Activity Recognition Using Wearable Sensor Dataset & Spark Platform

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TOC

Motivation and Problem Definition
(motivation)

Activity Classification for:

Decide to perform certain actions based on motion data

- IoT and Smart Homes

  Examples: turn off the light when the person goes to bed

- Assistive Systems for Elderly People

  Examples: calling emergency service on fall detection

Motivation and Problem Definition
(problem definition)

Goal:

Classify the activity of the person in a room using a scalable solution

Given:

Motion data of the person wearing batteryless sensor

Motivation and Problem Definition
(dataset description)

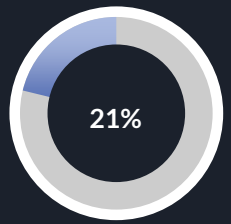
01 Motion Data of 14 healthy elderly people aged between 66 and 86

02 Using batteryless wearable sensor on top of clothing

03 Experimentally captured data for two room settings differing in location and number of RFID readers

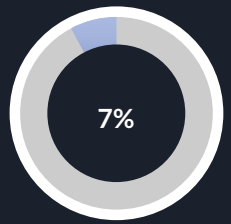
Motivation and Problem Definition
(data statistics)

- Setting 1: 4 RFID reader antennas, 1 on ceiling, 3 on wall
- Setting 2: 3 RFID reader antennas, 2 on ceiling, 1 on wall
- 75128 data samples, 52482 in setting 1, 22646 in setting 2
- 4 classes, imbalanced



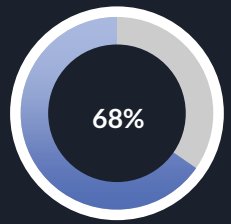
sit on bed

16406



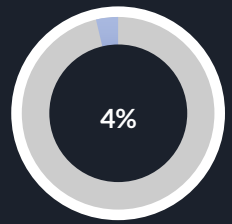
sit on chair

4911



lying on bed

51520



ambulating

2291

Motivation and Problem Definition
(dataset features)

Features

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Time	Acc frontal	Acc vertical	Acc lateral	Antenna ID	RSSI	Phase	Frequency

Big Data Solution using Spark
(a question)

What happens when we use libraries and data structures other than Spark's in our code?

Big Data Solution using Spark
(Spark support for DL)

- Spark does not support deep learning algorithms yet, usually used for data processing in DL
- Code using other libraries and data structures runs on single machine rather than Spark powered cluster
- Challenge: Just use Spark library

Don’t forget the objective!

Models and Implementation

- Logistic Regression
- MLP Neural Net
- Decision Tree

- Most of the code uses Spark data structures and functions to keep the method scalable
- Trying different combination of layers
- MinMax normalization, the correct way
- MLP hidden layers:
  [50, 30, 8, 6] or [10, 9, 8, 6]

Experiments and Results
(imbalanced data, holdout)

Setting 1:

	Accuracy	F1
Logistic Regression	89%	86%
MLP	94%	94%
Decision Tree	90%	89%

Setting 2:

	Accuracy	F1
Logistic Regression	98%	95%
MLP	98%	97%
Decision Tree	98%	98%

Experiments and Results
(balancing data)

- Under sample class 1 and 3
- Over sample class 2 and 4
- Setting 1:
  - 15000 samples for each class, 60000 total
- Setting 2:
  - 3500 samples for each class, 14000 total

Experiments and Results
(balanced data, holdout)

Setting 1:

	Accuracy	F1
Logistic Regression	71%	71%
MLP	88%	88%
Decision Tree	78%	78%

Setting 2:

	Accuracy	F1
Logistic Regression	79%	78%
MLP	86%	86%
Decision Tree	88%	88%

Experiments and Results
(10-fold CV)

Imbalanced Data:

	Accuracy	F1
Logistic Regression	83%	83%
MLP	86%	87%
Decision Tree	85%	86%

Balanced Data:

	Accuracy	F1
Logistic Regression	70%	70%
MLP	80%	79%
Decision Tree	77%	76%

Experiments and Results
(ideas)

- Setting 2 seems to have insufficient samples
- The performance of Decision Tree in comparison shows that the problem may be decidable with rule-based AI
- MLP seems to overperform other models, but training different models and exploring different structures for tune-up is computationally expensive

Future Work
(research)

- More of research than just implementations
- MLP and Decision Tree perform promising, we can improve them
- Time column of data can be looked at as sequence data
- Come up with some sequence modeling
- Maybe better datasets, authors confirm that the data is sparse and noisy

References

[1] Shinmoto Torres, Ranasinghe, Shi, “Sensor enabled wearable RFID technology for mitigating the risk of falls near beds,” *IEEE International Conference on RFID*, pp. 191-198, 2013.

[2] UCI Machine Learning Repository, “Activity recognition with healthy older people using a batteryless wearable sensor Data Set, ” [Online]. Available: https://archive.ics.uci.edu/ml/datasets/Activity+recognition+with+healthy+older+people+using+a+batteryless+wearable+sensor. [Accessed Dec, 2019].

Any questions?

Thanks for listening!