Cognitive Assistant Protocol Selection For Emergency Response Situations

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Technical Project Team Members

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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The scenes of an emergency medical service is a scene that requires immediate expert attention. Medical responders rush over and have to assess the situation, assist victims, and make appropriate split-second decisions based on the feedback and data the responders receive. Even just a few minutes of hesitation or errors can have a huge impact on whether a rescue is successful or not.

Collecting, gathering, filtering, and processing this type of data in fast, high-pressure situations require a lot of human cognitive effort which can lead to numerous mistakes if the responder isn't focused. There have been past research to address such concerns such as: wearable assistive agents for trauma documentation and management, stimulating dynamic interactions between different human agents and potential digital agents in a hospital emergency environment using state machine based models, and information visualization agents the present information gathered based on predicted intent and recent observations from the emergency scene. However, from what is known, no previous research focus on dynamically recommending situation-aware interventions for real-time emergency response decision support.

With the lack of previous research, cognitive assistants for emergency response are currently being developed that will improve situational awareness and safety of first responders by real-time collection and analysis of data from the incident scene and provide dynamic data-driven feedback to them.

The data will come from responder-worn devices and smart sensors to monitor activities and communications at the incident scene and aggregate this data with static data sources such as emergency response protocol guidelines to generate insights that can assist first responders with effective decision making and taking safe responses.

My research is based on how to improve specifically the protocol selection aspect of this entire cognitive assistant system. I inspected two different Machine Learning protocol selection models from previous works.

The first model works by taking in a csv input file with four columns: the narrative, CUI, concept, and protocol. The first model then pre-processes this input data through: tokenizing, removing stopwords, building an embedding matrix, converting to ASCII, splitting into sequences, and finally splitting into pairs. It then uses a concept extraction script to extract concepts, which are then passed to the processed data sequences. At the same time the pre-processing, concept extraction, and processed data sequencing is happening, labels are also being built from the raw input data. Once the labels are built out, the GRU Network trains the model, and both losses and accuracy are computed. This model produced a Top-1 Accuracy of 0.39 and a Top-3 Accuracy of 0.77.

The second model works by also taking in the same type of csv input file with four columns: the narrative, CUI, concept, and protocol. However the second model uses narrative data concepts extraction by Metamap, which results in the input data being filtered through the signs and symptoms concept list. There are no intervention concepts in the filter list, so even though intervention concepts were extracted, they would pass through the concept filter list. The second model pre-processes the input data the same as the first model through tokenizing, removing stopwords, building an embedding matrix, converting to ASCII, splitting into sequences, and finally splitting into pairs. Word embeddings are then created on extracted and filtered concepts. Then finally the GRU model is trained with the word embedding, and both losses and accuracy are computed. This model produces a Top-1 Accuracy of 0.82 and Top-3 Accuracy of 0.97.

Below shows a table comparing the results of the two models.

Protocol Selection Model	**Top-1 Accuracy**	**Top-3 Accuracy**
GRU (Model 1)	0.39	0.77
GRU (Model 2)	0.82	0.97

The next step is building and evaluating a new model that can potentially improve the performance of the protocol selection and the intervention suggestion pipeline. Currently I am working on two methods for improving the performance of the model. The first method is working on a new model for predicting “Impressions" based on “Signs and Symptoms”. A baseline model is currently being built, where the labels used for training are changed from “Protocols” to “Impressions”, but the rest of the model, including feature extraction and GRU model, remains the same. The second method is evaluating the correlation between selected protocols and impressions. A correlation analysis is currently being executed to see if the percentage of the reports match.