MedBrain: A Novel Deep Learning Tool for Holistic Patient Data Interpretation and Clinical Event Prediction

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Approximately 55,000 patients are treated daily in ICUs within the U.S., most of whom are extremely sick and require rapid clinical decision-making. However, copious patient data engenders information overload, leading to slower care and poorer outcomes. Current computer-aided diagnostic solutions for decision-making support are used minimally, either unable to capture complex patient data or lacking interpretability. MedBrain is an interpretable deep learning python framework created to improve clinician decision-making by predicting significant clinical events and identifying relevant patient variables based on charts. Time-series patient data from Beth Israel Deaconess Hospital (2001-2012) was manually preprocessed via anomaly detection, imputation, and quality control. A Skip-gram and Bidirectional Transformer were created to encode textual diagnoses and notes into numeric embeddings. With these data, multiple Long Short-Term Memory Recurrent Networks with Attention were constructed to predict future likelihood of the critical short-term events of mortality, sepsis, respiratory failure, acute kidney injury, vancomycin admin, and myocardial infarction (MI). These achieve an Area under the Receiver Operating Characteristic (AUROC) of 0.94, 0.88, 0.86, 0.85, 0.83, and 0.80, respectively. Attention maps identify relevant patient variables, like troponin as a predictor of MI. Moreover, spatial analysis of embeddings enables physicians to discern possible overlooked diagnoses associated with the patient's history. This innovative prediction model harnesses the power of deep learning while providing unprecedented transparency via attention mechanisms, distilling vast patient data to show relevant variables. MedBrain could reduce cost and improve patient outcomes.