DATA ANALYTICS FOR HEALTHCARE

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INTRODUCTION

Data analysis plays an important role in healthcare research to discover hidden data features, provide useful insight and support decision-making. This abstract provides an overview of several studies carried out at our laboratories that involve healthcare data analysis, which include: 1) multi-level classification for high sensitivity cardiovascular biomarkers based on Lateral Flow Immunoassay (LFA) images; 2) infectious disease modelling for COVID19 via integration of mobility trends and 3) applying smartphone technology for cardiovascular healthcare.

METHODS & RESULTS

1) Multi-level Classification of High Sensitivity Cardiovascular Biomarkers via LFA Images

LFAs are low cost, rapid and highly efficacious Point-of-Care (PoC) devices. Traditional LFA testing faces challenges to detect high-sensitivity biomarkers due to its limited sensitivity. Unlike most approaches based on averaging image intensity from a region-of-interest (ROI), this study proposed a novel system that considers each row of an LFA image as a time series signal and, consequently, does not require the detection of a ROI. Long Short-Term Memory (LSTM) networks are used to classify LFA data obtained from multilevel high-sensitivity cardiovascular biomarker C-Reactive Protein (CRP) in a range of 0~5mg/L, which is aligned with clinically actionable categories for early risk assessment of cardiovascular disease (CVD). The technique of Dynamic Time Warping (DTW) was incorporated with LSTM to align the LFA data from different concentration levels to a common reference before feeding the distance maps into an LSTM network. The results show that the LSTM network outperforms other classifiers [1]. Furthermore, performance of all classifiers is improved after incorporating DTW [2]. The positive outcomes suggest the potential of the proposed methods for early risk assessment of CVD.

2) COVID19 Modeling with Mobility Trends

The objective of this study was to integrate multiple data sources for COVID19 disease modeling to improve the performance of model fitting and forecasting. A dynamic time-varying transmission rate has been proposed with a control rate governing the speed of disease spreading, which potentially can be associated with the information related to infectious disease intervention. The global mobility trends of driving via Apple Maps were applied to the data from six EU countries. Different options for processing the mobility trends data were explored, and the relationship between mobility trends and the control rate in dynamic disease model was investigated. The results suggest that the proposed method improved the performance in model fitting and forecasting during the early stage of the pandemic. Positive correlation has been found between the average daily change of mobility trends and control rate [3]. The results support further development for the incorporation of multiple sources into infectious disease modelling.

3) Smartphone Technology for Cardiovascular Healthcare

The objective for this project was to assess and quantify conjunctival microcirculatory haemodynamics using a smartphone camera-based system; to compare the changes in the microcirculation of the conjunctiva with different groups including healthy controls, myocardial infarction (MI) and cyanotic congenital heart disease (CCHD). Image processing techniques were applied to extract the microvessels; 1D+T Continuous Wavelet (CWT) [7] was applied to estimate the conjunctiva axial velocity of the red blood cells. A repeatability test was also carried out to validate the proposed method for estimation of microcirculatory haemodynamics parameters. The initial study has found the feasibility of smartphone video acquisition and subsequent haemodynamic measure quantification via semi-automated means [4]. Two further pilot studies have been carried out to compare the conjunctival haemodynamics obtained from the control group to CCHD [5] and MI [6] (the research outcomes are currently under review).

CONCLUSION

Data analytics have been demonstrated to be an efficient tool for different applications in healthcare. The challenges remain in data availability, which can be sought via open source data and multidisciplinary collaboration. The future work will consider assessment of reliability and reproducibility for the proposed methodologies in clinical studies.

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