

Predict ICU Admission For Patients With Specific Diseases

Project Walkthrough

Objectives

- Timely decision of ICU (Intensive Care Unit) admission for patients. Physicians rely on guidelines or scoring systems to evaluate the need for ICU admission. However, disease specific guidelines for intensive care do not reflect real-world decision making. This project aims at using machine learning algorithms to predict the need for ICU admission for patients with specific diseases within 24 hours of admission.
- This walkthrough material presents results using randomly generated dataset, the python code in the directory demonstrates the methods behind a real-world project using electronic health records.
- The model achieved AUC .98 on pediatric pneumonia patients using real hospital data and features chosen by clinicians.

Disease Relevant Features

| Dimension | Item | Data Type | Remark |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------|
| Demographics | Age, Sex | Numerical, Categorical | Use age at admission. |
| Comorbid Conditions | Comorbid Condition 1, Comorbid Condition 2, Comorbid Condition 3, Comorbid Condition 4, Comorbid Condition 5 | Categorical (Y, N) | Comorbid conditions categorized based on ICD (International Classification of Diseases) Codes. |
| Pathogens | Pathogen A | Categorical (Y, N) | 1. Patients with no positive results within admission plus 1 minus 3 days are considered negative. |
| Lab Exams | LabItemA, LabItemB, LabItemC | Numerical | 1. Data sampled within admission plus 1 minus 3 days. 2. Missing value replaced with median. |
| Vital signs | Body Temperature (Maximum), Pulse (Maximum), Systolic Pressure (Minimum), Systolic Pressure (Minimum) | Numerical | 1. Recorded within admission plus/ minus 1 day. 2. Missing value replaced with median. |

* Feature selected by domain experts.

Predict ICU Admission .

| Model | Accuracy | Precision | Recall | F1-Score | AUROC |
|------------------------|----------|-----------|--------|----------|-------|
| Boosted Trees | .88 | .20 | .01 | .02 | .52 |
| Random Forest | .89 | .50 | .01 | .01 | .51 |
| Feedforward Neural Net | .89 | .00 | .00 | .00 | .50 |
| Logistic Regression | .89 | .00 | .00 | .00 | .49 |
| SVM | .89 | .00 | .00 | .00 | .50 |
| KNN | .87 | .11 | .02 | .03 | .51 |

Results gained on test dataset, model tuned on training set with cross validation.

Parameters

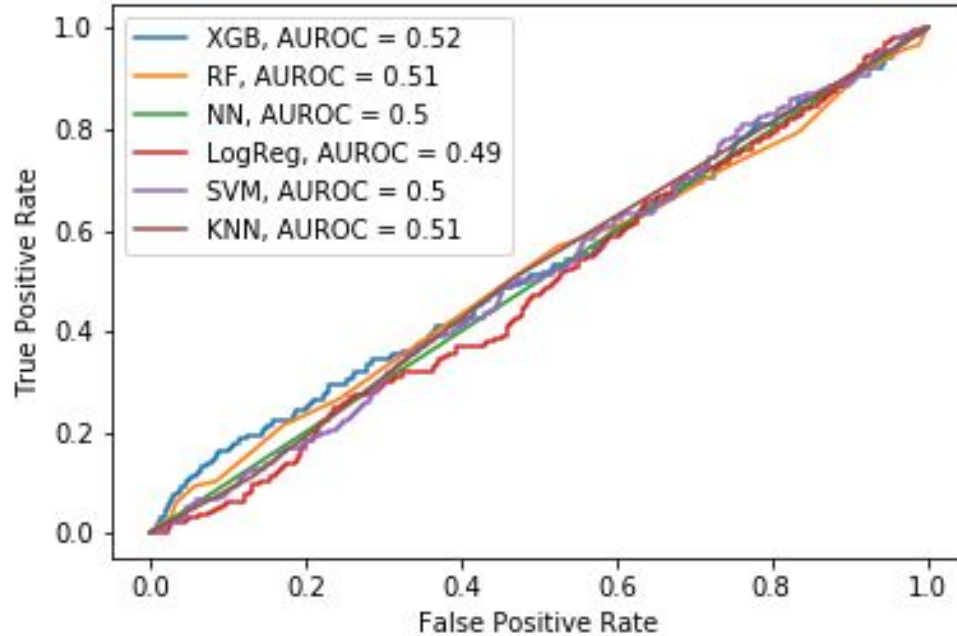
XGBoost: max depth= 3, learning rate= 0.4.

Random Forest: # of estimators = 50, gini impurity index, minimum sample per leaf = 1.

Feedforward Neural Net: Layer = 3 (ReLU hidden layer, nodes = 3, 3, Sigmoid for output layer), Adam optimized, epoch = 100, learning rate = .01

Logistic Regression: threshold =.5, L2 regularized (lambda=1), SVM: squared hinge loss, soft margin, C = 1, L2 regularized. KNN: K =5, standard normalized.

The Receiver Operating Characteristic Curves



Exploratory Analysis

Demographics And Severity

| | ICU Admission 24H | Not ICU |
|------------------------------------------|----------------------|------------------|
| Admissions | 1,183 | 8,321 |
| Male (%) | 579 (48.9) | 4,138(59.7) |
| Age Median (IQR) | 14.3 (10.0-19.1) | 14.5 (10.0-19.2) |
| In Hospital Days Median (IQR) | 14 (7-22) | 15 (8-23) |

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Comorbid Conditions

| | ICU Admission 24H (N = 1,183) | Not ICU (N = 8,321) |
|-----------------------------------|-----------------------------------------|-------------------------------|
| Comorbid Condition 1 # (%) | 192 (16.2) | 1,237 (14.9) |
| Comorbid Condition 2 # (%) | 109 (9.2) | 856 (10.3) |
| Comorbid Condition 3 # (%) | 324 (27.4) | 2,370 (28.5) |
| Comorbid Condition 4 # (%) | 249 (21.0) | 1,867 (22.4) |
| Comorbid Condition 5 # (%) | 315 (26.6) | 2,193 (26.4) |

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Exam And Pathogen Results

| | ICU Admission 24H (N = 1,183) | Not ICU (N = 8,321) |
|-------------------------------|-----------------------------------------|-------------------------------|
| Lab Item A median, IQR | 1.0 (0.5-1.5) | 1.0 (0.5-1.5) |
| Lab Item B median, IQR | 10.3 (6.5-14.3) | 10.6 (6.9-14.3) |
| Lab Item C median, IQR | 139 (129-150) | 140 (129-150) |
| Pathogen A # (%) | 40 (3.4) | 281 (3.4) |

Vital Signs

| | ICU Admission 24H (N = 1,183) | Not ICU (N = 8,321) |
|--------------------------------------------------|-----------------------------------------|-------------------------------|
| Body Temperature (Max), Median (IQR) | 35.7(35.3-36.2) | 35.7(35.3-36.2) |
| Pulse (Max), Median (IQR) | 75(69-83) | 74(69-83) |
| Systolic Pressure (Min), Median (IQR) | 95(84-104) | 95(84-104) |
| Diastolic Pressure (Min), Median (IQR) | 60(52-66) | 61 (53-66) |