A Location Predictor based on Dependencies Between Multiple Lifelog Data

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Location Prediction

By predicting future locations, we can provide useful information to a user.

- Time limited sale info at the supermarkets near the predicted locations

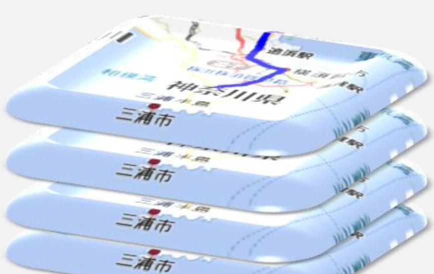
- Weather info of future locations

- To-Do Tasks related to future locations

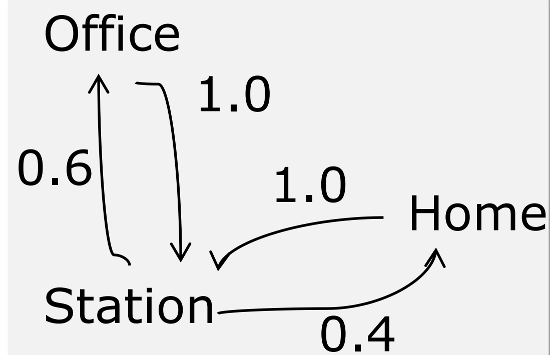
Related Works

Extract and use regularities in movement from location log

- Markov Model[Ashbrook, 2003]
- Dynamic Bayesian Network[Liao, 2007]
- Sequential Pattern Mining[Monreale, 2009]



accumulated location logs



prediction models

Problems

Since previous research uses regularities, they cannot predict irregular movements.

Regular

go to school on weekdays

go to the gym every Monday

etc...

Irregular

irregular meeting

business trips

etc...

Our proposal

Integrate different kinds of lifelogs to predict both regular and irregular movements

Regular
go to school on weekdays
go to the gym every Monday.
etc...

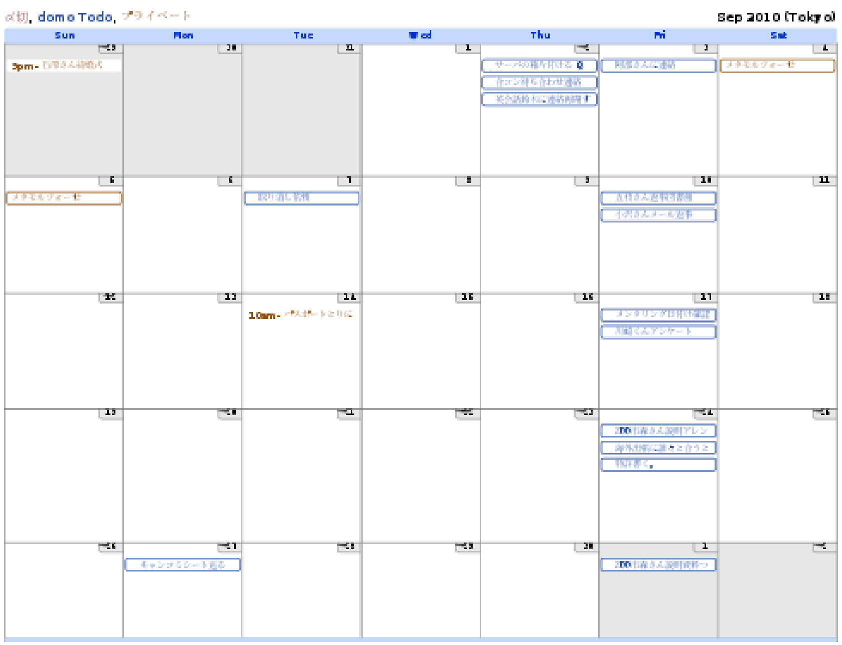
Irregular
irregular meeting
business trips

→ can predict with location log.

→ can predict with integrating different kinds of logs.

Calendar data

We use calendar data as a source for making predictions of irregular movements



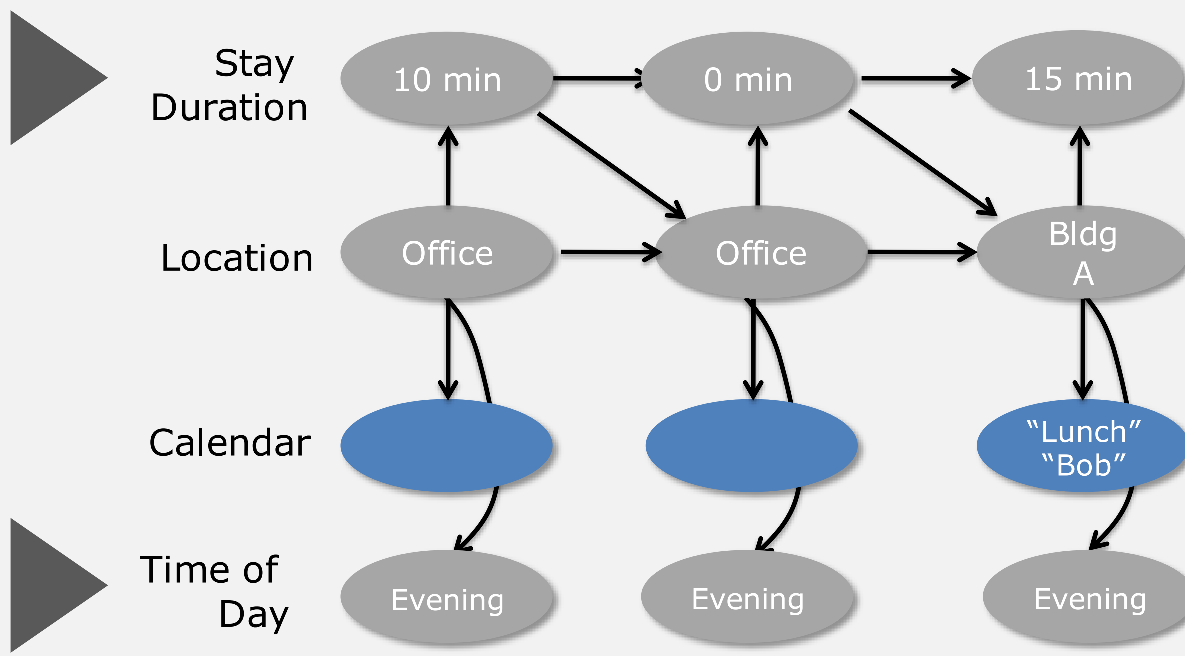
- People enter info about irregular events into it
- Widely used.

Dynamic Bayesian Networks model for integrating different data.

DBN model can make reasonable predictions when prediction with only calendar/GPS data is difficult

GPS Data

Calendar Data

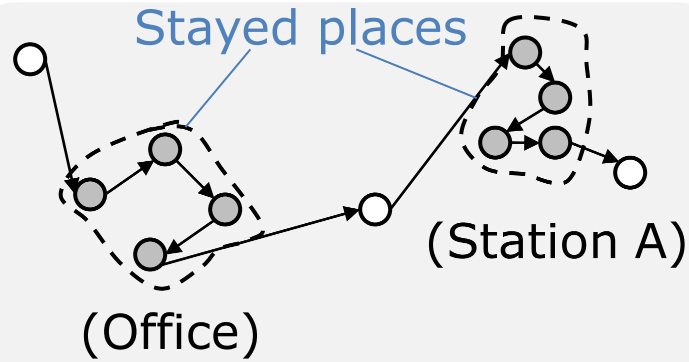


Integrated DBN Model

Preprocesses

(37.53,-122.08)
(37.50,-122.00)

GPS Data



Clustering

(Office)
(Station A)

Stayed Places

“Meeting with Bob”
“See the Dentist”

Calendar Data

“Meeting” , “Bob”
“Dentist”

Extracting Keywords

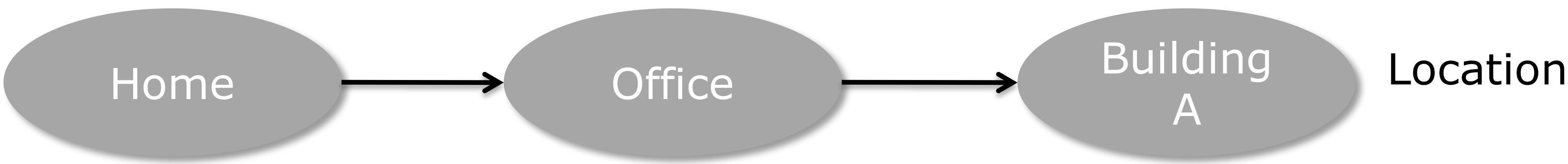
“Meeting”
“Bob”
“Dentist”

Keywords

Concepts of DBN Model

Place-place relationship

Markov Model

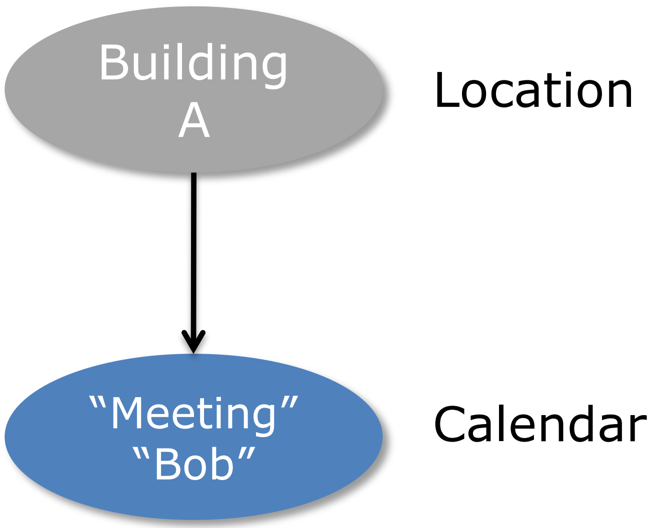


Simple model for predicting locations.
Can predict regular movements.

Concepts of DBN Model

Place-Keyword relationship

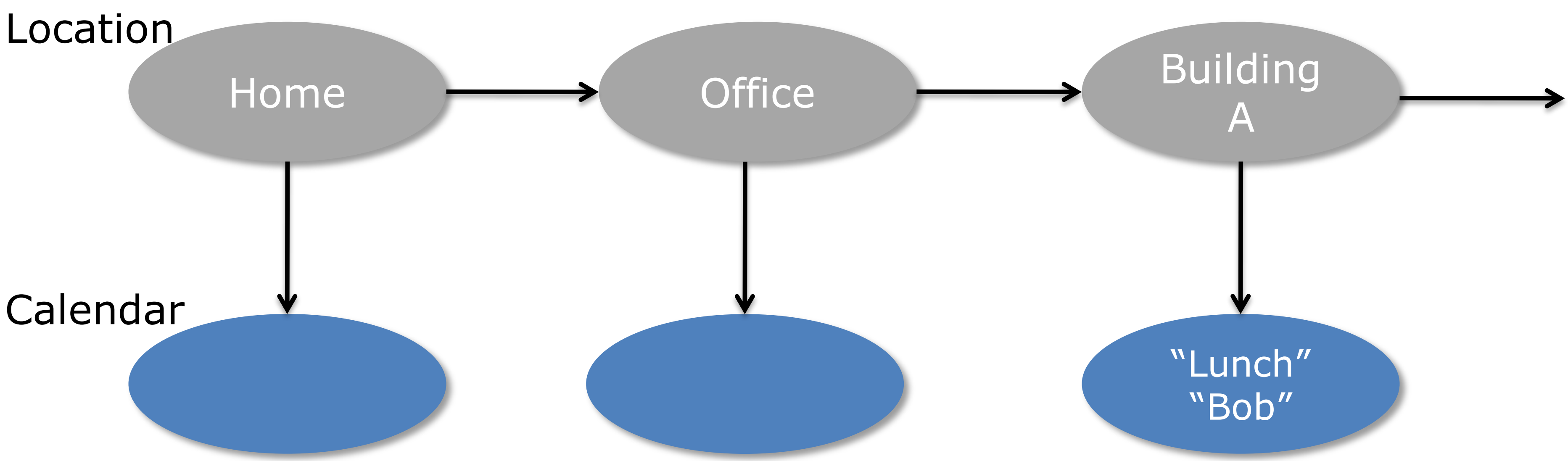
Infer a user's own relationship between place and keyword from co-occurrences.



- Can predict irregular movements

DBN model (basic)

Integrate place-place relationship
and place-keyword relationship

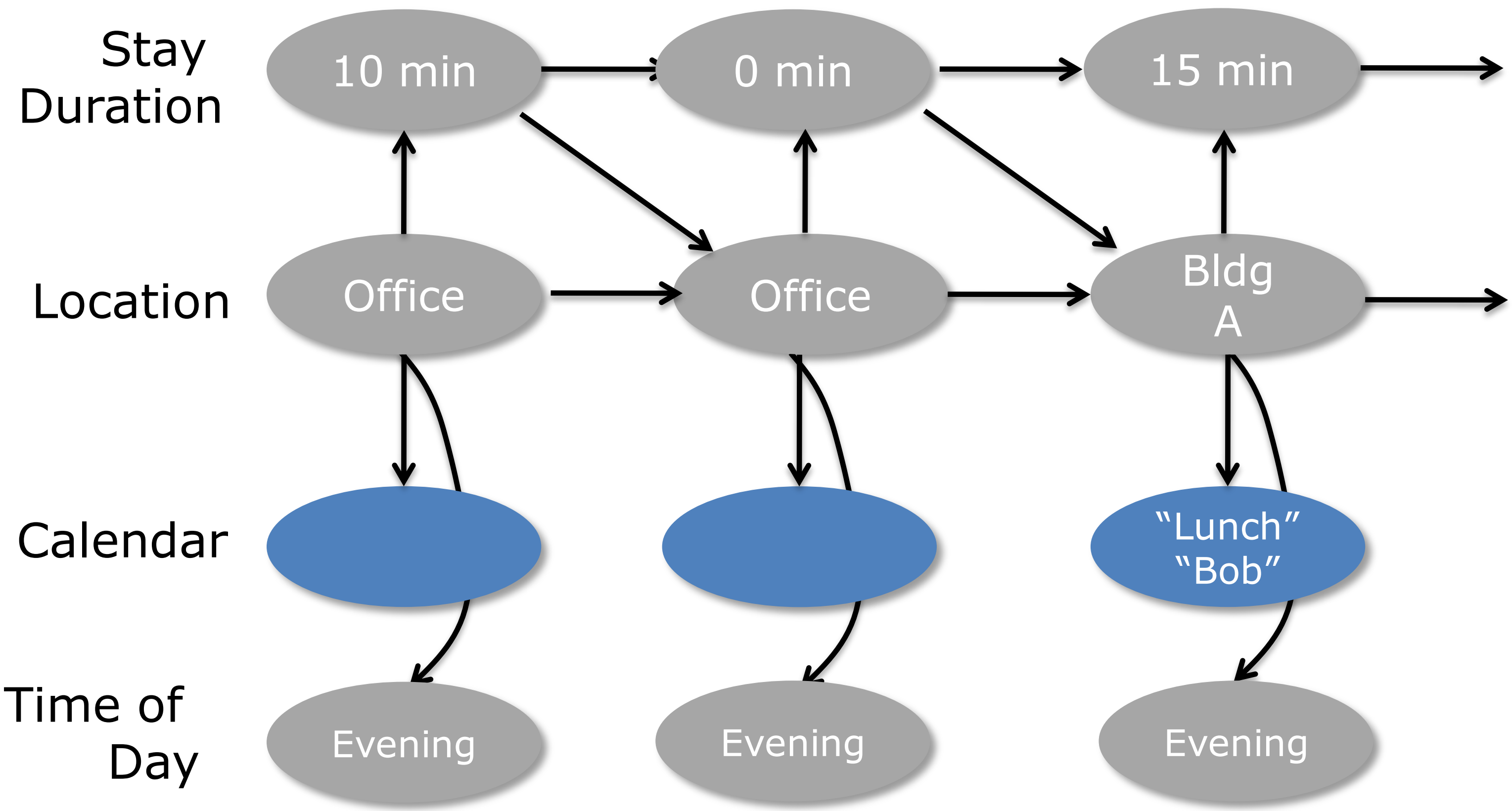


Both regular and irregular movements can be predicted.

DBN model (actual model)

Make some extensions to basic model.

- add node that represents time of day, stay duration

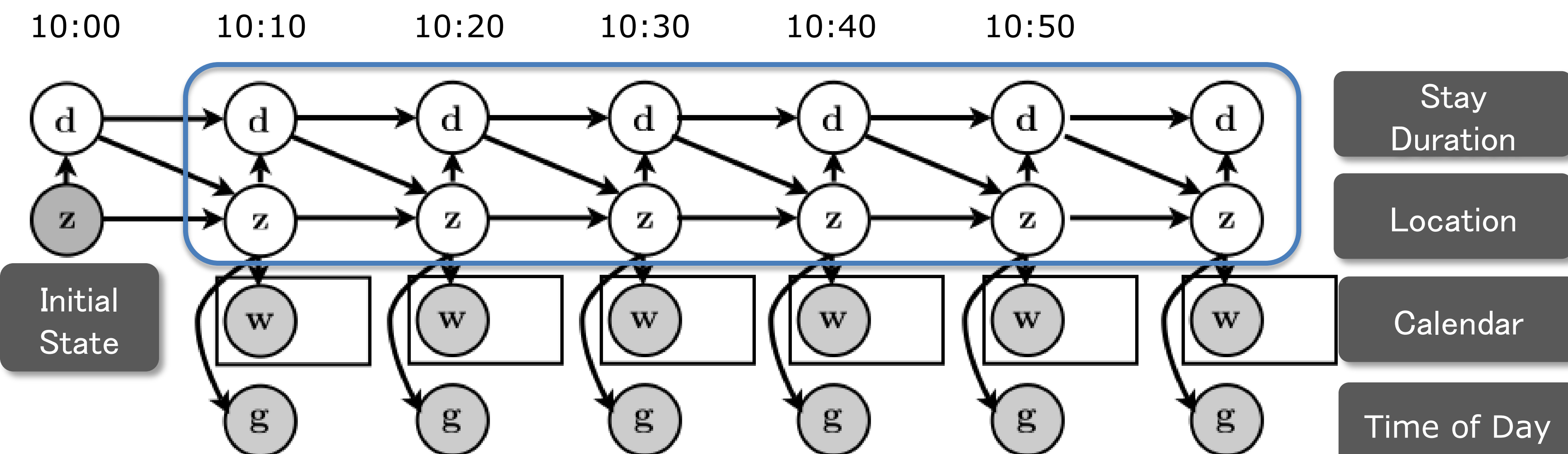


Learning

- Estimating the parameters of the probability distributions of DBN from data.
- Using maximum a posteriori (MAP) estimation.

Inference

Use the Viterbi algorithm to infer a state sequence that maximizes probability.



Experimental Settings

Whether prediction accuracy is improved or not by using calendar data.

Baseline:

DBN model without Calendar data

Dataset

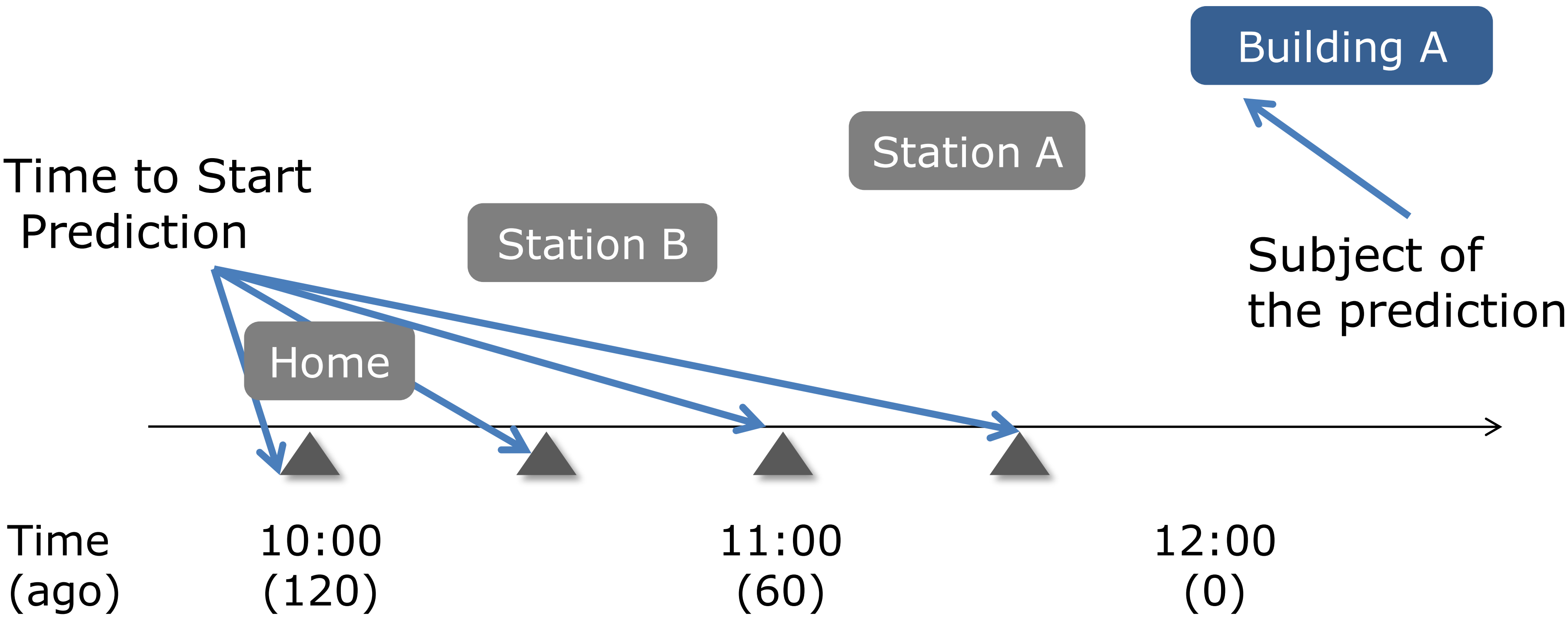
GPS and calendar data of two subject
(about 50 days)

Table 1: Information about data set.

	Subject A	Subject B
# of days	48	54
# of clusters	118	79
# of calendar entries	66	149
# of stays	827	432

Evaluation metrics

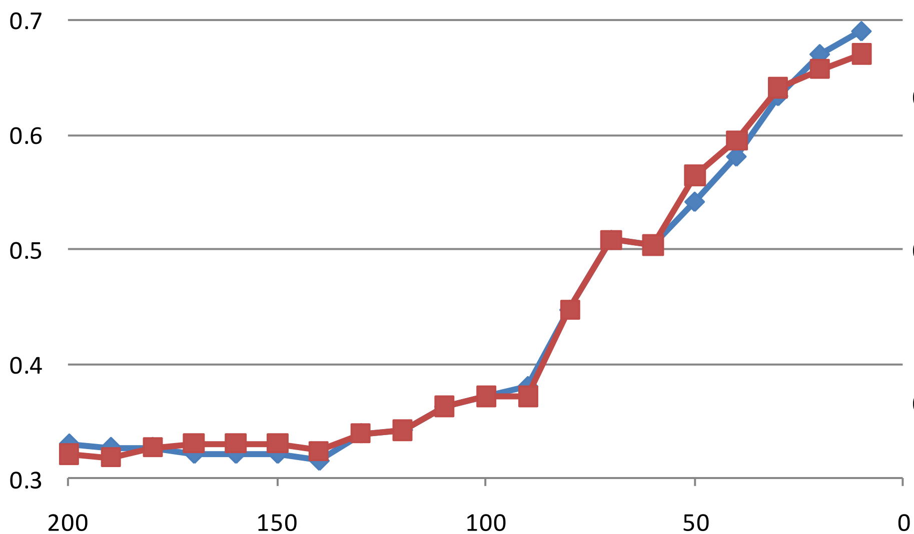
- Evaluate the accuracy of prediction by changing the time difference between the subject of prediction and the time to start prediction



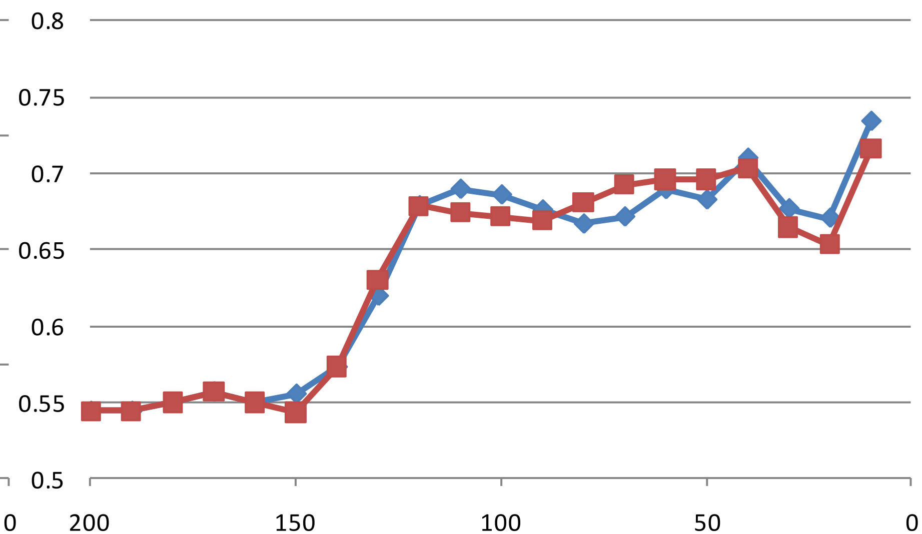
Prediction Results

Regular Movements

Subject A



Subject B



GPS Blue line

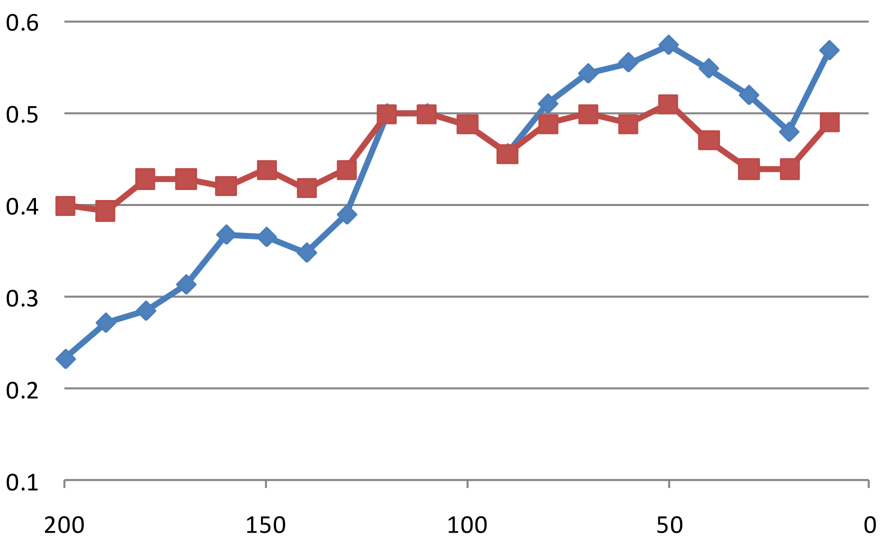
GPS+Calendar Red line

There are no much differences.

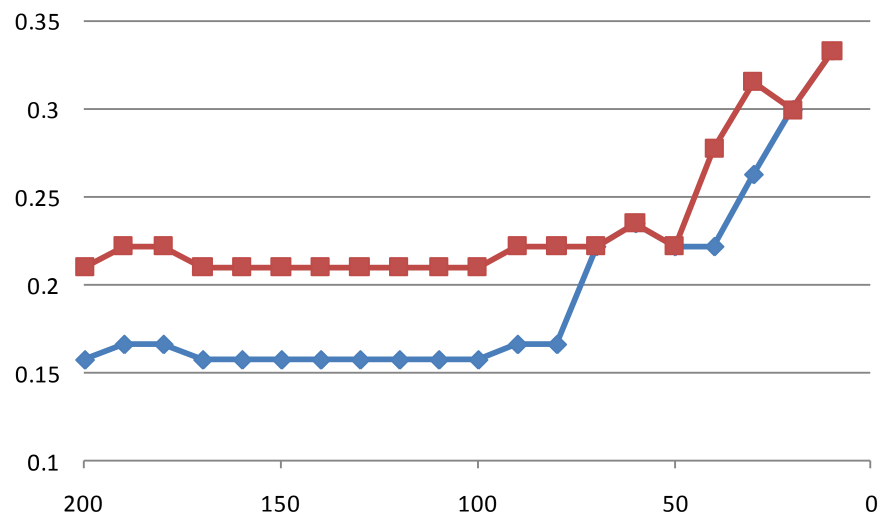
Prediction Results

Irregular Movements

Subject A



Subject B

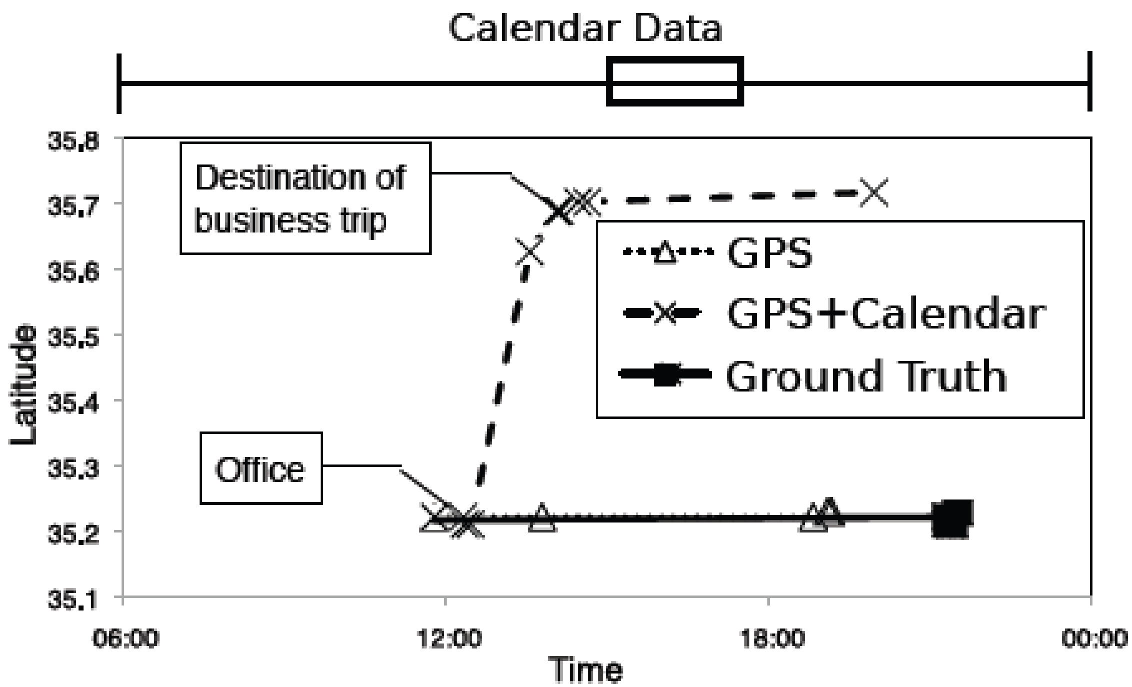


GPS Blue line

GPS+Calendar Red line

The accuracy was improved for irregular movements

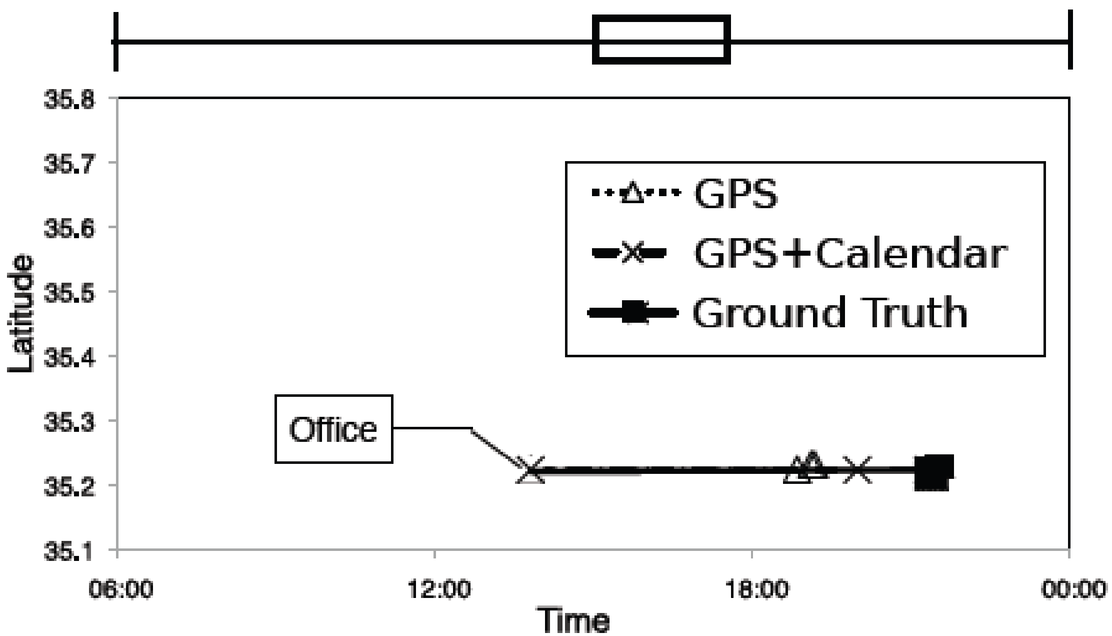
Example of Predictions



(a) The use of calendar data yields wrong predictions

The prediction failed since the wrong place is estimated from the calendar entry

Example of Predictions



(b) The modified predictions

The result was modified because the time needed for movement was considered

Conclusion

- We show a DBN model for making prediction for both regular and irregular movements by using GPS and calendar data.
  - The accuracy of predictions for irregular movement was improved.
  - Wrong prediction due to wrong schedule can be modified by using GPS data.

- Future works
  - Use other kinds of logs.

Thank you.