

# In-hospital Mortality Prediction

## Holistic Patient Representation

Hamed Hassanzadeh, Sankalp Khanna, and Norm Good  
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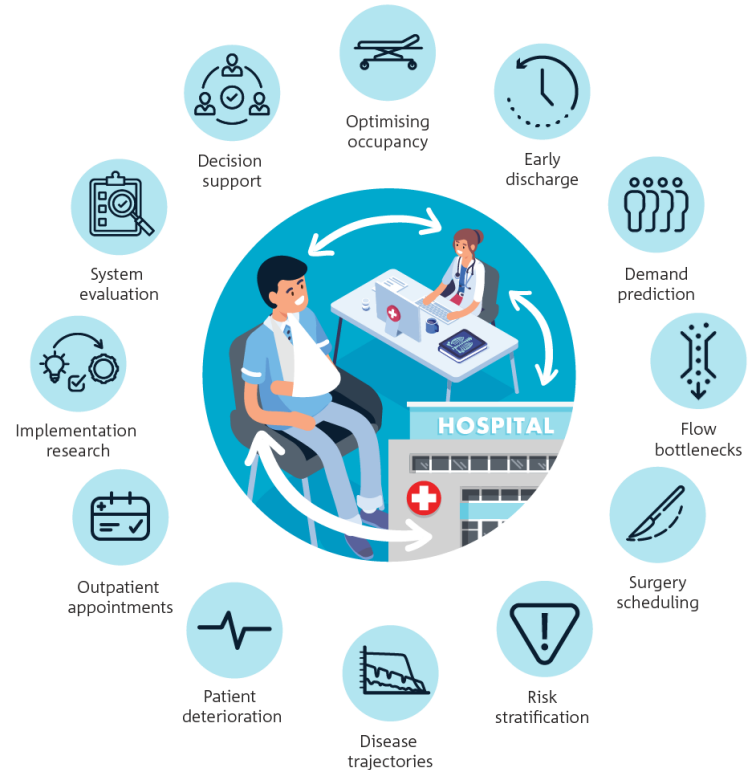
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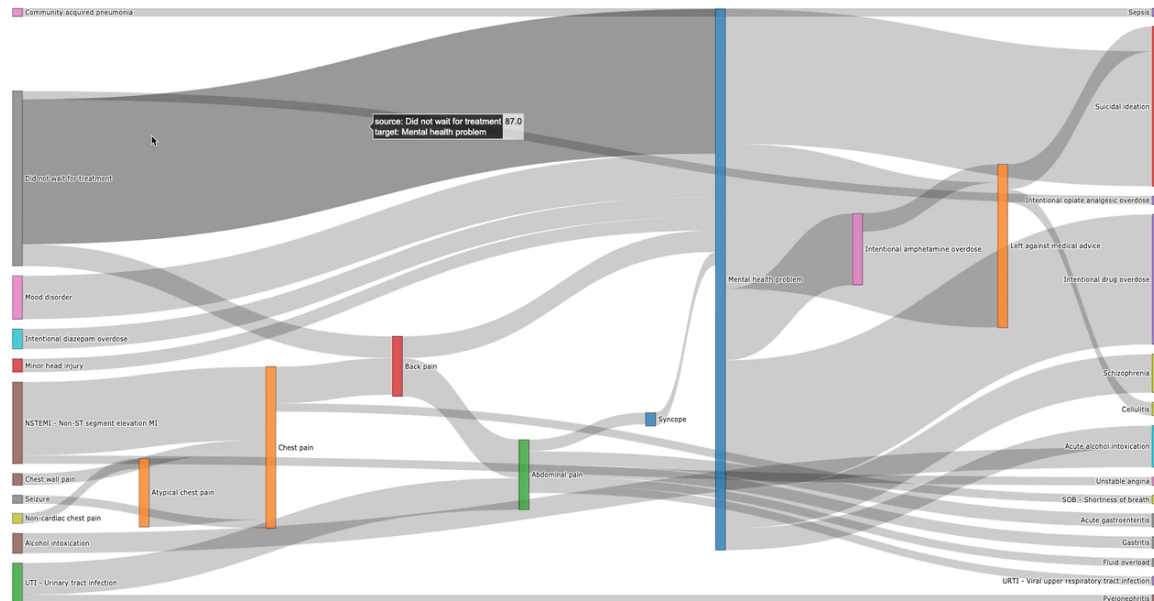
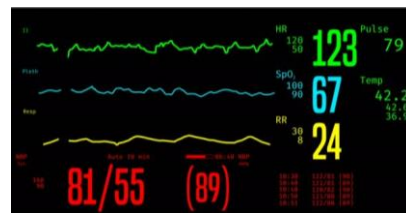
# Who we are?

- Health System Analytics
  - Resource management
  - Demand forecasting
  - Modelling and Simulation
  - Risk Stratification
  - Clinical Decision Support
  - etc.



# In-hospital Mortality

- Risk factors
- Clinical conditions
- Patient characteristics
- Patient history
  - Disease trajectory
  - Number of admissions
  - etc.



# Patient Representation

- From patient records to predictive models
  - Model processable format (numerical feature vector representation)
  - Numerical values – this is OK
  - Categorical values ??
  - Unstructured text ??
  - Longitudinal information ??

# Traditional Representation

- Dummy variables

- Type of admission

Elective	Non-elective
1	0
0	1

- Age Range

AGE LT40	AGE 40-60	AGE 60-80	AGE GT80
0	1	0	0
0	0	1	0
0	0	0	1
1	0	0	0

- Diagnoses

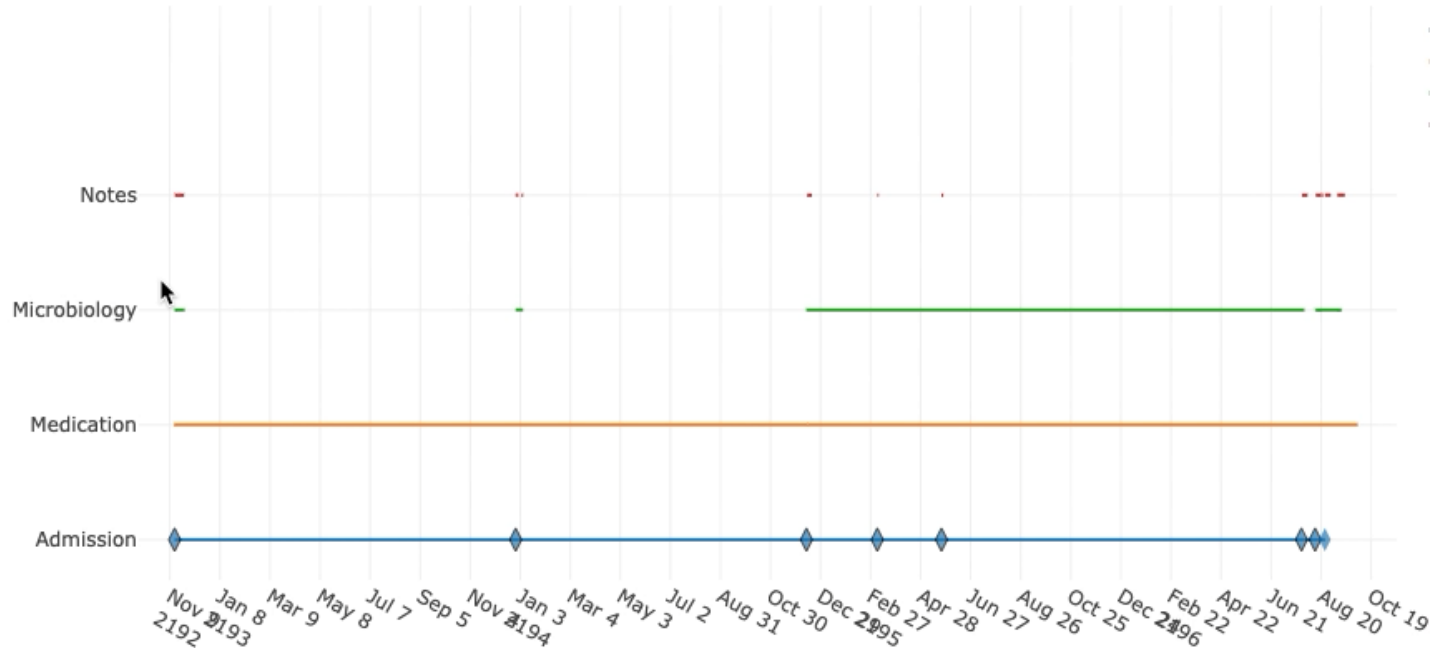
AORTIC DISSECTION	BILATERAL PNEUMONIA	FLUCONAZOLE DESENSITIZATION	MYOCARDIAL INFARCTION	PULMONARY VASCULITIS	SEIZURE-MRSA IN SPUTUM	SHORTNESS OF BREATH
0	1	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	1	0	0	0
1	0	0	0	0	0	0
0	0	0	0	0	0	1
0	0	0	0	0	1	0
0	0	0	0	0	0	0
0	0	1	0	0	0	0

...

# Electronic Health Records (EHR)

- Longitudinal
- Structured
- Unstructured

Patient Journey

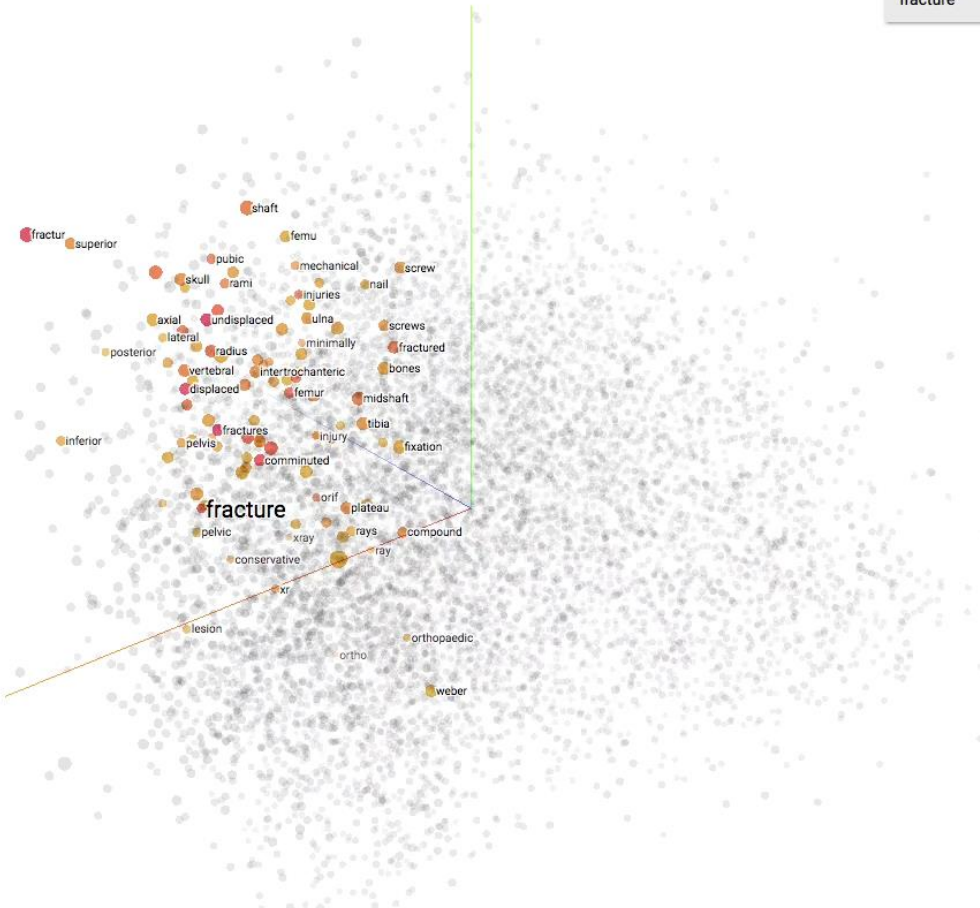


# Methodology

- Holistic approach
  - Structured & unstructured
  - Full potential of categorical variables
  - Longitudinal information
- Artificial Neural Network Vector Representation
  - Vector Space Models
  - Unsupervised Feature Learning

# Flashback – HIC18

- Vector representation
  - Embedding Models
  - Contextual information





# Methodology (cont.)

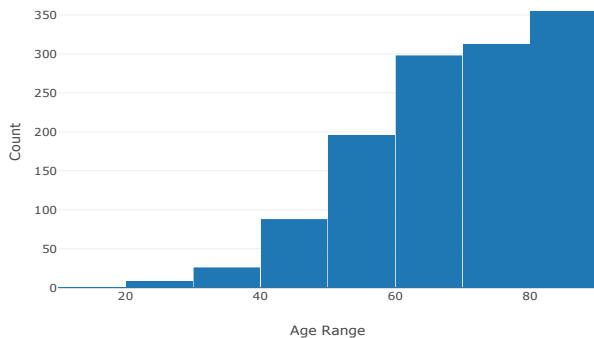
- Predictive models
  - Naïve Bayes
  - Stochastic Gradient Descent
  - Random Forest
  - Multi-layer Perceptron

# Data

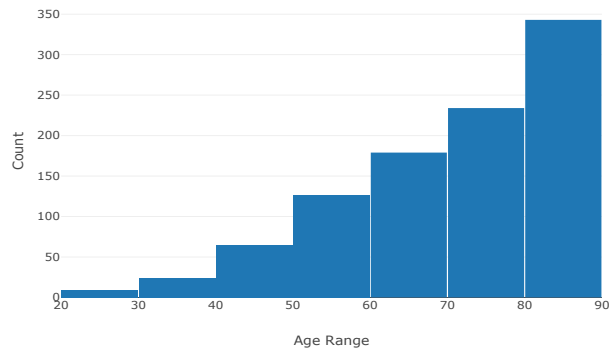
- MIMIC III Dataset
  - 58976 hospital encounters
  - 46520 unique patients
  - 70% non-elective patients (n=32610)
  - 17% of these non-elective patients have been re-admitted (n=5475)
  - 41% of the re-admitted patients (n=2264) had an adverse event of in-hospital mortality (1283 male and 981 female).

# Data Analysis

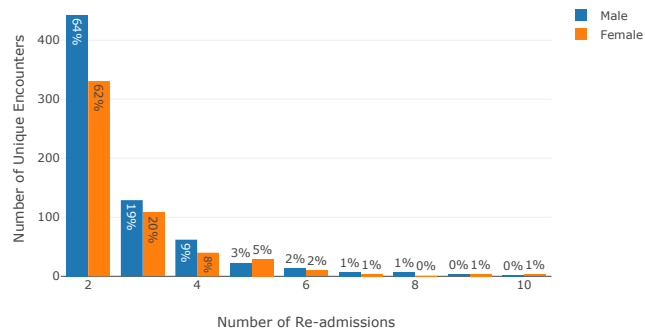
Age Range Distribution of Re-admitted Patients Died in Hospital - Males



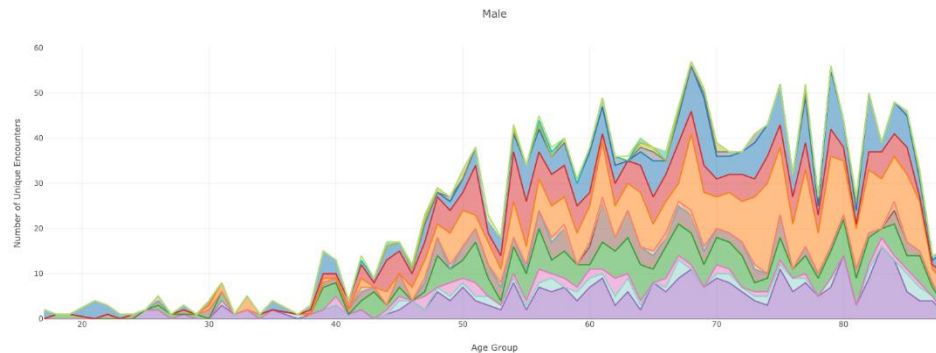
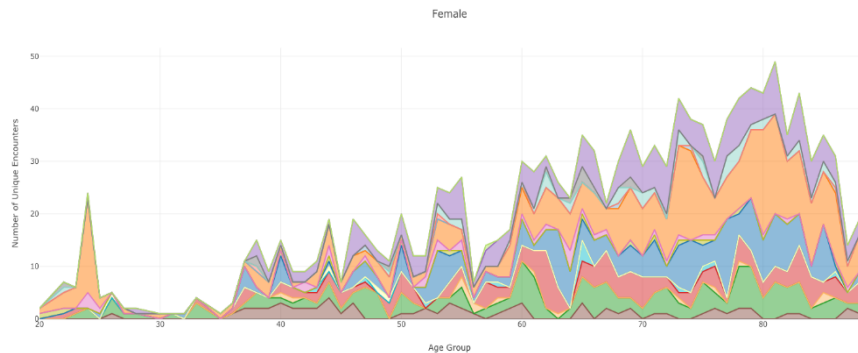
Age Range Distribution of Re-admitted Patients Died in Hospital - Females



Re-admissions Frequency among Males and Females



# Data Analysis (Disease Prevalence)



- XIV: Congenital Anomalies
- XVI: Symptoms, Signs, And Ill-Defined Conditions
- XVIII: Supplementary Classification Of Factors Influencing Health Status And Contact With Health Services
- VII: Diseases Of The Circulatory System
- XIII: Diseases Of The Musculoskeletal System And Connective Tissue
- V: Mental Disorders
- IX: Diseases Of The Digestive System
- XVII: Injury And Poisoning

- I: Infectious And Parasitic Diseases
- X: Diseases Of The Genitourinary System
- XII: Diseases Of The Skin And Subcutaneous Tissue
- III: Endocrine, Nutritional And Metabolic Diseases, And Immunity Disorders
- VIII: Diseases Of The Respiratory System
- VI: Diseases Of The Nervous System And Sense Organs
- IV: Diseases Of The Blood And Blood-Forming Organs
- II: Neoplasms

# Early Results

- Results on MIMIC III

Model	Male			Female		
	Precision	Recall	F1-Score	Precision	Recall	F1-Score
Naïve Bayes	0.6838	0.7311	0.7067	0.6889	0.729	0.7084
Stochastic Gradient Descend	0.7393	0.7257	0.7324	0.7187	0.7137	0.7162
Random Forest	0.6654	0.5245	0.5866	0.6408	0.5194	0.5738
Multi-layer Perceptron	0.7554	0.7567	0.7560	0.7441	0.723	0.7334

# Conclusion

- Comprehensive patient information representation
- Promising approach for patient-level risk stratification
- Future work:
  - Incorporating more information from EHR (e.g., vital signs)
  - Improve explainability of our approach
  - Validation on more hospitals' data

# Thank you

Hamed Hassanzadeh, PhD  
Research Scientist  
hamed.hassanzadeh@csiro.au



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