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Hospital Admission Location Prediction Via Deep Interpretable Networks

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ABSTRACT

This paper presents a deep learning method of predicting where in a hospital emergency patients will be admitted after being triaged in the Emergency Department (ED). Such a prediction will allow for the preparation of bedspace in the hospital for timely care and admission of the patient as well as allocation of resource to the relevant departments, including during periods of increased demand arising from seasonal peaks in infections.

Methods: The problem is posed as a multi-class classification into seven separate ward types. A novel deep learning training strategy was created that combines learning via curriculum and a multi-armed bandit to exploit this curriculum post- initial training.Results: We successfully predict the initial hospital admission location with area-under- receiver operating-curve (AUROC) ranging between 0.60to 0.78 for the individual wards and an overall maximumaccuracy of 52% where chance corresponds to 14% for this seven-class setting. Our proposed network was able to interpret which features drove the predictions using a 'network saliency' term added to the network loss function

INTRODUCTION

Deep neural networks (DNNs) have revolutionized the field of machine learning by providing a way to utilize verylarge datasets as well as large feature spaces to makemeaningful predictions. State of the art performance has been achieved by DNNs in a wide range of tasks proving their efficacy as learning algorithms. Their strength in function approximation has not been overlooked by the medical community, with numerous publications exploiting them to make useful predictions for various healthcare scenarios [17,30, 21]. One of the challenges of utilizing DNNs is that they are no convex optimization problems meaning the best performance that the algorithmis capable of may not be achieved[8]. As a result ,muchwork has been carried out in developing methods ofpresenting data to the network for training in a structuredfashion. This has since been called a curriculum and iswidely used when training DNNs today. The aim of thiswork is to utilize the concept of curriculum training to traina model that will predict where in a hospital a patient willbe admitted based on very early information obtained in theED from the triage nurse. We aim to show that themovement of patients from ED to one of seven differentward types in hospital is predictable. This would allowallocation of a bed and resources for the patient well aheadof admission to ensure that they receive care and treatmentin as timely a fashion as possible. We also aim to demonstrate that this prediction can be done given data collected from a patient at point of entry to the EDdepartment, which in turn will improve the flow of patients out of the ED and into the hospital. Difficulties in admitting patients to the optimal hospital ward are often most marked during periods of high demand, such asduring peaks in seasonal infections including influenza.

LITERATURE SURVEY

Clinical decision making is based on recognizing complex patterns of patients signs and symptoms. Neural networks have been shown to be very effective at this type of pattern recognition, and in this study a neural-network approach wasused to predict which patients seen in a psychiatric emergency room required admission and which did not. Data from all walk-in patients (N = 658) evaluated during normal working hours in a psychiatric emergency room during a one-year period were used either to train a neural network orto test its performance. The network had 53 input nodes, one hidden layer, and an output layer with a single node. The back-propagation method was used to train the network. The neural network's admitting decisions were in substantialagreement with those of the clinicians (kappa coefficient = 0.63). When used as a diagnostic test for admission it had a specificity of 94%, a sensitivity of 70%, and an overall accuracy of 91%. The information gain was 35%of that of aperfect diagnostic test. These results show that a neuralnetwork can be trained to make clinical decisions that are insubstantial agreement with those of experienced clinicians.

PROPOSED SYSTEM

To the best of the author’s knowledge no other work has proposed the framework of predicting where in the hospital a patient from the ED will be admitted. This is also believed to be the first work to employ deep learning architectures in orderto carry out hospital admission prediction. We then implemented our curriculum training methodology on both simple classification models as is undertaken in to determine whether or not the proposed curriculum learning could improvetheir performance.

TRAINING AND TESTING THE DATASET

- Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, andthat program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .itis done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

- Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields.Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

- Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals. Functional testing is centered on the following items Valid Input: identified classes of valid input must be accepted. Invalid Input: identified classes of invalid input must be rejected. Functions: identified functions must be exercised.Output: identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked. Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

- System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test.

RESULT

- **Login page**

- **Registration page**

CONCLUSION

In this article we have presented a novel method of training and regularising deep learning model with the aim of predicting where a patient presented to the ED will be admitted in an OUH Trust hospital. This prediction will aid in the provision of timely care and treatment for the patient and those still in the ED. Our model achieves AUC values between 0.60 and 0.78 for the individual ward types. Furthermore, our model also provides an explanation as to the cause of the predictions, allowing the user to incorporate more important features for individual ward types in the future. The authors believe this may be useful for ensuring timely admission to hospital and reducing the time to care. This will in turn improve the quality of care for patients still in the ED due to less crowding.

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