Integrating Physiological Time Series and Clinical Notes with Deep Learning for Improved ICU Mortality Prediction

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Motivation

- Electronic health records store multimodal data related to individual medical history including clinical notes, physiological measurements, lab results, radiology images, and more.
- Most methods designed to learn predictive models from EHR data focus on a single modality.
- In this work, we explore the predictive value of integrating physiological time series data and clinical text into a unified mortality prediction model.
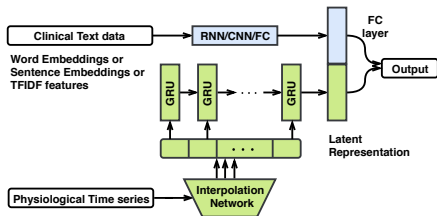
Interpolation-Prediction Networks

Interpolation-prediction networks for modeling sparse and irregularly sampled physiological time series data
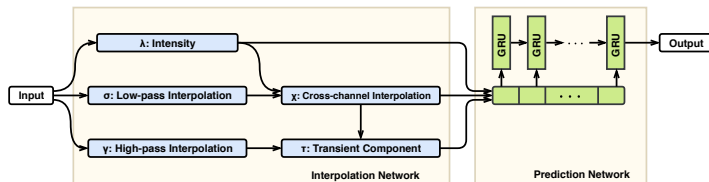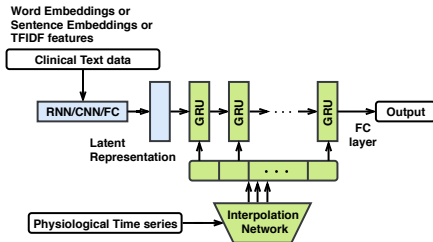
Proposed Fusion Approach
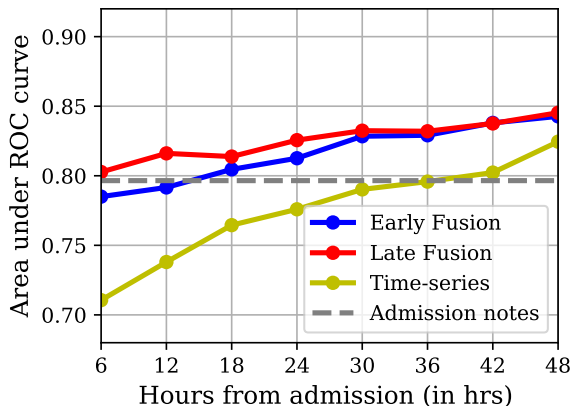

Late Fusion

Early Fusion

Experiments

- Experiments are based on the MIMIC-III dataset
- In-hospital mortality prediction using
  - clinical text data known at the time of admission such as chief complaints, past medical history, and history of present illness, as well as text data that become available over time such as progress notes from respiratory, ECG, echo, radiology, and nursing reports
  - physiological signals in form of sparse and irregularly sampled time series shown below

Table: Physiological signals extracted from MIMIC III

| feature	Sampling Rate	feature	Sampling Rate
SpO2	0.80	TGCS	0.14
HR	0.90	CRR	0.06
RR	0.48	UO	0.20
SBP	0.59	FiO2	0.06
DBP	0.60	Glucose	0.10
Temp	0.19	pH	0.04

Results: Fusion Approach

Performance comparison with text available at admission only but increasing amounts of physiological time series

Performance comparison with increasing amount of physiological time series and progress notes
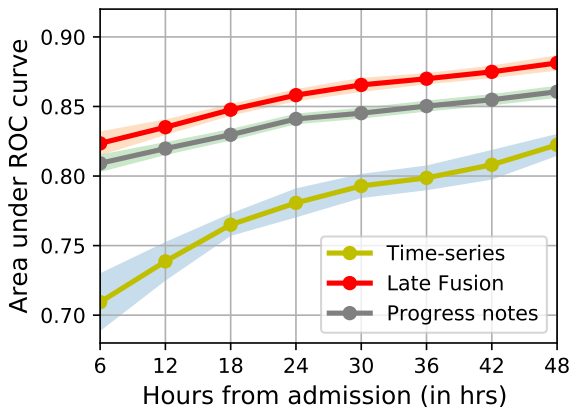
Bands correspond to 95% confidence interval around the mean

Discussions and Conclusions

- In this work, we have developed methods for investigating the relative predictive value of the content of clinical notes and physiological time series data in ICU EHRs.

- We show that the relative value of information in text records known at the time of admission decreases over time as more physiological data are observed but incorporating newly available text data can significantly boost predictive performance.

- Our results strongly support the conclusion that fusing both data modalities result in the best overall predictive performance.