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Exploration of neural networks to predict critical care patient outcome

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Introduction: We explore the use of an artificial neural network (ANN) model to predict discharge APACHE IV scores for intensive care unit (ICU) patients. Predicting mortality based upon scoring systems or models have been described but typically only use data from the first 24 hours. This work explores ICU outcome prediction using data from both the first 24 hours and beyond in order to ultimately develop a real-time risk management tool.

Methods: As part of an IRB-approved protocol, a convenience sample of retrospective physiological vital signs, laboratory values, clinical assessments, and outcome from throughout each patient's hospital stay were collected retrospectively for traumatic brain injury (TBI) patients admitted to the ICU at a Level I Trauma-Military Medical Center during the five-year period ending in October 2007. Values were collected at frequencies according to routine clinical practice. Admission and discharge APACHE scores (range 0-299) were calculated by a nurse researcher independent of the authors. A static back propagation ANN with 3 layers (90 'log-sig' neurons, 25 'log' neurons, and one linear neuron) was developed and trained using resilient back propagation and leave-one-out methodology. Patients with at least 20 consecutive days of data were included in the analysis. Inputs consisted of collected clinical data from the first ten days, averaged daily, and the admission APACHE score. Output was the predicted APACHE score at discharge.

Results: Data were collected for 139 TBI ICU patients (132 later discharged, seven died). Daily averages were computed for each of 26 clinical values. Twenty-seven patients had sufficient data to be included in this preliminary analysis. The resulting ANN predicted discharge APACHE scores within 12.9% of actual scores.

Discussion: Some limitations of this preliminary work are that the retrospective data had missing values such that only a small subset was usable for modeling, and that computed daily averages do not reflect intra-day trends. While ANNs are usually used for discrete classification (e.g., discharged or died), we used an ANN to predict APACHE scores calculated at discharge, which may help identify risk leading to post-ICU death. Next steps include trying better temporal abstraction methods and improved techniques for handling missing values, as well as developing other regression and classification models to understand which are best suited for this domain.

Biography

Cindy Crump is a Technology & Business Expertise in Telecommunications Networks, Enterprise Health Software, eCommerce, SaaS Platforms ω Pioneer in Mobile Health and the Application of Network Technologies for Industry Transformation: Executive management and entrepreneurial experience demonstrated in a wide array of business verticals in the midst of technology transformation at Fortune 50, federal R&D, small business and start-up environments. ω Effective & Accountable Revenue and Cost Management: Built new business from concept to execution using an effective lean funding and Go-To-Market strategy including multiple Small Business Innovation Research (SBIR) awards from DARPA and NIH as well as Navy and state R&D contracts to build the system. He has developed targeted marketing tactics that garnered significant mindshare (company and services have been featured in CNBC, Washington Post and other leading media outlets) and executed effective partnership and customer relationships leveraging showcase programs and ROI value propositions from one market segment into new market and sales opportunities in adjacent segments. He has excellent ability to ascertain and manage uncertainty, risk and strategy with strong, award winning results.

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