LOCALIZING CHEMICAL AND BIOLOGICAL THREAT DETECTION

Biological And Chemical Threat Prediction And Reasoning System (BiCEPS) To Aid Detection Of Biological And Chemical Threat

Kakali Bandyopadhyay Airanaculus.com **Daniel Giger** Airanaculus.com **Zarius Shroff** Airanaculus.com **Apurva Mody** Airanaculus.com

Background Information: Timely alerts and localization of chemical and biological (CB) threats is critical to DTRA/JSTO's mission and to help achieve that wearable sensor technology is rapidly evolving. Continuous monitoring of human physiological data derived from the wearables can be used to develop efficient Artificial Intelligence and Machine Learning (AI/ML) models with a high degree of prediction for any CB threat or outbreak, allowing for situational awareness of the individual and alerting the commander.

Purpose: BiCEPS work aims at development and use of efficient (AI/ML) models based on data extracted from wearable devices -based datasets to develop algorithms with a higher confidence predictive model for a threat exposure at lower than a 15% false positive rate, with capability to provide earlier prediction before symptom onset and with the capability to differentiate and account for confounding factors. This will allow to gather localized information on CB threat, data on individual physiological conditions and

Objective: BiCEPS proposes an AI/ML based approaches on the data / features extracted from existing wearable device-based datasets, to develop algorithms with a higher confidence predictive model, for a threat exposure at lower than a 15% false positive rate, with capability to provide earlier prediction before symptom onset and with the capability to differentiate and account for confounding factors. The developed ML model/software will be threat agnostic, provide high accuracy for an earlier prediction(>48 hrs.) , differentiate and account for confounding factors , deployable on a host machine/platform and optimized for data degradation, allowing for timely, accurate alerts to DTRA/JSTO.

Res Rationale: DTRA/ JSTO seeks person centric wearable technology solutions equipped with efficient models that provide localized, instant information with high degree of accuracy for any CB threat /outbreak, thereby informing commander's knowledge of the field.

Relationship to other study areas: BiCEPS methodology on time series data analyses is based on A10's prior ML work detecting RF signals. Current BiCEPS results and models is highly relatable for application in future CB Detection and Diagnostics.

Methods: We use neural networks and ensemble techniques such as Extreme Gradient Boosting to detect COVID in data from wearable devices, such as Garmin watches and Oura rings. For the ensemble models, we use feature engineering to extract salient features from the time series data before passing them into the model. These extracted features include rolling windows, means, medians, skew, and trend. With convolutional neural networks, we instead use the time series data directly since they are well-suited for processing the raw data.

Prelim Results: BiCEPS ensemble models showed ROC AUC at 91%, with 85% True Positive Rate at 15% False Positive Rate. Neural network approaches yielded ROC AUC at 80% with a 50% True Positive Rate at 15% False Positive Rate.

Prelim Conclusions: BiCEPS' ML techniques like neural networks and ensemble models can detect biological threats (COVID 19) such as heart and respiration rate data collected by wearable devices.

Impact on JSTO/JF: BiCEPS will enable JSTO with efficient ML models, capable of predicting localized information on biological threats, using data derived from wearables.

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