# **Human Activity Recognition in Smart Homes**

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## **Project Overview**



- Objectives:
  To map a sequence of sensor events to a corresponding activity label
- Applications:
  - Health care
  - Energy saving
  - Security

#### **Dataset**

- Public source: UCI repository
- 30 datasets for 30 smart homes with different floorplans:
  - 7M+ observations
  - 37 features
  - Multivariate classification with 45 classes
- Date reflects info from motion sensors, door sensors, and light sensors.
- 1 floorplan for EDA and initial modeling:
  - 320k+ observations
  - 37 features
  - Multivariate classification with 35 classes

## **Explanatory Data Analysis**

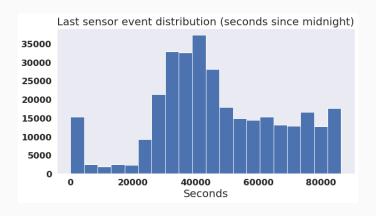
- A great majority of activities belong to 'Other Activity'.
- The rest of activities (which are not shown in the below plot) have less than 1% distribution.



• The data is pretty imbalanced.

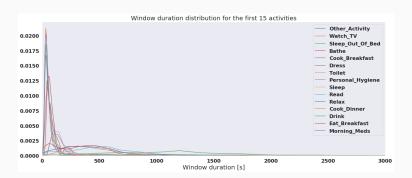
## **Explanatory Data Analysis**

• The sensors record less activity during the normal sleeping time.



## **Explanatory Data Analysis**

 The activities with the highest majority seem to have smaller window duration.

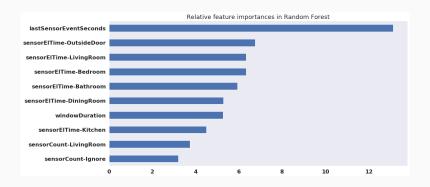


## **Machine Learning Modeling**

- Model selection
- Performance Metrics
  - Accuracy
  - Confusion matrix
  - Elapsed run time
- Resampling dataset
- Model tuning
- Dimensionality reduction (PCA and tSNE)
- Generalizing Decision Tree to the combined 30-smart-home datasets with 7M+ observations:
  - Accuracy: 92.3%
  - Elapsed run time: 294 sec

	Accuracy	Elapsed Time[s]
Logistic Regression	0.662	86.73
<b>Decision Tree</b>	0.953	8.67
Random Forest	0.973	83.05
<b>Gradient Boosting</b>	0.840	4646.25
XGBoosting	0.966	973.75
Ada Boosting	0.410	67.64
Multi-layer Perceptron	0.887	106.59

## Feature Importance (top 10)



- The number of seconds since last sensor activation is the main contributor to activity prediction.
- The sequence of sensor records are pretty important.

### **Conclusions**

### Concluding Remarks

- The predictive model is able to recognize human activity in a smart home with 97% accuracy.
- The prediction error is for the categories that have not been defined clearly.
- The raw data was processed fairly well by domain experts which affects the model performance.

#### Future Plans

- To generalize all models to the combined 30-smart-home dataset which makes my predictive model independent of floorplan
- To approach the problem unsupervisingly
- To generalize the model to wearable sensors such as smart devices

## Github Repo

Thank you!

## **Appendix - Data Description**

- Data description:
  - Data was recorded continuously for two months.
  - Date reflects info from motion sensors, door sensors, and light sensors.
  - The raw data was processed in the form of feature vectors using a sliding window of 30 sensor events.
  - Eventually there exist 11 sensors in each dataset, each of them corresponding to a location in smart home.

## **Appendix - Confusion Matrix**

