香港浸會大學 HONG KONG BAPTIST UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE 計算機科學系

Research Cluster on Data Analytics & Artificial Intelligence

A Hybrid Residual Network and Long Short-Term Memory Method for Peptic Ulcer Bleeding Mortality Prediction

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OBJECTIVES

1. To design a hybrid residual network and long short-term memory method for accurate peptic ulcer bleeding mortality prediction [1, 2].

HIGHLIGHTS

Motivations

- Static and dynamic medical data contain different aspects of information about the health status of patients. Therefore, we design a hybrid method to jointly model both types of data to effectively improve mortality prediction results.
- Correlations between static data and dynamic data are important because of the influencing relationship. E.g., patients with different static data usually have different personal physiques and dynamic data. Therefore, we propose to utilize Residual Network to extract their correlation information by using convolutions units to jointly analyze different variables.

The proposed method

➢ **Data processing:**
- ✓ Extract static information from the irregularly sampled dynamic time series data
- ✓ Design a modified dynamic Time Warping (DTW) method to align multiple irregular time series

➢ **Extracting correlation and temporal information:**
- ✓ Design a deep Residual Network to capture correlation information between static data and dynamic data
- ✓ Utilize Long Short Term Memory (LSTM) method to extract temporal dependencies information from dynamic data

➢ **Feature fusion:**
- ✓ Propose a novel multi-residual multi-scales network to fuse correlation and temporal features information

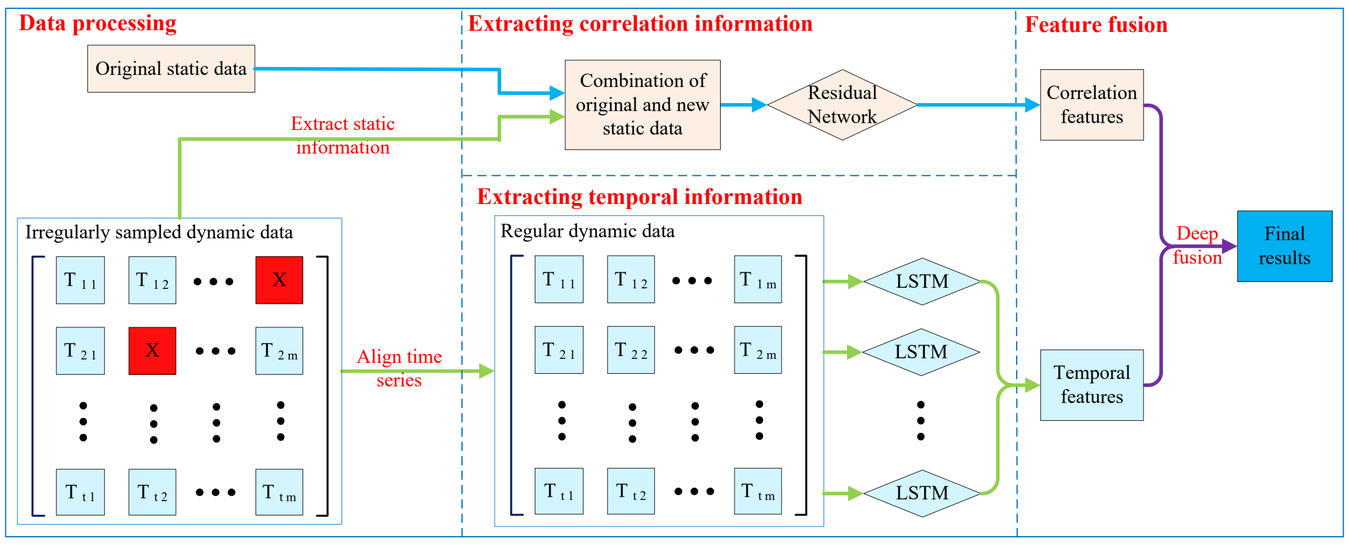

Figure 1: The block diagram of the proposed method

Experimental results

Table 1: AUC values of different methods

Method	ResNet	ResNet	ResNet	ResNet
Input	Static-I	Static-II	Static-III (Frequency-I)	Static-III (Frequency-II)
AUC [95% CI]	0.8683 [0.8553 to 0.8813]	0.8937 [0.8821 to 0.9057]	0.9234 [0.9141 to 0.9331]	0.9080 [0.8969 to 0.9182]
Method	LSTM	LSTM	Logistic Regression	Random Forests
Input	Dynamic (Frequency-I)	Dynamic (Frequency-II)	Dynamic (Frequency-II)	Dynamic (Frequency-II)
AUC [95% CI]	0.8524 [0.8488 to 0.8561]	0.8495 [0.8447 to 0.8543]	0.7099 [0.7034 to 0.7164]	0.6670 [0.6600 to 0.6741]
Method	Hybrid method	Method in reference [1]	Method in reference [2]	Our method
Input	Static-III + Dynamic (Frequency-II)	Static-III + Dynamic (Frequency-I)	Static-III + Dynamic (Frequency-I)	Static-III + Dynamic (Frequency-I)
AUC [95% CI]	0.9173 [0.9077 to 0.9264]	0.9111 [0.9000 to 0.9219]	0.9200 [0.9101 to 0.9296]	0.9353 [0.9261 to 0.9440]

Symbol description:

Static-I: original static data; Static-II: Static-I and mean values; Static-III: Static-II and missing data labels. Frequency-I: resampling frequency is twice a year; Frequency-II: resampling frequency is once a year.

(a) ROCs of ResNet for different static variables

(b) ROCs of LSTM for different dynamic variables

(c) ROCs of different methods under Frequency-II

(d) ROCs of different methods under Frequency-I

(e) ROCs of our method and method in reference [1]

(f) ROCs of our method and method in reference [2]

Figure 2: ROC curves of different methods

[1] Che, Z., Purushotham, S., Khemani, R., and Liu, Y. Interpretable deep models for icu outcome prediction. In Proceedings of American Medical Informatics Association Annual Symposium, 371-380, 2016.

[2] Esteban, C., Staeck, O., Baier, S., Yang, Y., and Tresp, V. Predicting clinical events by combining static and dynamic information using recurrent neural networks. In: 2016 IEEE International Conference on Healthcare Informatics (ICHI), 93-101, 2016.

SELECTED PUBLICATIONS

1. Tan, Q., Ma, A. J., Deng, H., Wong, V. W. S., Tse, Y. K., Yip, T. C. F., Wong, G. L., Ching, J. Y., Chan, F. K and Yuen, P. C. A Hybrid Residual Network and Long Short-Term Memory Method for Peptic Ulcer Bleeding Mortality Prediction. In Proceedings of American Medical Informatics Association Annual Symposium, 998-1007, 2018.

2. Tan, Q., Ma, A. J., Deng, H., Wong, V. W. S., Tse, Y. K., Yip, T. C. F., Wong, G. L., Ching, J. Y., Chan, F. K and Yuen, P. C. Using Correlative and Temporal Analysis Deep Learning Model to Predict Mortality Risk of Peptic Ulcer Bleeding Patients. submitted to IEEE Journal on biomedical and health informatics: An International Journal.