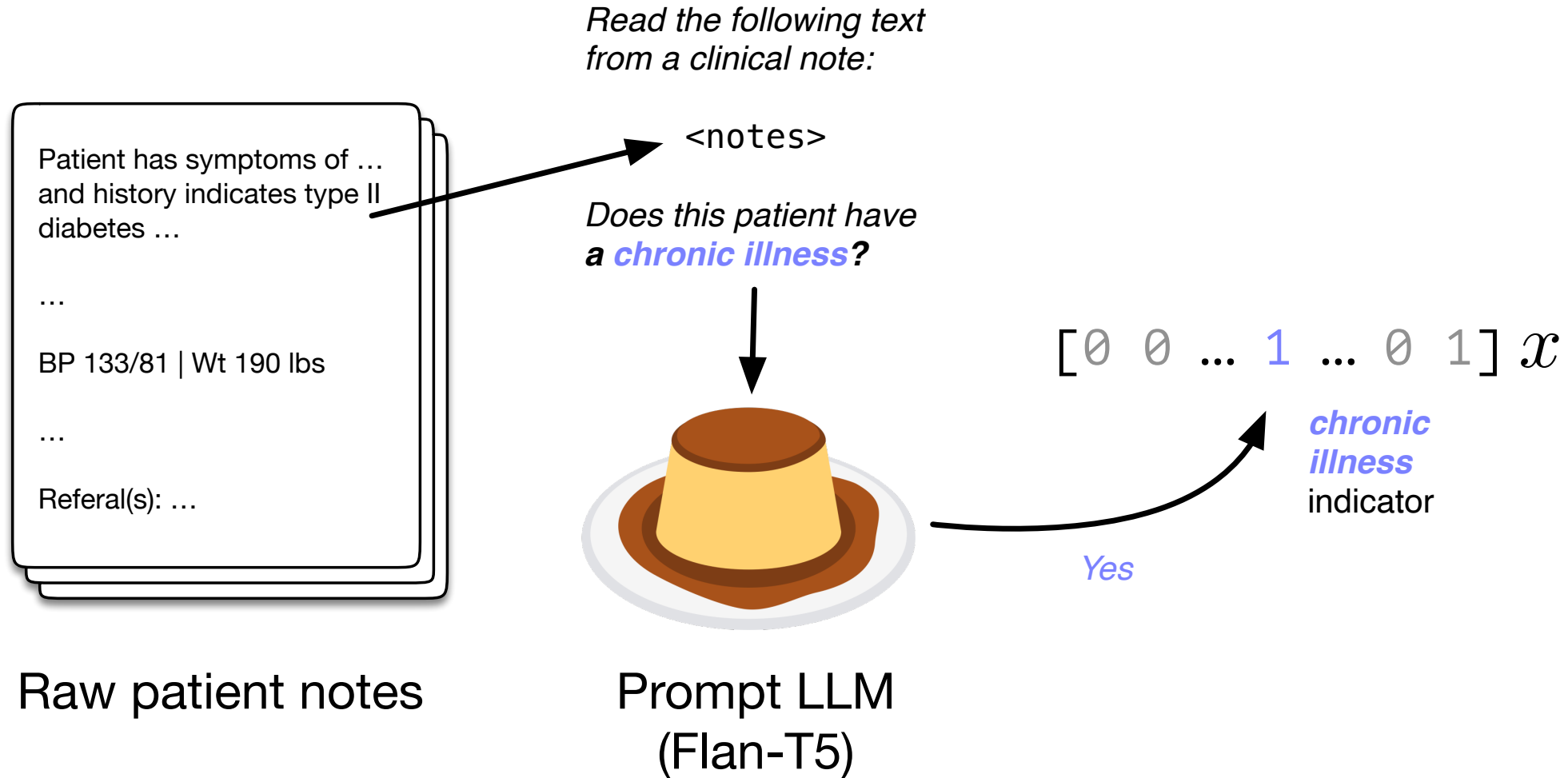


Raw patient notes

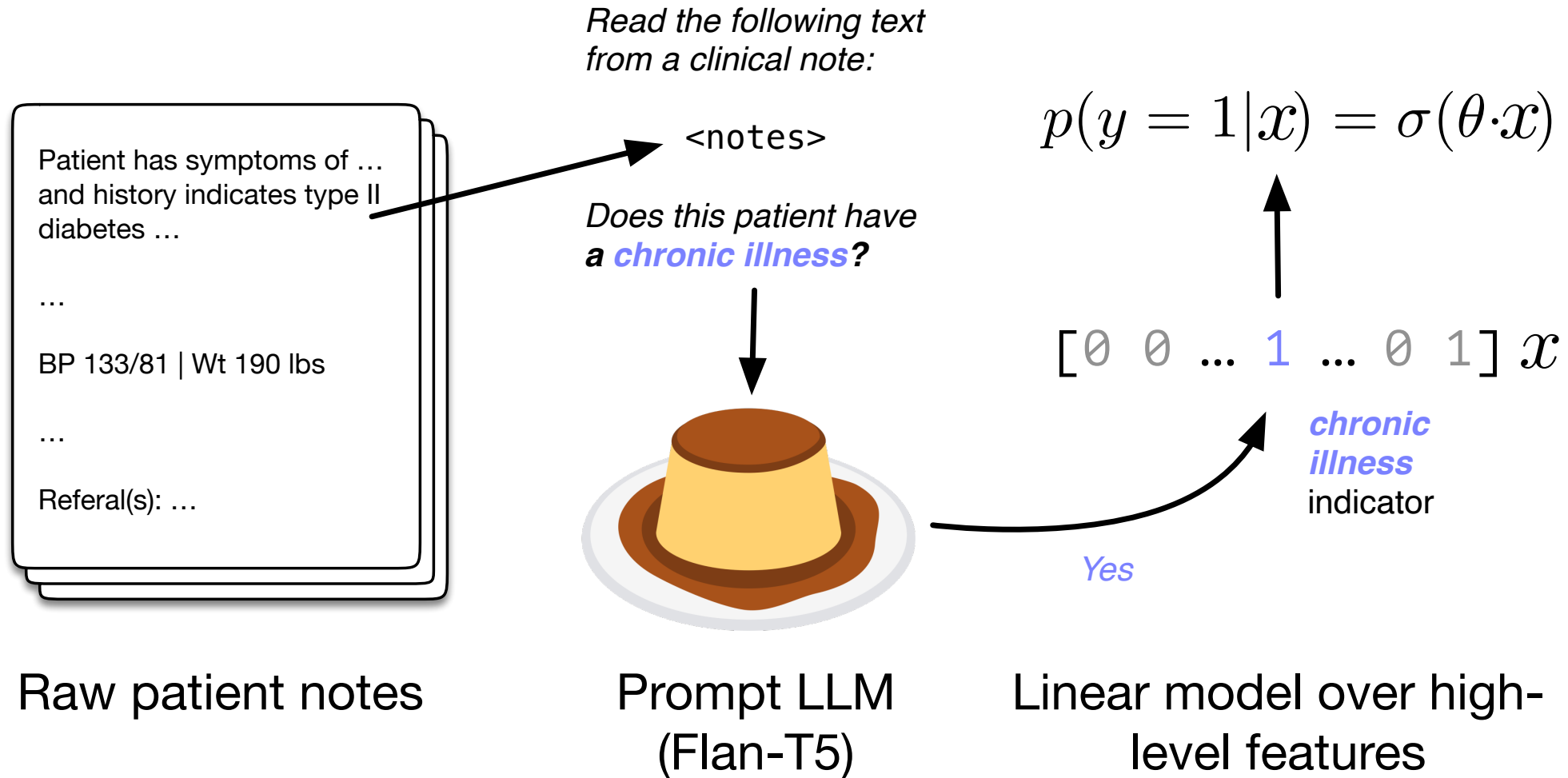
# Craft **H**igh-**L**evel **L**atents (**CHiLL**)



# Craft **H**igh-**L**evel **L**atents (**CHiLL**)



# Craft High-Level Latents (CHiLL)



# Feature Extraction Performance

## MIMIC-III Feature Extraction (ICD Code Features)

For Example:

- Unspecified Essential Hypertension
- Congestive Heart Failure
- Atrial Fibrillation

...

## MIMIC-CXR Feature Extraction (Expert-Crafted Features)

For Example:

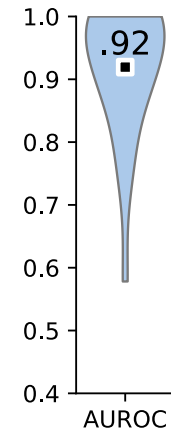
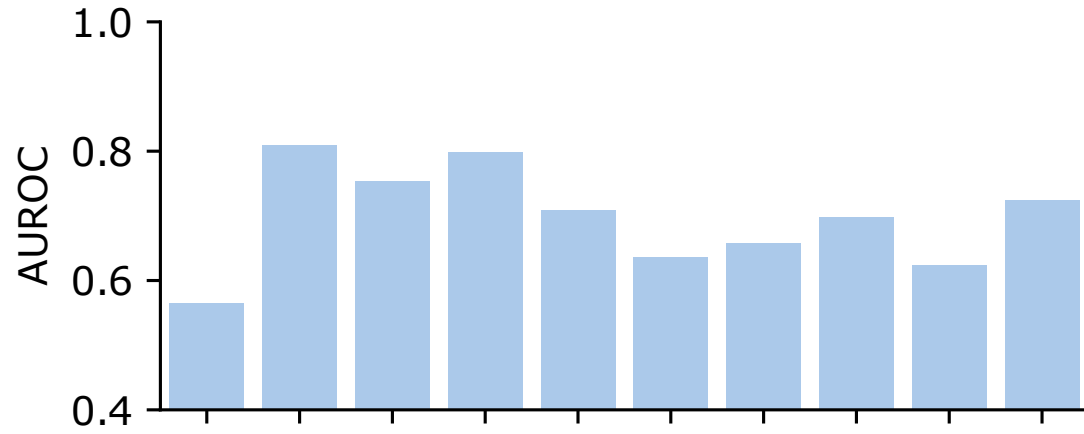
- Bulging Fissures
- Decreased Lung Volumes
- Collapse of Lung

...

# Feature Extraction Performance

MIMIC-III Feature Extraction  
(ICD Code Features)

MIMIC-CXR Feature Extraction  
(Expert-Crafted Features)

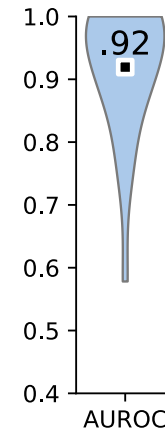
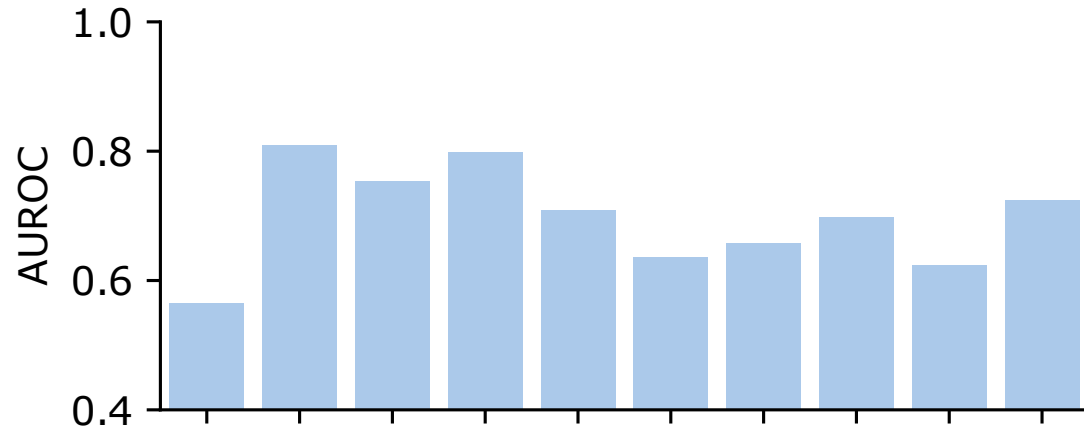


Unspecified essential hypertension  
Congestive heart failure  
Atrial fibrillation  
Coronary atherosclerosis of unspecified type of vessel  
Acute respiratory failure  
Acute kidney failure  
Long-term (current) use of anticoagulants  
Diabetes mellitus without mention of complication  
Other and unspecified hyperlipidemia  
Hypertensive chronic kidney disease

# Feature Extraction Performance

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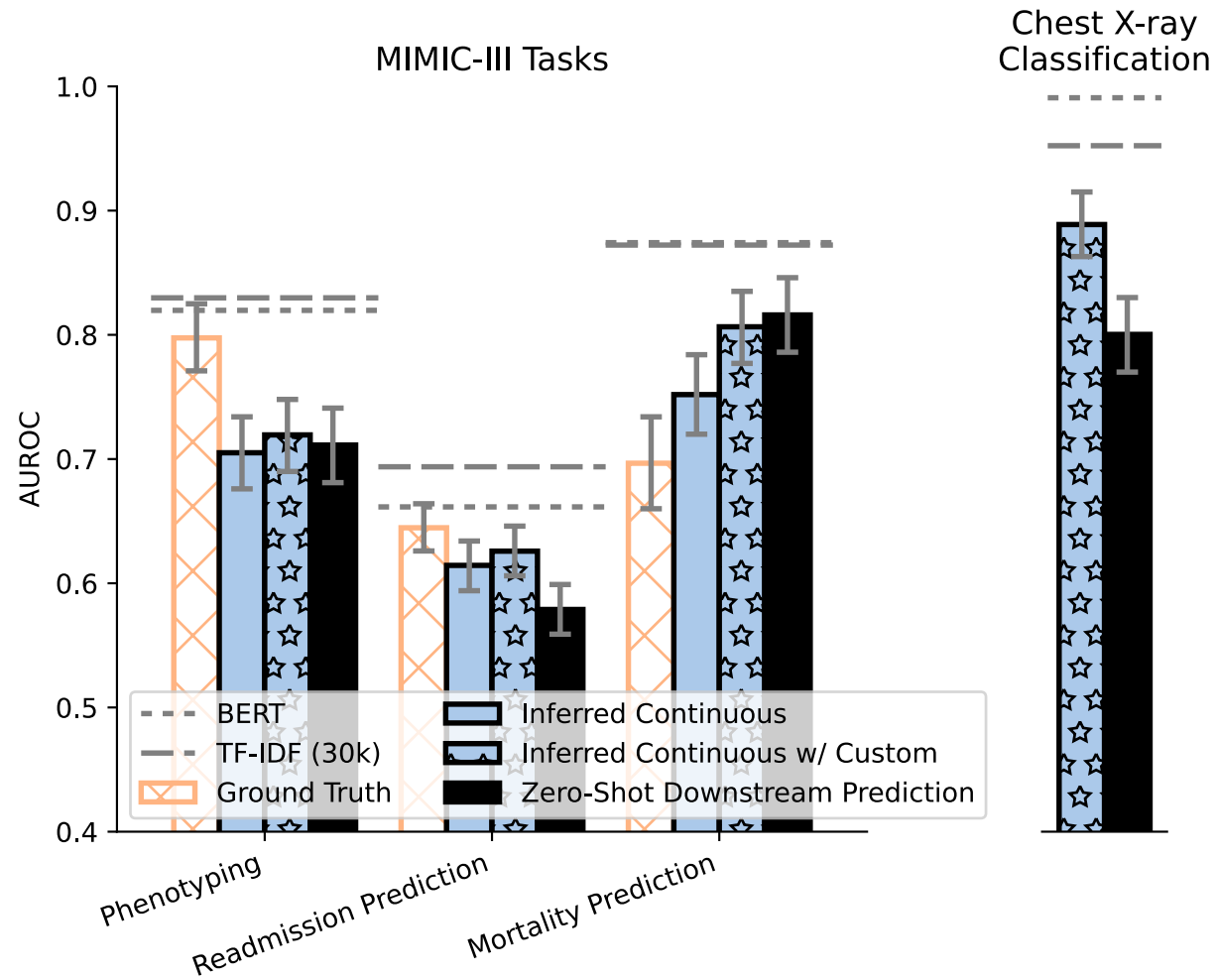


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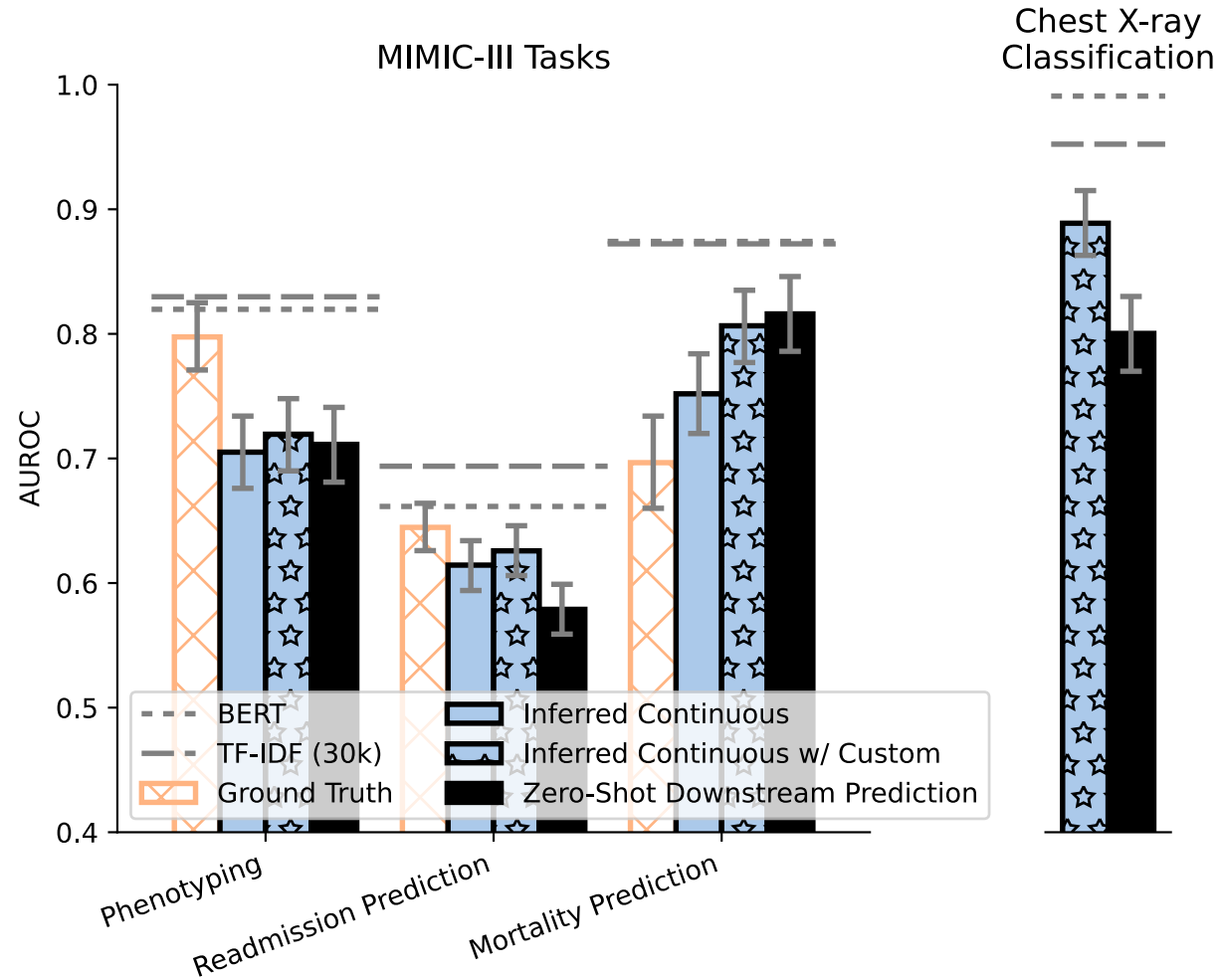
Reasonable!



# Downstream Performance



# Downstream Performance



Reasonable!

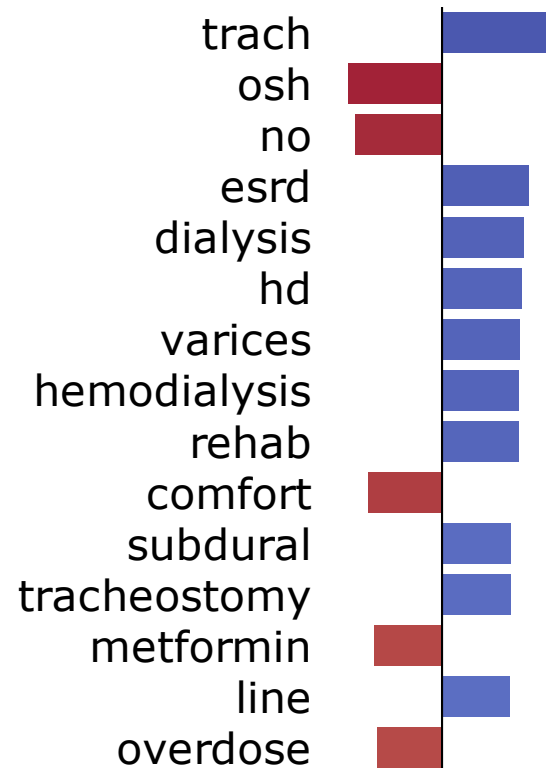
# Feature Interpretability

**Crafted feature names are more naturally interpretable**

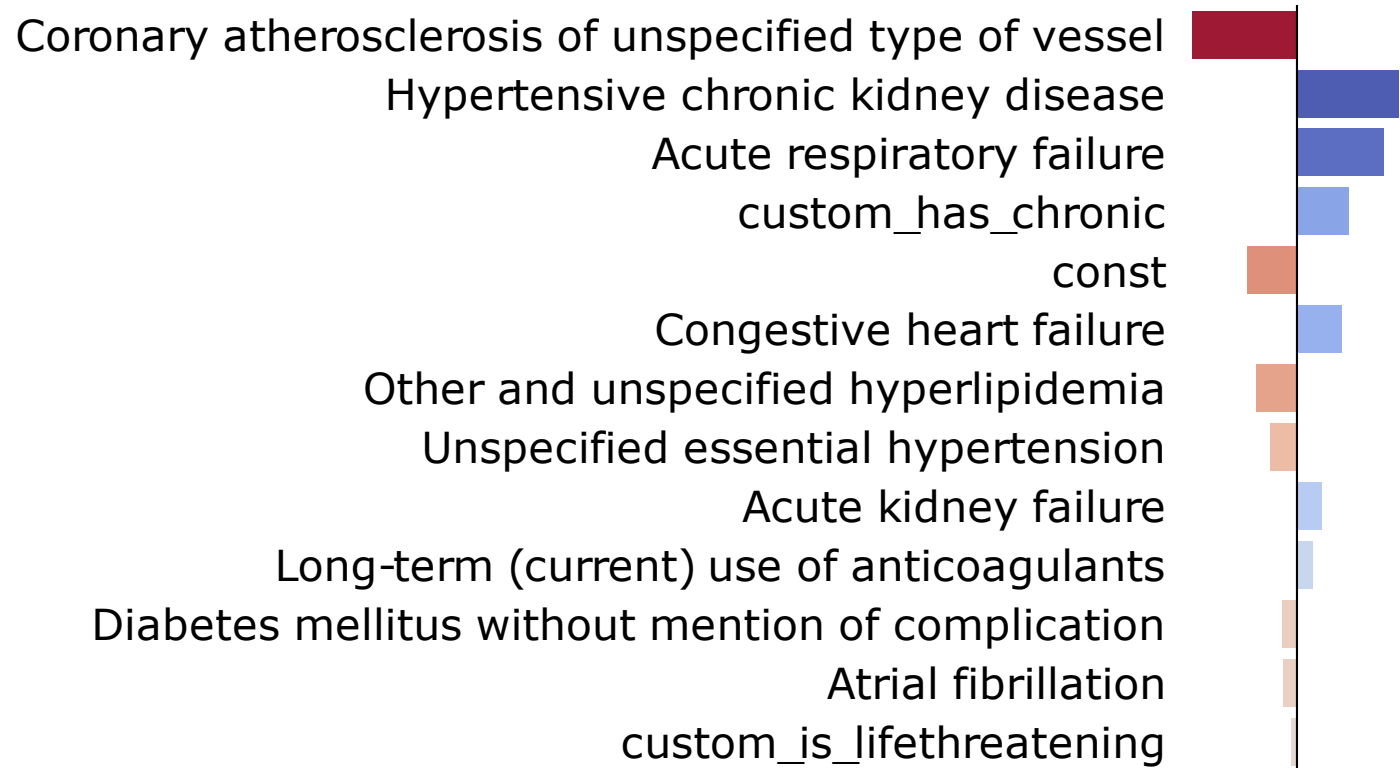


## Readmission Prediction Features

TF-IDF (30k)



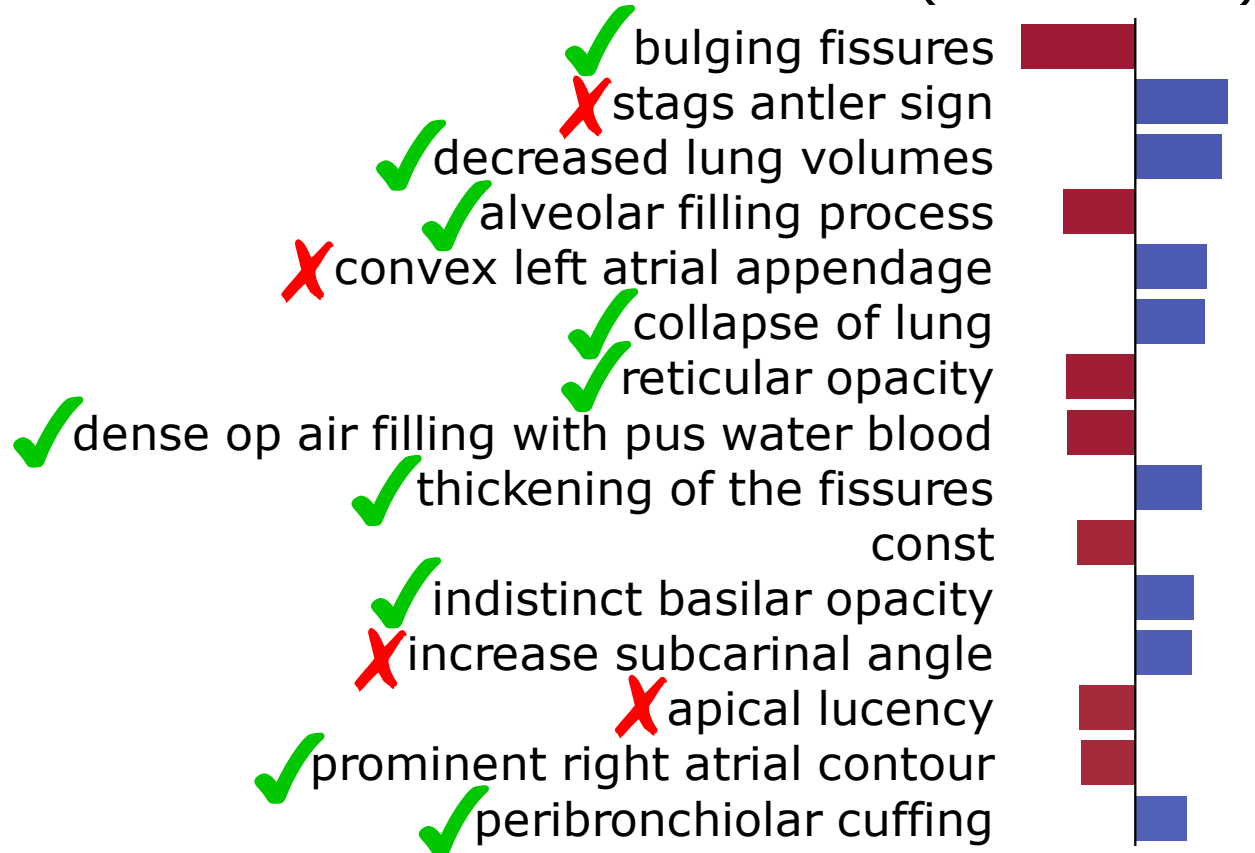
Inferred Continuous w/ Custom



# Model Interpretability

Continuous Feature Coefficients (Atelectasis)

Weights align with clinical expectations



# Feature Interpretability

HISTORY: Intubated, evaluate ET tube.

FINDINGS: The ET tube is 3.5 cm above the carina. The NG tube tip is off the film, at least in the stomach. Right IJ Cordis tip is in the proximal SVC. The heart size is moderately enlarged. There is ill-defined vasculature and alveolar infiltrate, right greater than left. This is markedly increased compared to the film from two hours prior and likely represents fluid overload.

## Targets (CheXpert Labeler)

Cardiomegaly

Lung Opacity

Support Devices

## Model

### Predictions

Cardiomegaly

Edema Lung Opacity

Support Devices

What went wrong?

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## Top Continuous Features

endotracheal tube

tube

enlarged heart

enlarged cardiac silhouette

alveolar fluid

alveolar filling process

esophageal tube

nasogastric tube

gastric tube

enlarged cardiomedastinal silhouette



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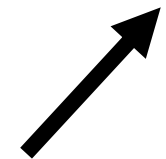


## Top Decision-Impacting Features (Edema)

const  
alveolar filling process  
alveolar fluid  
peripheral lucency  
enlarged heart  
upper lobe pulmonary venous engorgement  
hazy perihilar opacity  
gastric tube  
esophageal tube  
rounded left heart border



Feature Values  $\times$  Model Weights



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Extracted features permit easier inspection and validation of predictions on individual examples



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1. Check Features that impacted the decision

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- Cardiomegaly
- Lung Opacity
- Support Devices

## Model Predictions

- Cardiomegaly
- Edema**
- Lung Opacity
- Support Devices

## Top Continuous Features

- endotracheal tube
- tube
- enlarged heart
- enlarged cardiac silhouette
- alveolar fluid
- alveolar filling process
- esophageal tube
- nasogastric tube
- gastric tube
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## Top Decision-Impacting Features (Edema)

- const
- ✓ alveolar filling process
- ✓ alveolar fluid
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- hazy perihilar opacity
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- esophageal tube
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2. Reference the Report to Validate the Features

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## Model Predictions

- Cardiomegaly
- Edema**
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Clinical Judgment:

**Edema** **Should be a target!**

## Top Continuous Features

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- nasogastric tube
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- enlarged cardiac silhouette
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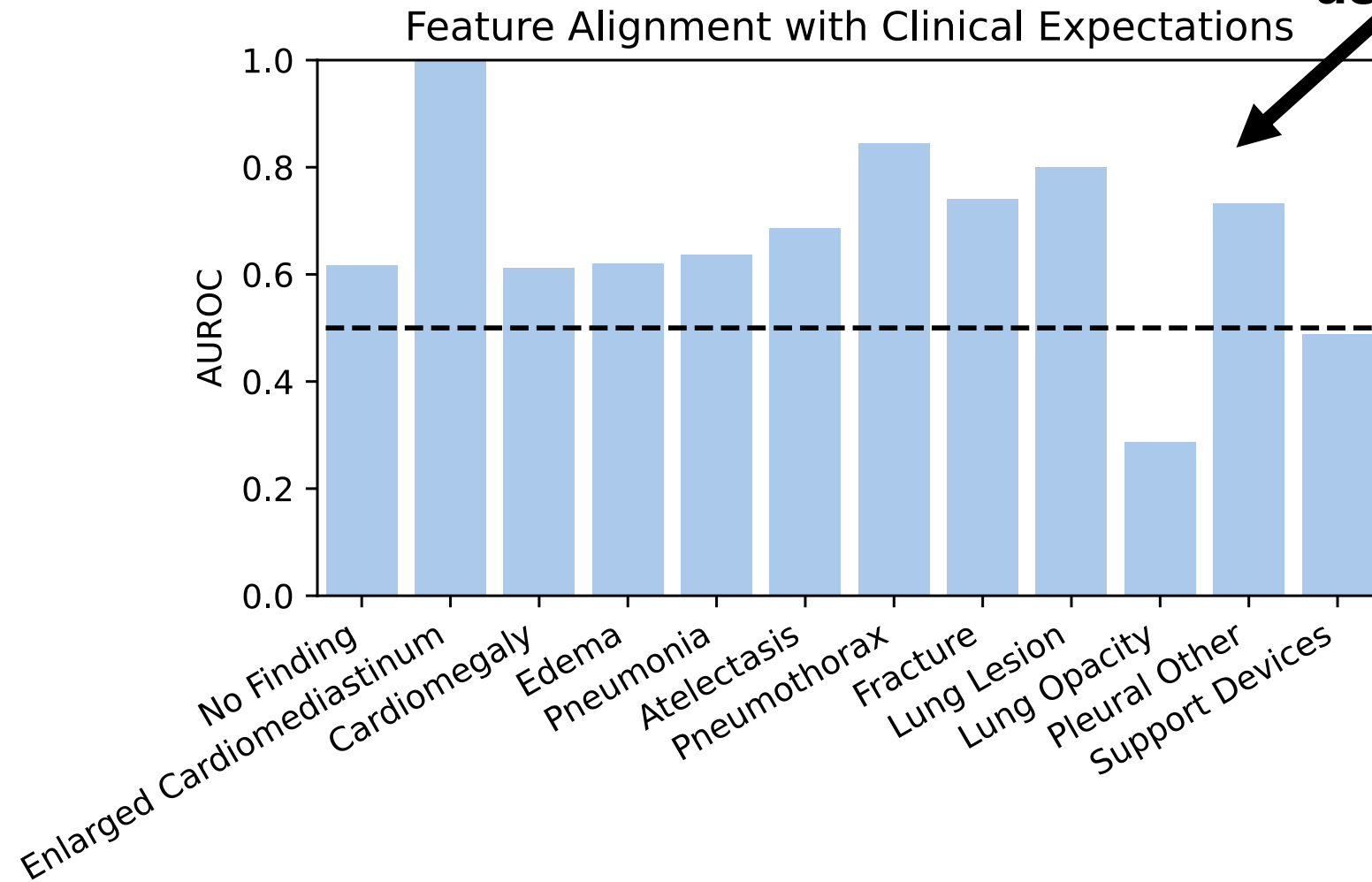
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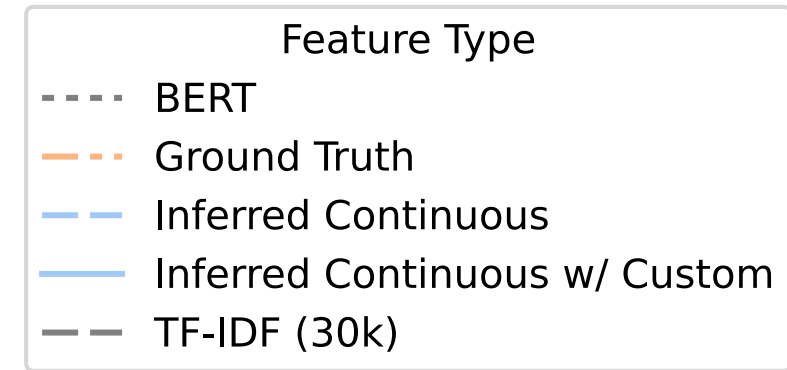
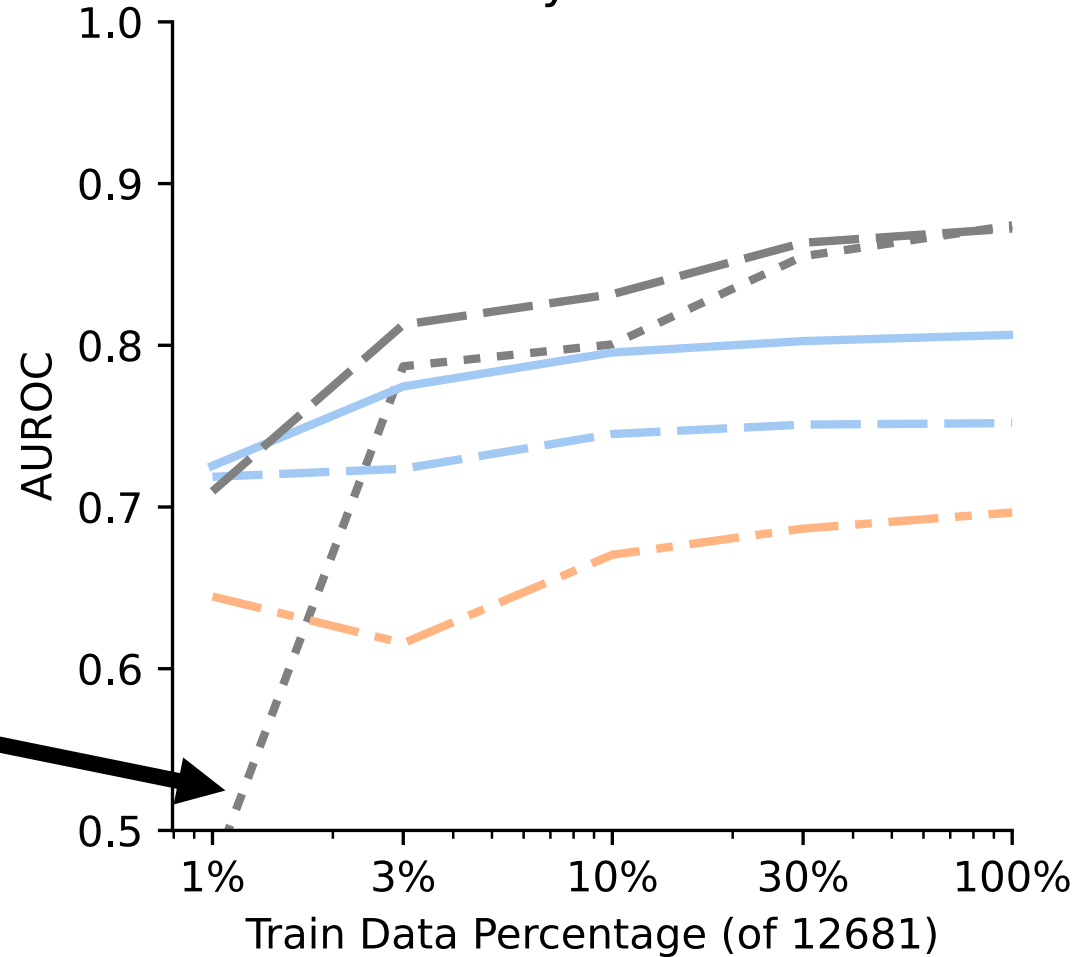
# Feature Alignment with Clinical Expectations

We can retrieve positively-contributing features using the model weights



# Data Efficiency

Mortality Prediction



**Less data-hungry  
than BERT**

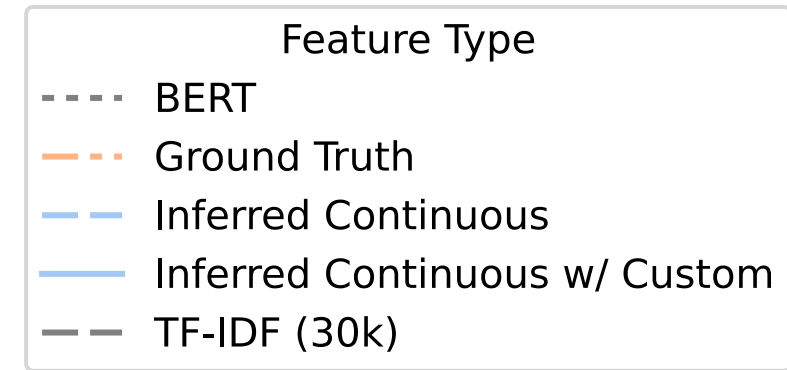
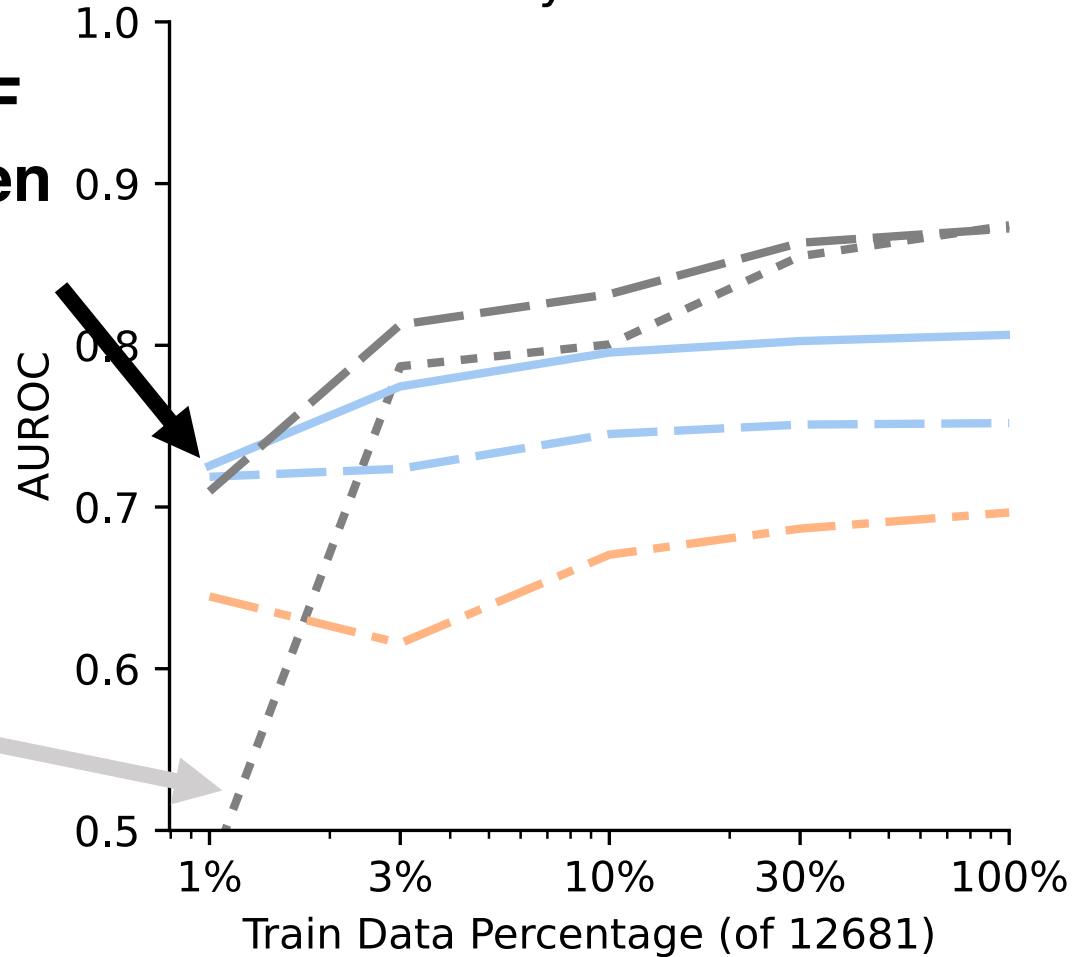


# Data Efficiency

Mortality Prediction

**Similar to TF-IDF  
Performance when  
training data is  
scarce**

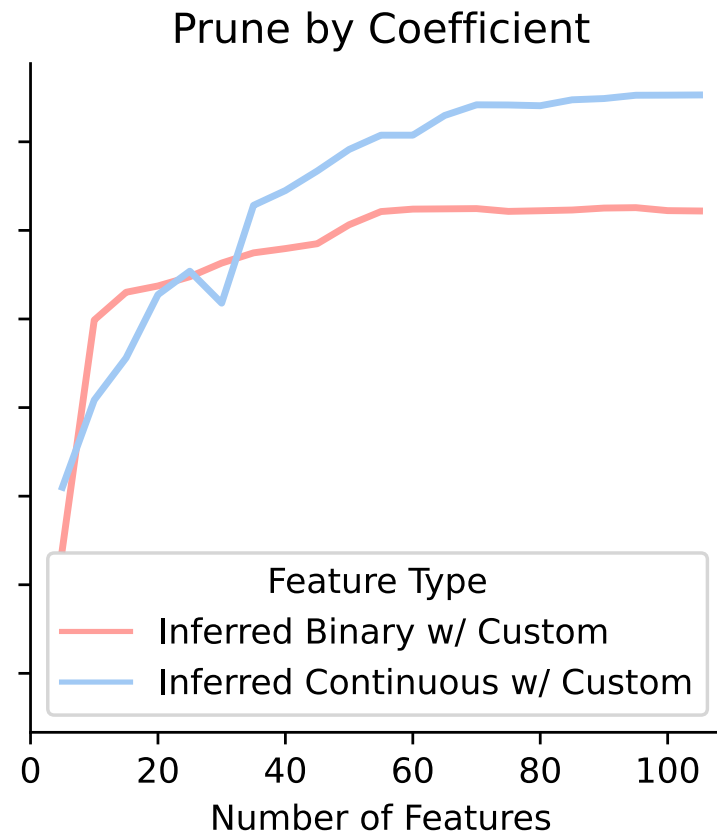
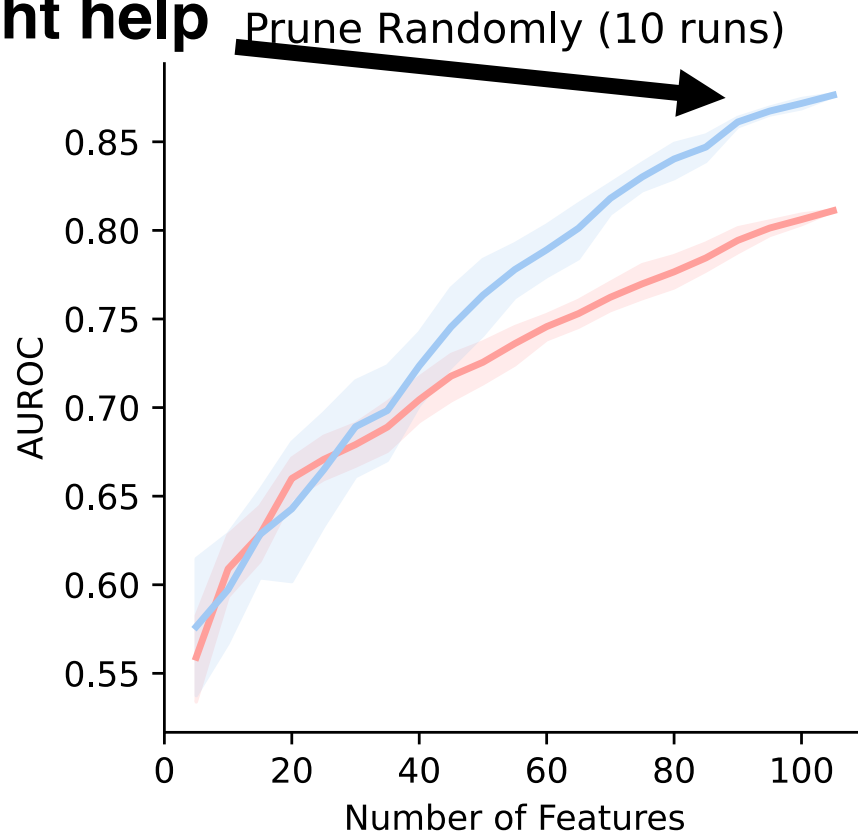
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# Feature Efficiency

**Not too much  
Plateau, so more  
features might help**

## Chest X-Ray Feature Ablation

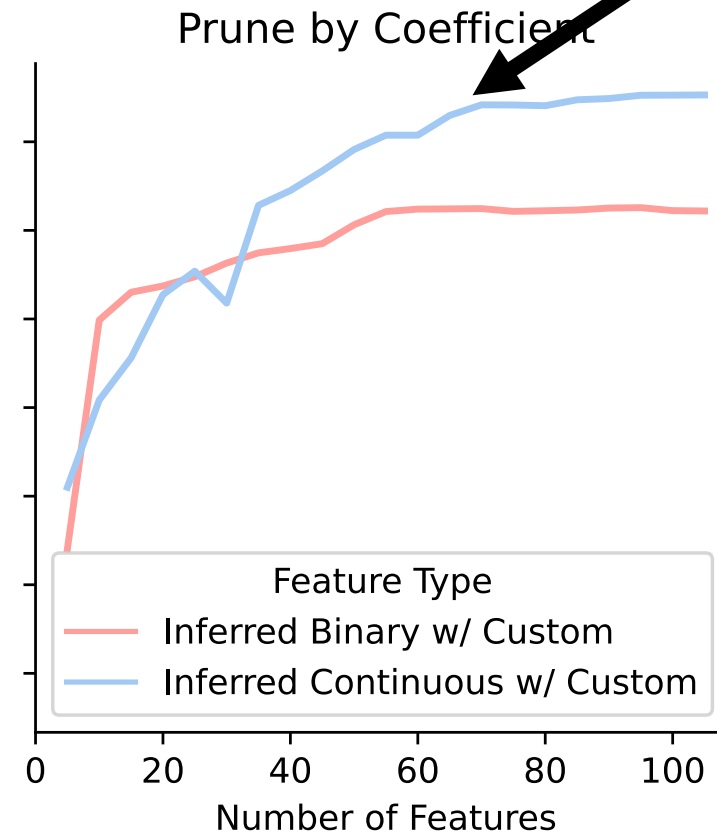
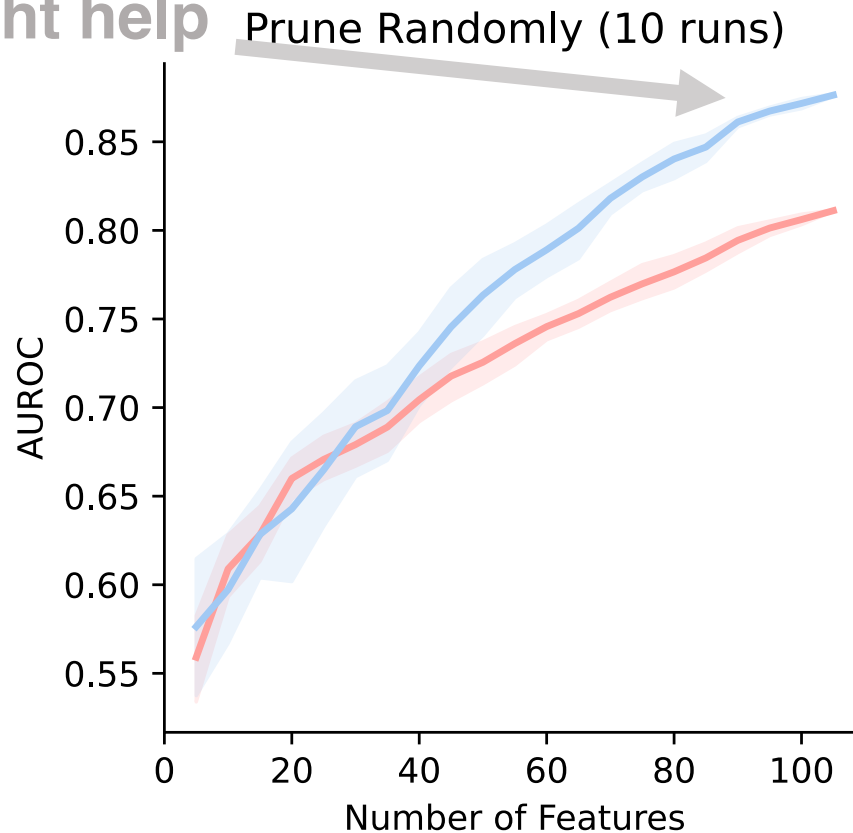


# Feature Efficiency

**High Density of Useful Features**

Not too much  
Plateau, so more  
features might help

### Chest X-Ray Feature Ablation





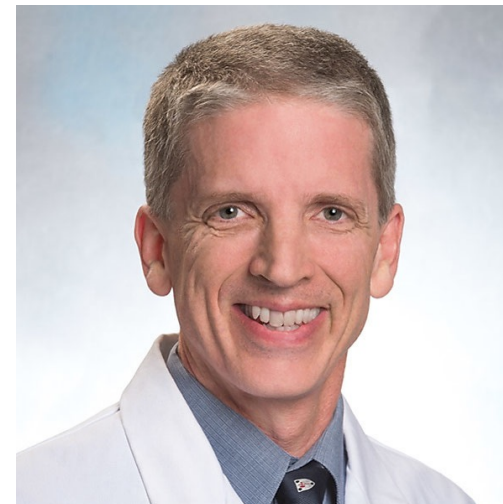
# Thank you



Byron C. Wallace  
Northeastern University



Jan-Willem van de Meent  
University of Amsterdam  
Northeastern University



Geoffrey Young  
Brigham and Women's  
Hospital

McInerney, Denis Jered, Geoffrey Young, Jan-Willem van de Meent and Byron C. Wallace. (2023). That's the Wrong Lung! Evaluating and Improving the Interpretability of Unsupervised Multimodal Encoders. Preprint.

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