



# Activity recognition in Smart Home

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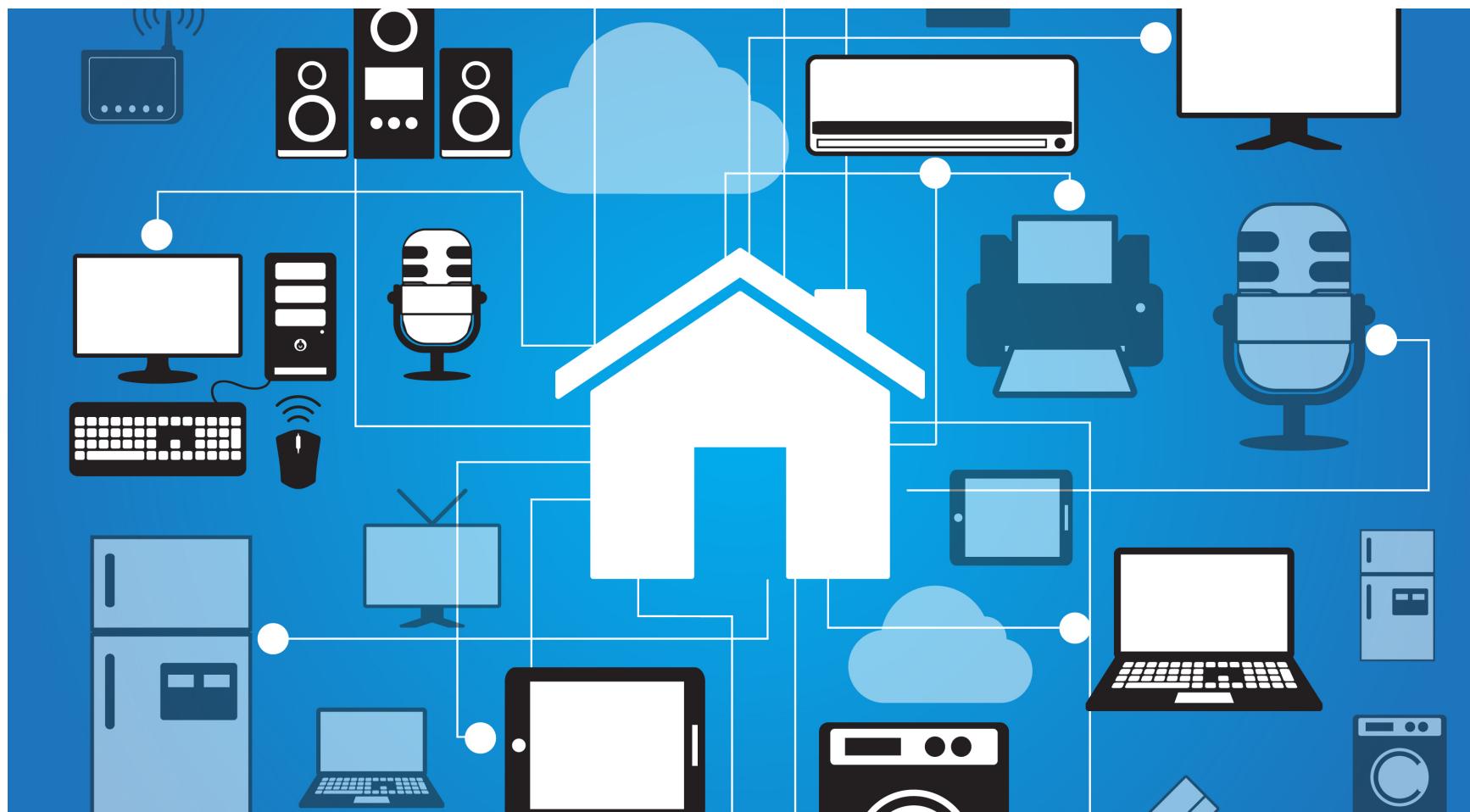
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co-organizer SF Data Mining

NN

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# IOT of connected home



# Dataset

<http://courses.media.mit.edu/2004fall/mas622j/04.projects/home/>

- 22 Every day Activities
- 2 weeks of sensor data in March/April 2003



Sensors in the smart home placed in:

- Bathroom
- Foyer
- Kitchen
- Living room
- Bedroom
- Porch
- Office/study

# Activity recognition

|                     | <i>continuous</i>          | <i>categorical</i>    |
|---------------------|----------------------------|-----------------------|
| <i>supervised</i>   | <i>regression</i>          | <i>classification</i> |
| <i>unsupervised</i> | <i>dimension reduction</i> | <i>clustering</i>     |

## Some activities had less than five examples...

| Activity                    | Number of Examples |
|-----------------------------|--------------------|
| Other                       | 1                  |
| Washing hands               | 1                  |
| Going out for entertainment | 1                  |
| Lawnwork                    | 1                  |
| Going out for shopping      | 2                  |
| Putting away dishes         | 2                  |
| Putting away laundry        | 2                  |
| Putting away groceries      | 2                  |
| Watching TV                 | 3                  |

# The activities we used:

| Activity             | Number of Examples |
|----------------------|--------------------|
| Preparing dinner     | 8                  |
| Washing dishes       | 8                  |
| Cleaning             | 9                  |
| Going out to work    | 12                 |
| Preparing breakfast  | 14                 |
| Preparing a snack    | 15                 |
| Preparing a beverage | 15                 |
| Preparing lunch      | 17                 |
| Bathing              | 18                 |
| Doing laundry        | 19                 |
| Dressing             | 24                 |
| Grooming             | 37                 |
| Toileting            | 84                 |

# Main Challenge: Data format

Toileting,4/1/2003,11:52:1,11:58:50

100,137

Toilet Flush,Freezer

11:55:43,11:56:2

16:35:49,11:56:13

Going out to work,4/1/2003,12:11:26,12:15:12

81,139,140

Closet,Jewelry box,Door

12:12:29,12:13:27,12:13:45

12:13:0,12:13:35,12:13:48

Preparing lunch,4/1/2003,11:21:17,11:38:22

140,137,131,53,84,131

Door,Freezer,Toaster,Cabinet,Drawer,Toaster

11:23:4,11:23:55,11:24:8,11:34:59,11:35:4,11:35:12

11:23:7,11:24:3,11:24:14,11:35:1,11:35:7,11:35:22



95% of time spent  
on  
data cleanup  
and  
feature engineering

# Sensor Features

- Sensor activation duration
- Order of sensor activation
- Relative order
- Seconds from the start of activity
- Seconds from the activity start normalized by the total activity duration in seconds
- ...

# External features

- Day of week
- Time of day
  - 4am-10am
  - 10am-4pm
  - 4pm – 10pm
  - 10pm-4am



Potential feature candidates (not used here):  
sensors locations, national holidays, ...

# Dataset

578 features

78 sensors

280 examples

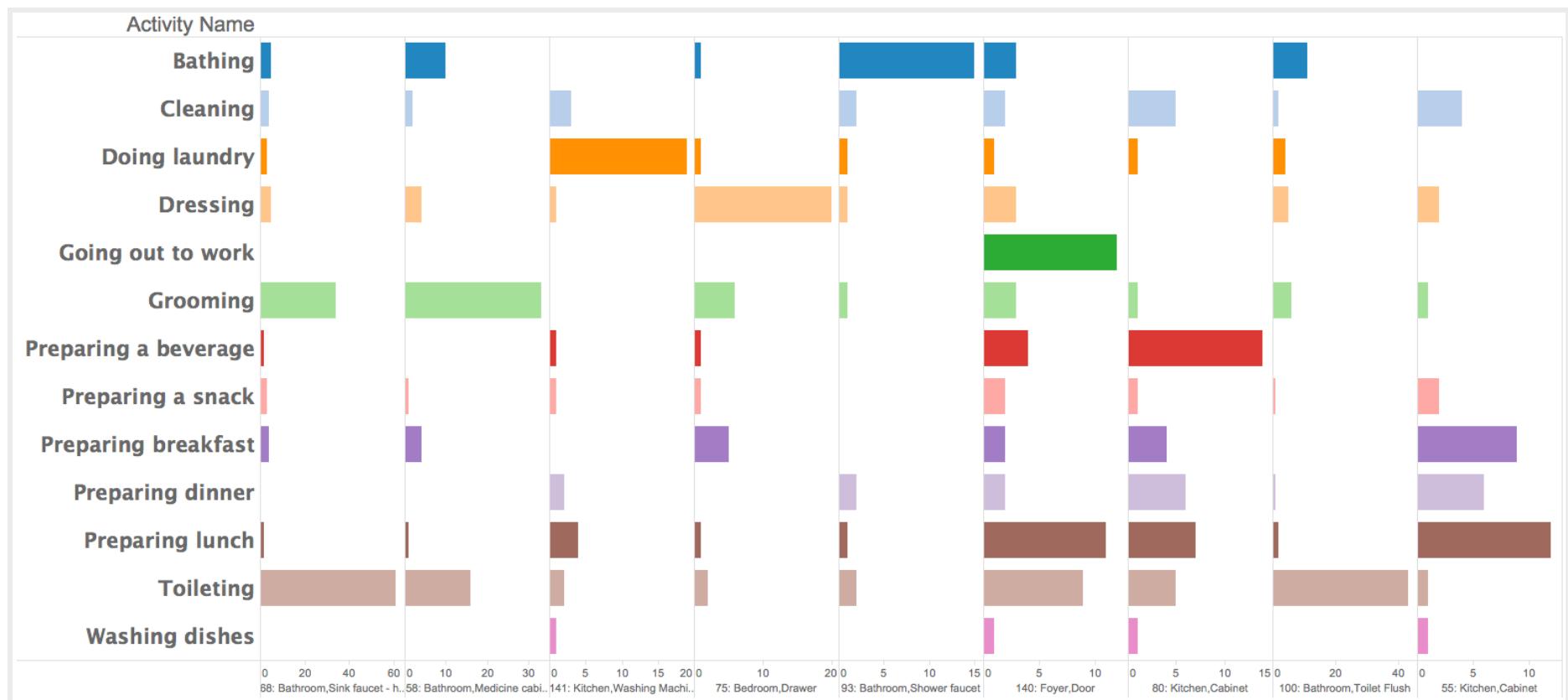
13 activities

Lots of NaNs

# Machine Learning

- Decision tree (full/reduced features): 0.52  
with full 0.55 with partial
- Logistic Regression (full features): 0.5
- KNN (full features): 0.53
- **Random forest** (full features/partial features)  
**0.73** with full features, 0.57 with partial

Most important features come from  
these sensors



Bars show total number of sensors activation per certain activity over all activities in the data. Sensors can be activated multiple times per activity

## WORKED

## DID NOT WORK

- Taking time for feature engineering
- Random Forest

- Naive Bayes
- Reducing number of features for Random Forest
- Logistic Regression

# If I only had more time...

- More features for Random Forest
- Better feature engineering
- More time on understanding results/refining the features



# Thought of the day

More Data and clever  
feature engineering beats  
better algorithms



