Predicting Tomorrow’s COPD and Asthma ER Visits from Historical Visits and Weather Data

Student Researcher: Lixuan Liu, Supervisor: Professor David Skillicorn

Goal:
To predict tomorrow’s COPD and Asthma ER visits from previous ER visits with some weather factors for Kingston and Windsor hospitals, and to find the predictive sequences from various data decompositions.

Data Preparation:
Decomposing the ER visits data, humidity data and temperature data using the following derivations:
- Linear
- Exponential
- Discrete Cosine Transform
- Singular Value Decomposition (SVD)
- Independent Component Analysis (ICA)

Building the Model:
- XGBoost - a gradient boosted decision trees algorithm implemented predictor

Interpreting the Prediction Results:
- Mean Absolute Error: indicates the estimation error in the prediction model
- SHAP Values Graph: indicates the predictive variables selected by XGBoost as ranked by the importance in the plot.

<table>
<thead>
<tr>
<th>Kingston Hospitals COPD ER Visits Prediction</th>
<th>Mean Absolute Error (MAE) Test (25% of the data)</th>
<th>Kingston Hospitals Asthma ER Visits Prediction</th>
<th>Mean Absolute Error (MAE) Test (25% of the data)</th>
<th>Windsor Hospitals Asthma ER Visits Prediction</th>
<th>Mean Absolute Error (MAE) Test (25% of the data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicting from Previous COPD ER Visits Only</td>
<td>1.194</td>
<td>Predicting from Previous Asthma ER Visits Only</td>
<td>2.512</td>
<td>Predicting from Previous Asthma ER Visits Only</td>
<td>4.077</td>
</tr>
<tr>
<td>Predicting from Previous COPD ER Visits and Temperature</td>
<td>1.187</td>
<td>Predicting from Previous Asthma ER Visits and Temperature</td>
<td>2.540</td>
<td>Predicting from Previous Asthma ER Visits and Temperature</td>
<td>3.979</td>
</tr>
<tr>
<td>Predicting from Previous COPD ER Visits and Humidity</td>
<td>1.160</td>
<td>Predicting from Previous Asthma ER Visits and Humidity</td>
<td>2.525</td>
<td>Predicting from Previous Asthma ER Visits and Humidity</td>
<td>4.131</td>
</tr>
<tr>
<td>Predicting from Previous COPD ER Visits, Temperature and Humidity</td>
<td>1.154</td>
<td>Predicting from Previous Asthma ER Visits, Temperature and Humidity</td>
<td>2.546</td>
<td>Predicting from Previous Asthma ER Visits, Temperature and Humidity</td>
<td>4.045</td>
</tr>
</tbody>
</table>

SHAP Variable Importance Plot for Predicting Kingston COPD Visits using COPD Visits and Humidity

Plots of Predictive Sequences Indicated by SHAP Values

Conclusion:
- Temp and Humidity do affect COPD, and they are about the same predictive in the prediction as the MAE indicates. The general prediction results are about +1 or −1 compared with the true data for COPD ER visits among Kingston hospitals.
- SHAP Values Plot shows that the ICA, SVD components of humidity and the SVD components of historical ER visits data are selected as the top three predictive features by XGBoost when using humidity and ER visits to predict for Kingston hospitals COPD ER visits.
- Asthma is a more complicated case. Adding humidity and temperature into the prediction does not reduce the MAE compared with just predicting from previous asthma ER visits for Kingston hospitals. Adding humidity slightly reduces the MAE in the prediction for Windsor asthma ER visits.