Classroom Population Recognition without Lens

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1. Motivation

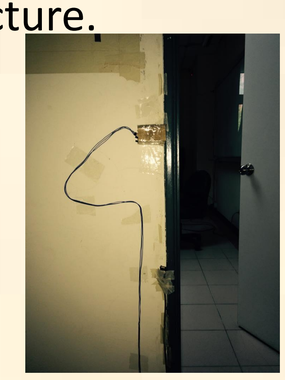
How many people are there in a classroom? Answering this question opens applications like auto-switching of electronic devices to save energy and to smartly light up the room. And we try to answer this question without the help of cameras, i.e. to find a cheap and privacy-aware solution.

2. Detecting People Going In/Out at Entrance

Sensors: one PIR sensor on the door frame of R324 front door; another inside the door.
Data: 900 seconds of 103 times people entering or leaving the room
Goal: To recognize the status – in/out/null of each second
Windowing: 1 seconds before and 3 seconds after each second.
Accuracy: about 90%/90%/55% for the three classes.

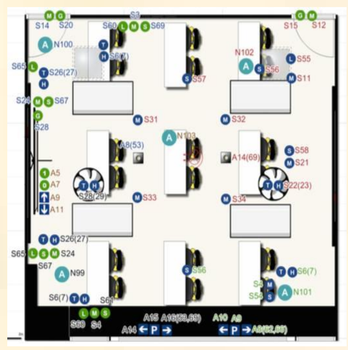
3. Model Population of People

Sensors: PIR*13, sound*9, light*5, humidity*7, temperature*7 and magnetic*3 spread on the ceiling, corners, and walls of R324.
Sensor data: Each second from November 1st, 2014 to December 13th, 2014.
Ground truth: We took pictures every 5 minutes from November 1st, 2014 through November 27th, 2014 and from December 4th, 2014 to December 13th, 2014. And then we labeled them by human.
Goal: To recognize population – zero, 1 to 3 or more than 4 people, for each sample.
Windowing: 10 seconds before and 10 seconds after a picture.

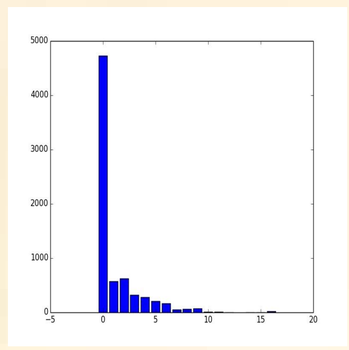


PIR setting-1

PIR setting-2



R324 setting



population distribution

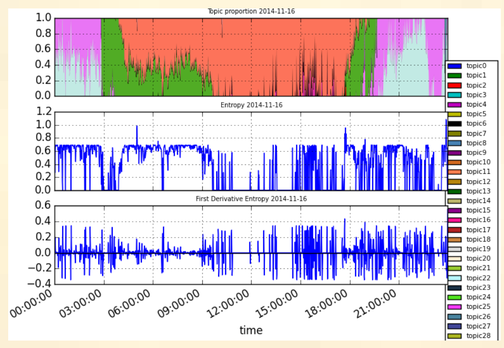
3.1 Raw data

Scale: We scale raw data to between zero and one.
Train and test data: We randomly split November samples into 5-fold data for training, and spared December samples for testing.

Accuracy (%)	Validation		Test	
	Linear	RBF	Linear	RBF
All	86.07	92.21	76.18	24.83
PIR + sound	80.62	84.34	77.06	79.24

3.2 Topic Modeling to Transform Features

Scale: We scale raw data by transform data into standard normal distribution and round it.
Dictionary Generating: We generate vocabulary as sets of sensor-value pairs. 2 kinds of dictionary are generated based on whether we combine sensors of the same type as one sensor.
Topic modeling:
We use python package Genism to transform the scaled data into topic model- LDA and HDP model.

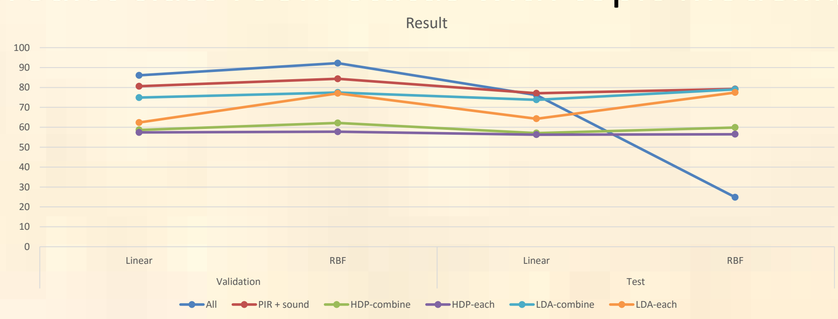


Train and test data:
We randomly split November samples into 5-fold data. Choose 4-fold of it doing 5-fold cross validation, and spared one-fold data as testing data.

Accuracy (%)	Validation		Test	
	Linear	RBF	Linear	RBF
HDP-combine	58.65	62.16	57.09	59.9
HDP-each	57.42	57.75	56.3	56.52
LDA-combine	74.9	77.47	73.79	79.05
LDA-each	62.39	77.04	64.29	77.47

4. Contribution and Conclusion

We collected and labeled 40 days of classroom data with a variety of 44 sensors and taking pictures as ground truth. Our pilot study shows that direct population modeling may have some advantages over unreliable entrance in/out detection. We analyzed the dataset and provide raw data performance as baseline.
We are among the first people, another is 王詩翰(Hans), to predict class room status with topic modeling.



5. Reference

1. Libsvm http://www.csie.ntu.edu.tw/~cjlin/libsvm/
2. Gensim https://radimrehurek.com/gensim/
3. R324 http://www.agent.csie.ntu.edu.tw/