Sepsis Treatment Prediction Model Evaluation using Dynamics Model

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BACKGROUND

Sepsis:

Sepsis is a life threatening condition that requires prompt and effective treatment. Sepsis is the body's extreme response to an infection, which can lead to tissue damage, organ failure, or death without immediate treatment. The main treatment prescriptions for sepsis include IV fluids and Vasopressors.

SOFA Score:

The Sequential Organ Failure Assessment (SOFA) score is a clinical tool used to assess the performance of several organ systems in the body of critically ill patients, including those with sepsis. In general, a higher SOFA score is associated with a higher mortality risk.

THE PROBLEM

The treatment of sepsis is extremely challenging, due to the high variability among patients, suggesting the need for a dynamic and personalized approach to treatment.

There are many approaches to designing an optimal decision making model for sepsis treatment. Recently, there has been considerable interest in the application of Reinforcement Learning to extract treatment policies for septic patients from electronic health records data, such as the AI Clinician model. **However, the studies use varying methods for evaluating the performance of the model.** Some evaluation models may be flawed, leading to biased results.

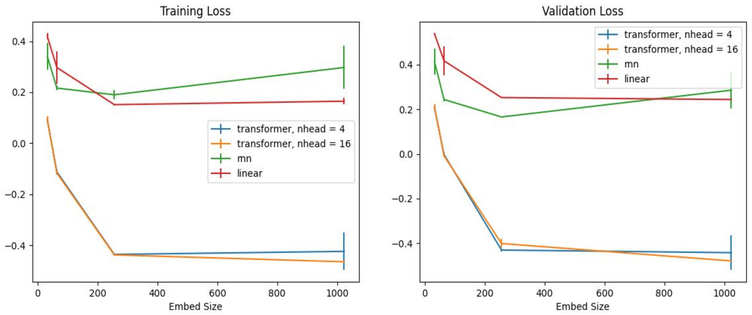
OBJECTIVE

This study aims to fill the gap in the evaluation of AI-guided medical decision models for sepsis treatment by **creating a unified evaluation model that can be used to measure the performance of many AI-guided sepsis treatment models.** The purpose is to improve the accuracy and effectiveness of sepsis treatment by providing clinicians with a reliable and efficient decision-making tool.

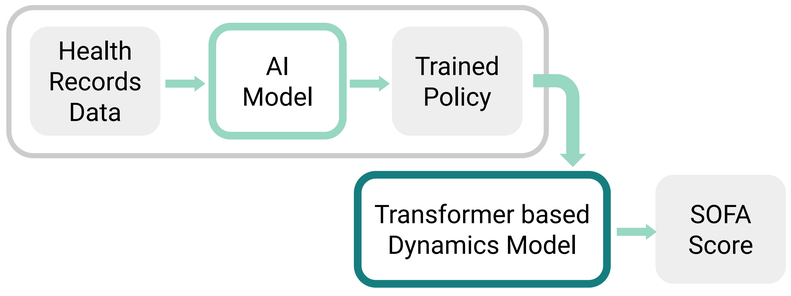
THE EVALUATION MODEL

This study uses dynamics models to predict the resulting state of a patient when a set of actions are taken. Specifically, the performance of transformer-based, RNN-based, and linear-regression-based dynamics models were tested. The transformer model is a neural network that learns context by learning information from sequential data.

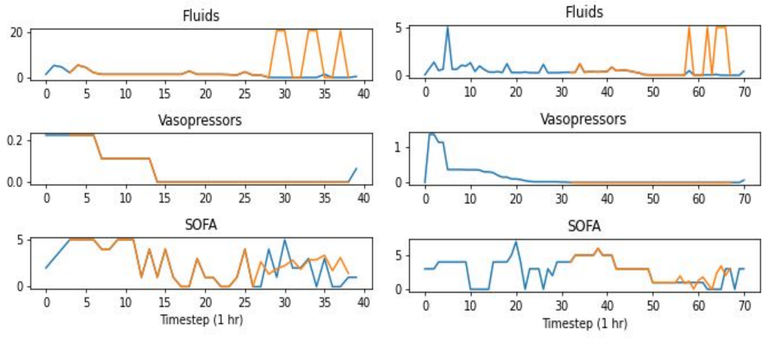
Comparing the performance showed that the transformer based dynamics model outperforms the RNN and linear regression based models.



The evaluation model uses the **transformer based dynamics model** on a dataset of real trajectories.



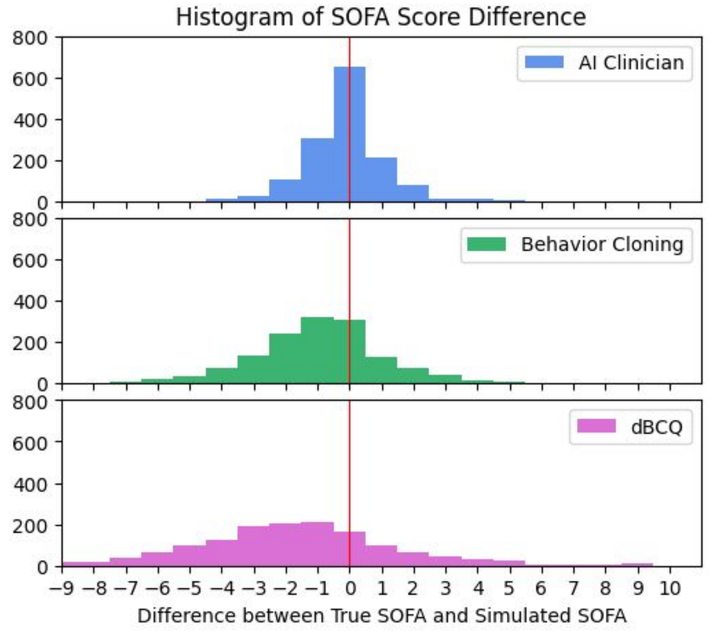
The evaluation model predicts the future SOFA score of the patients based on the policy action; the treatment (IV Fluids and Vasopressor dosage).



RESULTS

Three different types of AI-guided sepsis treatment methods were evaluated: the AI Clinician Model, Behavior Cloning Method, and the discrete Batch Q-Learning method.

The evaluation model also evaluated the real clinician actions, which served as a reference point for accuracy comparison. Out of the 3354 trajectories evaluated, only those with a zero difference between the real clinician simulated SOFA score and true SOFA score were included in this histogram.



DISCUSSION

The evaluation result demonstrates the variability in the performance of each AI-guided sepsis treatment method, with some methods showing a higher frequency of more successful trajectories compared to others. This information can help clinicians and researchers better understand the potential effectiveness of different AI-guided sepsis treatment methods, and guide the development of more accurate and reliable decision-making models.