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ENGINEERING

Applying Clustering to Optimize Markovian Models in Human-Machine Interactions

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Much like human-human interactions, human-machine interactions require an appropriate level of trust. If the human's trust on the machine is ill-calibrated, the interaction's result will be suboptimal. If a machine wishes to improve trust, it must first know the state of the human's trust in it. To this end, partially observable Markov decision processes (POMDPs) have been used to estimate trust. Given observations resulting from trust (e.g., compliance or defiance), POMDPs can estimate the probability of high or low trust in a machine given its previous action.

Previous work, however, assumed a general model for the entire population. Nonetheless, different people trust differently; therefore, it is desirable to create specialized models for different "types" of people. A useful tool for this is clustering, which groups similar data sets into "clusters," separating them from dissimilar ones. This research focuses on human subject data in an online interaction with a robot. Therefore, each participant can be seen as one data set. After clustering, the data from a single cluster can be used to train a POMDP model representing its members.

The work is ongoing, but preliminary results using k-means clustering based on the literal distance between participants' models are promising. Clustered models were more accurate at predicting behavior and trust. Furthermore, the resultant POMDPs were visibly different, yielding a quantitative method of determining the aforementioned "types" of people. One cluster was seen to comply even with low trust, for example. So far, clustering shows more accurate trust estimation, leading to improved human-machine interactions. It also has psychological implications, since different "types" of people will be uncovered through examination of the models.

Research advisor Kumar Akash writes: "Griffon's research sets the foundation for capturing individual differences in humans' cognitive behavior without the need for customized models for each individual. By clustering human trust models, his work not only aids in further improving human-machine interactions, but also provides key insights toward variations in human trust psychology and perception."

McMahon, G. (2020). Applying clustering to optimize Markovian models in human-machine interactions. *Journal of Purdue Undergraduate Research, 10,* 92–93.

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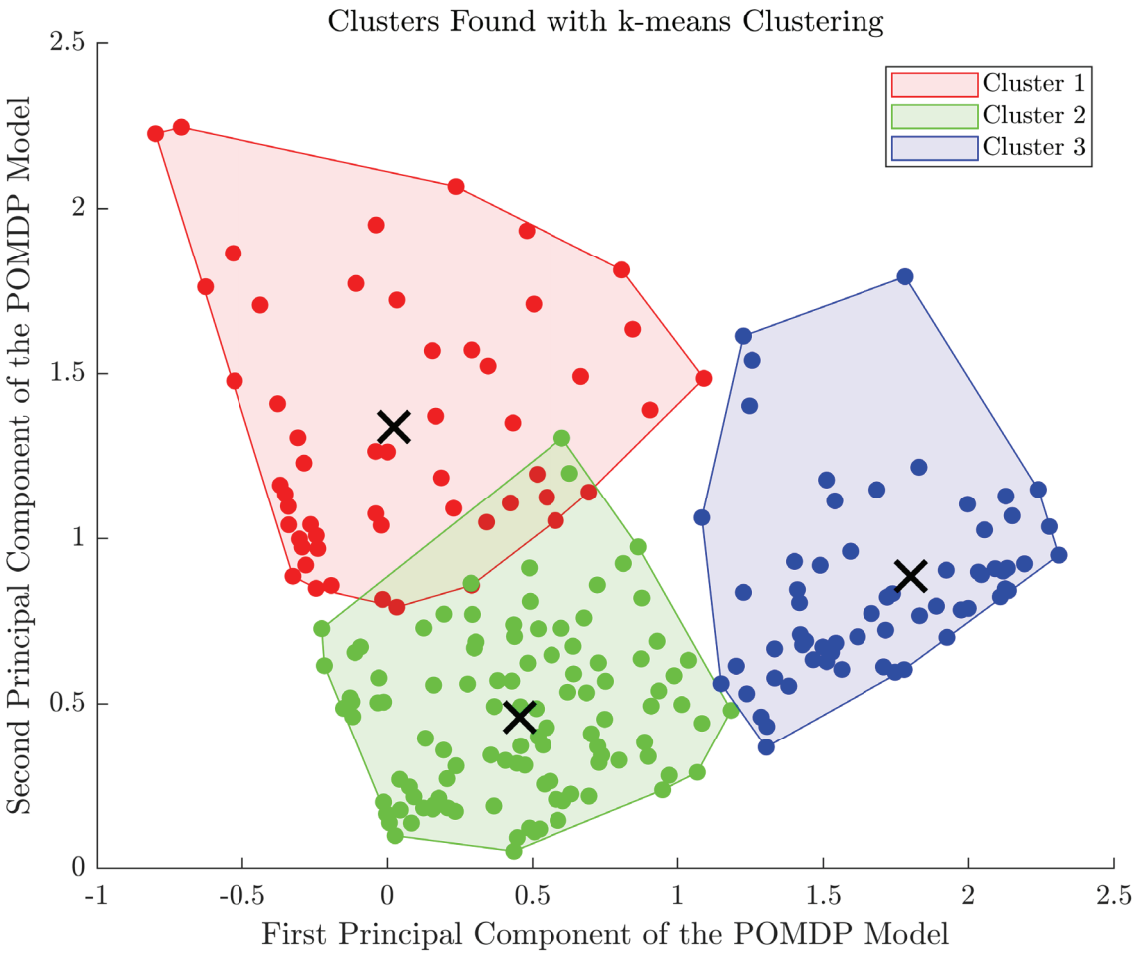

A *k*-means clustering of participants plotted by their individual POMDP models using principal component analysis (PCA), with the cluster centers marked with an "×." The apparent overlap between clusters is due to visualization of a 14-dimensional space in 2D using PCA.

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