Are You Going to Have Heart Failure Soon?
Presented By: Ari Afshar

Motivation
• About 6.5 million (1 in 8 deaths) American adults have heart failure [1,2].
• Electronic Health Records (EHRs) consist of patient information such as diagnosis codes, medications, vital signs, demographics, and procedures.
• The large electronic data on health records in the past 15 years opens new opportunities to implement early detection surveillance.

Objectives
We categorize factors causing heart failure (HF) into two:
• Time Variant Factors: these factors change with time.
  - Vital Signs
  - Medication
  - Diagnosis
  - Health records
• Time-invariant Factors: these are factors that are not evolving with time or changing very slowly.
  - Gender
  - Race & Ethnicity
  - Body Mass Index (BMI)
  - Smoking Status

How to combine Time Variant and Time-invariant factors to improve early prediction of heart failure?

Methodology [3]
1. Data Collection
   - A nested case-control design was applied to the primary care population from Sutter Clinics.

   ![2-year observation window](image)

   ![6-month prediction window](image)

   **STATISTICS SUMMARY**
<table>
<thead>
<tr>
<th>COUNT</th>
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<tbody>
<tr>
<td>CASE PATIENTS 3244</td>
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<td>CONTROL PATIENTS 31860</td>
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<td>PATIENTS (K) 35113</td>
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<td>DIAGNOSIS FEATURES 178</td>
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<td>MEDICATION FEATURES 142</td>
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<td>VITAL SIGNS FEATURES 5</td>
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<td>TIME VARIANT FEATURES (J) 22</td>
</tr>
<tr>
<td>TIME-INVARIANT FEATURES (P) 6</td>
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   **Phenotypes**
   - Recurrent Neural Network (RNN)
   - Logistic Regression
   - Interpretable RNN
   - Tensor Model
   - Our Proposed Model

2. Predictive Performance Results
   - Why Predictive modeling is important? It helps us to identify people at high risk and prioritize them for early intervention strategies.
   - **AUC Score** is a performance measurement for classification problem when data in imbalance.
   - How is the predictive power our proposed model in compare to other baselines?
   - The average AUC score of our proposed model in compare to other baselines.

   ![AUC Score Chart](image)

3. Computational Phenotyping Results
   - **Phenotyping:** Identifying patient sub-groups sharing common clinically meaningful Characteristics.
   - Why Phenotyping is important? Phenotype characterizations can be used to predict an individual's risk of disease or response to drug therapy.

   ![Phenotypes](image)

   **Clinical Phenotyping Results**

4. Elderly Heart Failure with Preserved Ejection Fraction
   - **Diagnosis**
     - Essential hypertension
     - Chronic kidney disease
     - Diabetes with renal manifestations
   - **Medication**
     - Calcium Channel Blockers
     - ACE inhibitors
     - Beta Blockers Cardiac-Selective
     - Angiotensin II Receptor Antagonists
   - **Demographics and Life-Style Behavior**
     - Gender: Female
     - Age: Between 70 to 79.
   - **Vital Signs**
     - Pulse: High

5. Cardiometabolic Driving Heart Failure
   - **Diagnosis**
     - Diabetes mellitus without complication.
     - Cardiac dysrhythmias
     - Heart valve disorders
   - **Medication**
     - Biguanides
     - Sulfonlureas
     - Insulin
     - Angiotensin II Receptor Antagonists
   - **Demographics and Life-Style Behavior**
     - Gender: Male
     - Age: Between 60 to 69.
   - **Vital Signs**
     - Blood Pressure: High
     - Pulse: Normal

6. Conclusion
   - We proposed an interpretable model to tackle two important challenges in healthcare.
   - The predictive performance of our model is comparable with state-of-the-art deep learning models with the advantage of interpretability.

References