RNN based model to predict COVID-19 patients outcomes on admission

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Introduction

• There is an increased need for tools to help identify COVID-19 patients who are at high risk of clinical deterioration.

• Deep learning based models proved to better predict patients' health outcomes using their previous clinical information available in EHRs.

• We developed a predictive model that can predict different health outcomes on admission including mortality risk, intubation, and long length of stay.

Significance

• High accuracy predicting patient outcomes on admission, using historical patient information.

• Minimum need for data curation
  Embeddings use for better feature representations.

• Temporal patient information
  Time aware RNNs.

Fig: Problem description
Methods

Cerner Real World COVID-19 Data

- 117,496 COVID patients from 62 health systems. Patients had at least one emergency or inpatient encounter with a COVID diagnosis or a positive laboratory result.
- We excluded all patients who have <1 day of information after their index date. Index date is the first COVID encounter admission/service start date.
- We included all diagnoses, medication, laboratory results, and other clinical events values available before/on the index date.

RNN based Model

Evaluation

- Compare RNN based model results against a logistic Regression (LR) based model trained on same data.
- Metrics Reported:
  ✓ AUROC

https://github.com/ZhiGroup/pytorch_ehr
Results

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n= 55,068</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong> median (IQR)</td>
<td>57 (37-72)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>28,356 (51.5%)</td>
</tr>
<tr>
<td>Race / Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>32,675 (59.3%)</td>
</tr>
<tr>
<td>African American</td>
<td>10,321 (18.7%)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>15,589 (28.3%)</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>4,593 (8.3%)</td>
</tr>
<tr>
<td>Intubation</td>
<td>4,907 (8.9%)</td>
</tr>
<tr>
<td>Length of Stay median (IQR)</td>
<td>3 (1 - 7)</td>
</tr>
</tbody>
</table>

Discussion & Conclusion

- Our RNN models showed high prediction accuracy
- Our RNN model had a 69% sensitivity with a PPV of 38% while LR showed a sensitivity of 47% with a similar PPV.

- Limitations:
  - We build different model for each outcome

- Future Work:
  - Survival Prediction
  - Adding explainability layers to facilitate clinical judgment
  - A single model – multiple outcome predictions

Thank you!
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