**Data Fusion of Mobile, Wearable, and Stationary Consumer Sensors to Predict Bedroom Occupancy**

Many research questions and HVAC operation procedures like scheduling require accurate estimates of room occupancy. Advances in affordable sensing technology now allow researchers and building managers to outfit buildings with a variety of consumer-grade, Indoor Air Quality (IAQ) sensors that can be used to estimate occupancy. However, measurements from these low-cost, consumer-grade sensors can be inaccurate and therefore misleading. Sensor measurements, like GPS, from mobile phones and wearable fitness trackers can help improve our confidence that IAQ sensors are monitoring periods of occupancy.

In this analysis, we use machine learning (ML) methods to predict bedroom occupancy from IAQ, namely carbon dioxide and temperature, measured by our own consumer-grade device – the BEVO Beacon. Data were gathered from the UTx000 study: an 11-week long study conducted during the summer of 2020 with 20 university students living in homes and apartments within Texas. We leverage GPS data gathered from mobile phones and sleep episodes identified by wearable fitness trackers to accurately tag periods when participants are home and in their bedrooms. This process helps ensure a greater confidence that our training data contain IAQ measurements from periods of bedroom occupancy. We develop four binary classification models specific to each of our participants which are based on different ML principles: logistic regression, Naïve-Bayes, random forest, and a simplistic, feed-forward neural network. We compare these models within and across participants to identify the most promising model. Initial results indicate that we can predict occupancy for some participants with an accuracy of more than 90% when only considering carbon dioxide measurements with the greatest performance achieved by the neural network. This analysis highlights the importance of data fusion techniques to improve model performance and one of the varieties of uses for low-cost, consumer-grade sensors in a real-world application.