Non-Invasive Mobility Monitoring for Early Detection of Dementia

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INTRODUCTION

- Changes in mobility can be an early sign of dementia in the elderly.
- In-home care or nursing homes to monitor the elderly can be financially and emotionally draining.
- A system to monitor and detect changes in mobility can allow for early dementia diagnoses and treatment at one's home.

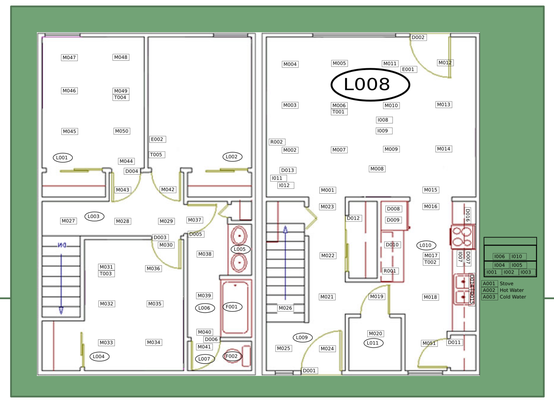
RESEARCH QUESTIONS

- Can we calculate a resident's total mobility using motion sensor data?
- Can the system learn to predict a resident's mobility?
- Can changes in mobility be detected and analyzed?
- Can these monitoring techniques be used for multiple residents simultaneously?

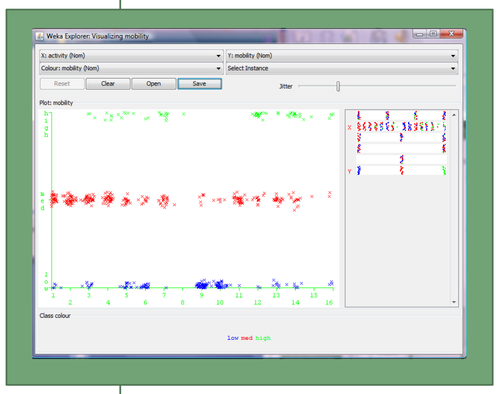
CALCULATING MOBILITY

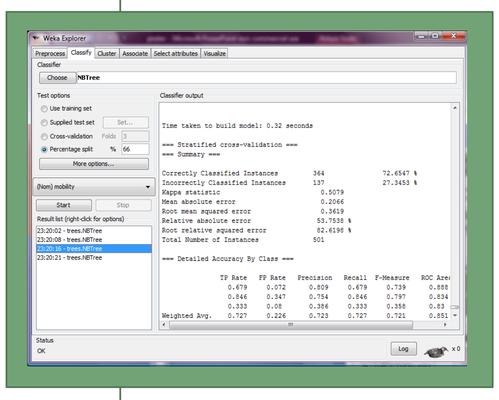
The Python program to calculate mobility:

- Used hardcoded sensor locations as seen in the home's layout.
- Read in the data from the sensors, isolating those data from the motion sensors.
- Stepped through the data looking at the "current" and "next" locations.
- Calculated the summation of all distances between the current/next sensor pairs.



PREDICTING MOBILITY





Using the datamining software, Weka:

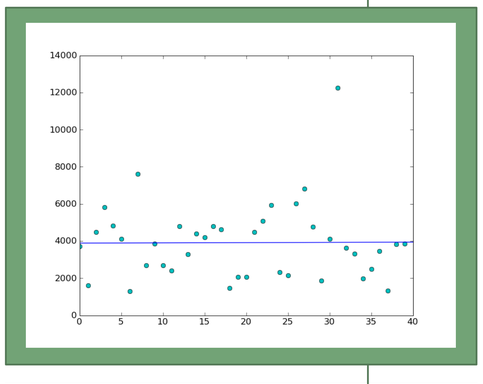
- A Naïve Bayes Tree was used to learn the expected mobility ranges (low, med, high).
- The training data included multiple attribute combinations, the best being: activity, time of day, resident, and week of the month.

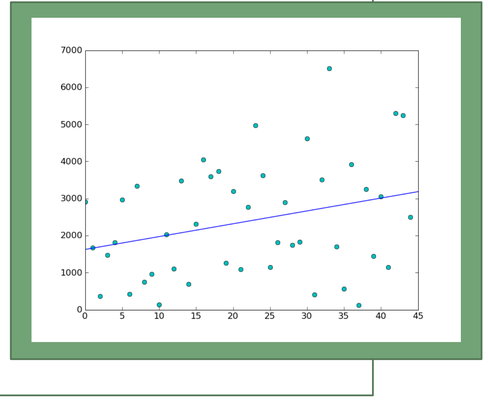
DETECTING MOBILITY CHANGES

Using the matplotlib Python library:

- The occurrences of an activity were reviewed chronologically .
- Their Linear Regression was then calculated and graphed.

In nearly all cases, the Linear Regression showed a slope of, or around, zero.





MULTIPLE RESIDENTS

Using Bayesian Updating techniques, a Python program was written to:

- Determine the probabilities of the residents being in a given location at a given time.
- With each added sensor event, the probabilities were updated.

RESULTS AND CONCLUSION

- The program created was able to calculate total, average, and the standard deviations of mobility.
- After training the results in Weka, the system was able to predict mobility correctly 72-74% of the time with the small amount of data available to it using cross-validation and a 66% split test.
- Adding functions to calculate Linear Regression was also successful and the graphs made the results easily readable.
- These results establish that monitoring changes in mobility within a smart environment is possible and could, indeed, help enable early detection of dementia from within an individual's home.
- The Bayesian Updating shows promise and with future work will greatly enhance the system.

FUTURE RESEARCH

- Future research should work to raise the accuracy of the system's mobility predictions.
- The research on Bayesian updating to monitor multiple residents should continue and should later work to assess the probability of one's location given the location of all other residents.
- Work could also be done using autocorrelation to detect cycles in mobility such as increases on weekends.