Discovering Activities to Recognize and Track in a Smart Environment

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Outline

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- Recognize and Track
- Experiments
- Conclusion

Introduction

Smart Environment

1) Track Activities
2) Life style patterns
3) Very important for health system and caregivers

Introduction

Sensor ID	time	value
8146000000B	12 10:50:45.673225	ON
E460000000D	12 10:50:48.903745	ON
A360000000F	12 12:30:09.56483	1.98

(a) (b)

Challenges

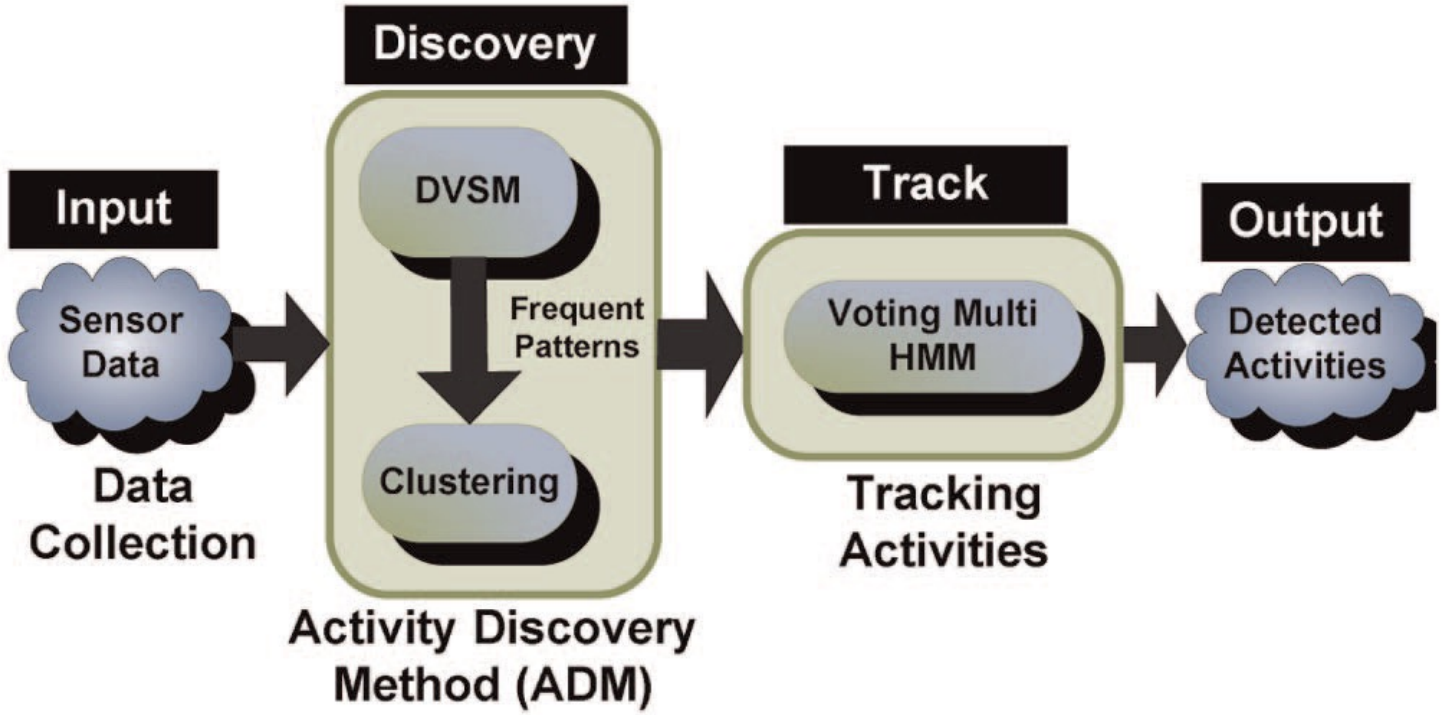
- Assume each individual performs standard activities (not true)
- Tracking only preselected activities (may miss important activities)
- Require trained data (very time consuming)

Problem statement

The system will deal with unsupervised data.

The system can discover, recognize and track activities.

System overview



Discovering Activities

Sequential Mining

1) Find all frequent items
2) Find sequential frequent patterns using prefix and suffix
3) Both require pruning steps

Ex: (<a, b>, a)

Discovering Activities

Discontinuous Varied-Order Sequential Model(DVSM)

1) Data mining techniques for sequential data
2) Discontinuous and order-varying

Discovering Activities

Event continuity

$$\Gamma_e(\text{é}) = \frac{1}{S_{\text{é}} + 1}$$

$$\Gamma_i\left(a_i^j\right) = \frac{1}{\left|a_i^j\right|} \sum_{k=1}^{\left|a_i^j\right|} \Gamma_e\,(\text{k})$$

$$\Gamma_v(a_i) = \frac{1}{n_{a_i}} \sum_{j=1}^{n_{a_i}} \Gamma_i\left(a_i^j\right)$$

Discovering Activities

$$\Gamma_g(a_i) = \frac{\sum_{i=1}^{n_a}(\Gamma_v(a_i) * f_{a_i}}{2a}$$

$$\frac{DL(D)}{DL(a)+DL(D|a)*(1-\Gamma_g(a))} > C$$

$$\frac{DL(D|a_i) * \Gamma_v(a_i)}{DL(D|a) * (1 - \Gamma_g(a)} > C_v$$

Discovering Activities

Clustering Sequences into Groups of Activities

1) Take the mining results to do clustering
2) Add additional information (such as type and duration)
3) Extend state (Combine all consecutive states corresponding to the sensors of the same type)

Discovering Activities

The general edit distance

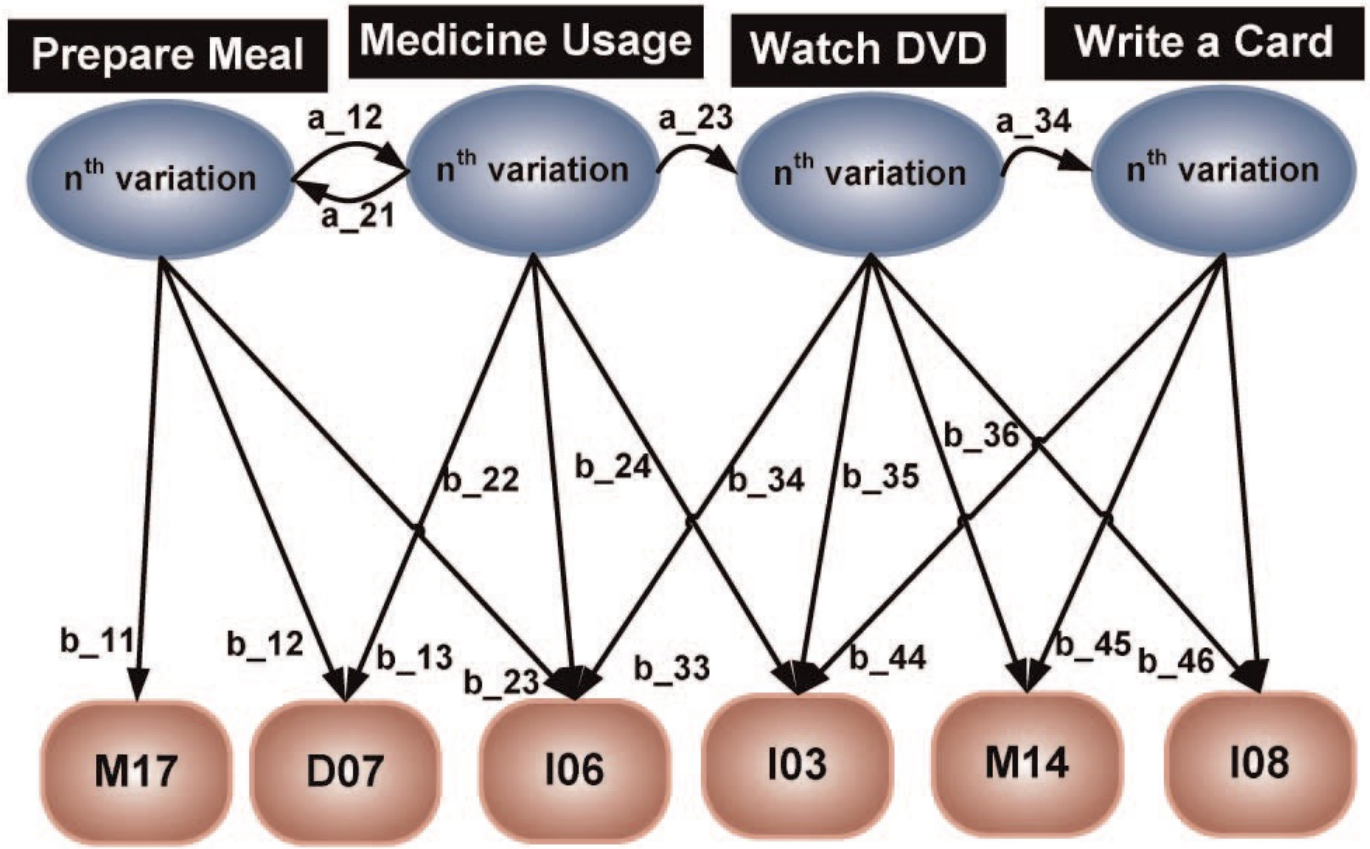
$$e_g(X,Y) = e(X,Y) + \sum_{\substack{x \in E(X) \\ y \in (Y), m(x)=y}} \Delta(x,y)$$

1) Use standard K-mean and find the centroid
2) The centroid represent common form of the activities

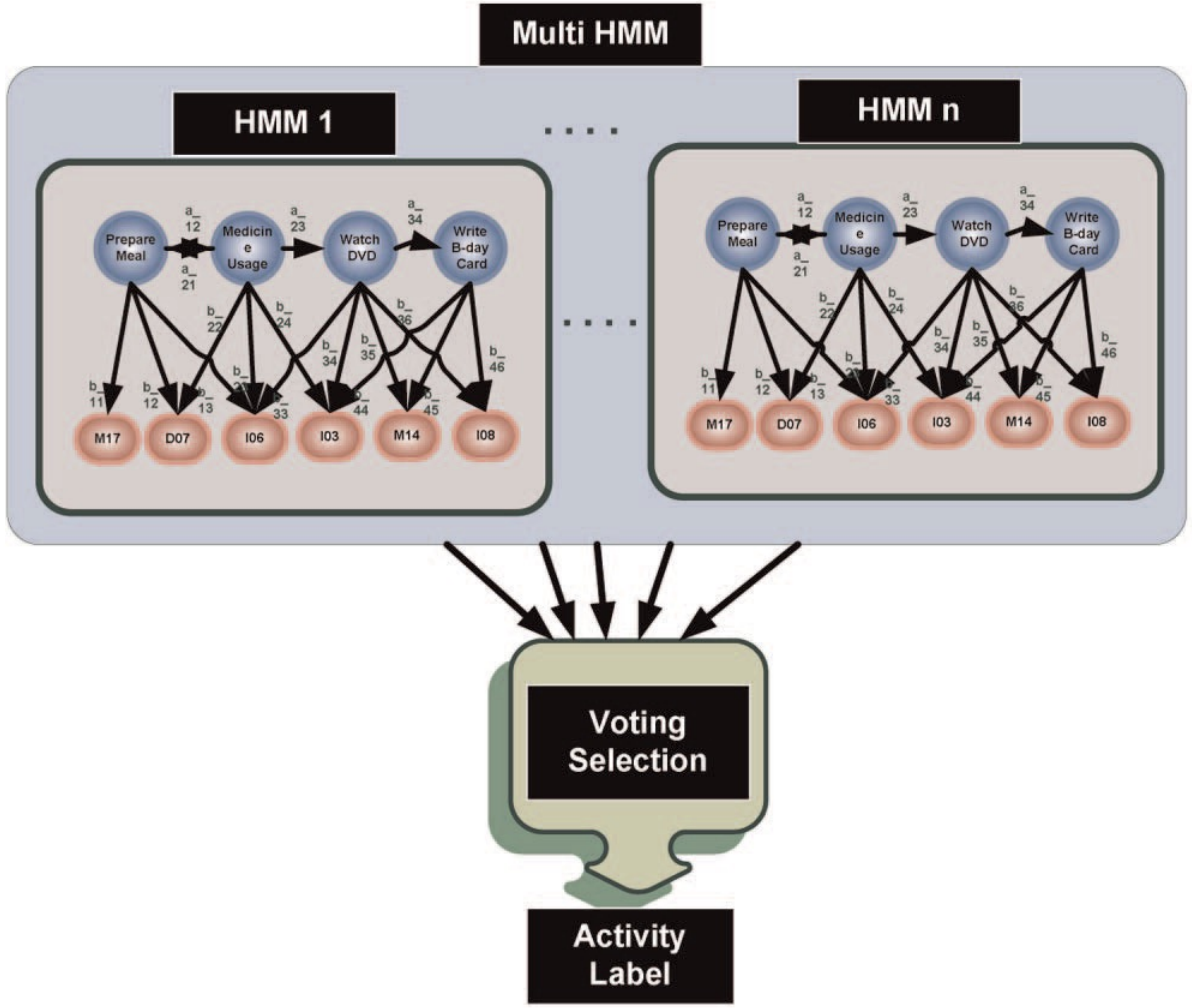
Recognize and Track

- Recognize the activities use Hidden Markov Model
- Use Viterbi algorithm for each HMM to identify sequences
- Use voting mechanism to label activities

Recognize and Track



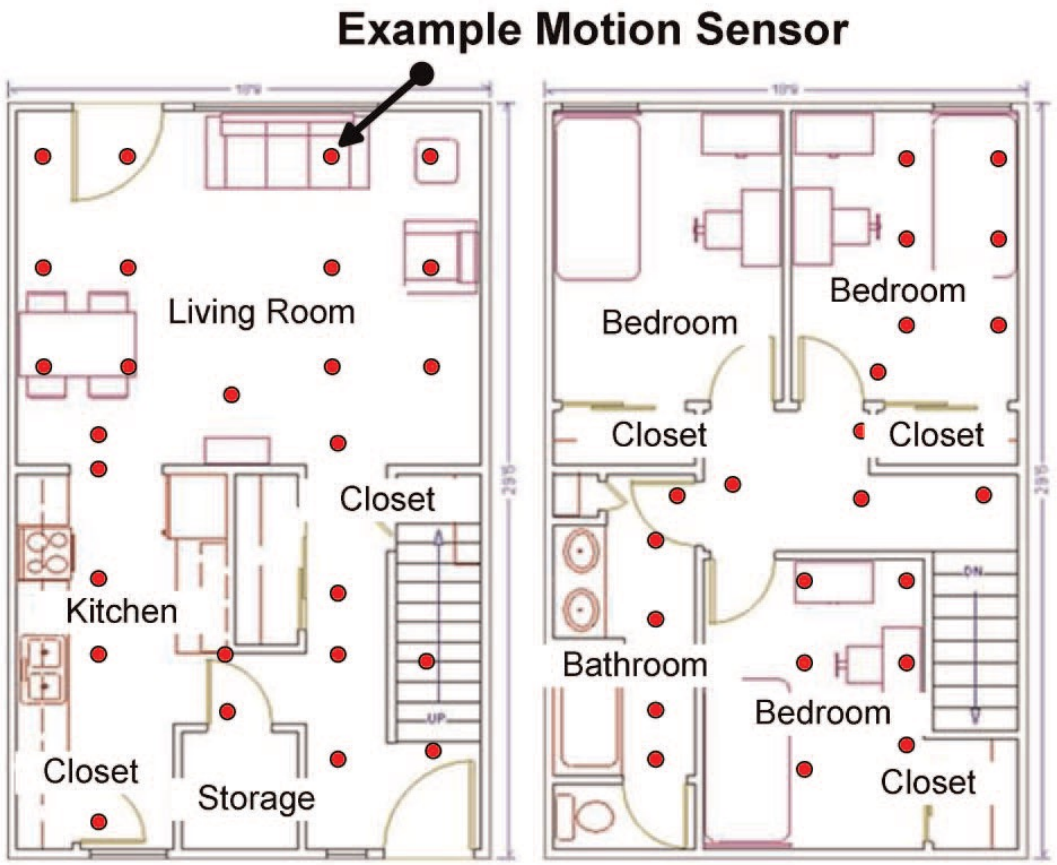
Recognize and Track



Experiments

- Three bedroom apartment Washington State University
- Motion sensor 1 meter apart throughout the ceiling
- Temperature reading and water reading sensors
- Jabber-based publish/subscribe protocol
- 20 students
- C and Cv to 0.3 and 0.1

Experiments



Experiments

Conclusion

- Smart system deal with unsupervised data
- Utilize data mining techniques to discover and track activities
- Very efficient to identify and track general activities
- Still need to work with difficult activities

Question