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Activity Recognition: Assignment 2.5

1. **Describe the data collection process. Make sure it is thorough and unambiguous; imagine you are submitting a paper to a conference or demoing a commercial system.**

   The phone was oriented in the pocket the same way for each activity: screen facing outward and charging port facing upwards. We did not specifically account for other phone orientations, but we are using the magnitude of the acceleration across all axes, so orientation should not matter anyway. Each activity was recorded for about five minutes. We collecte data for the following activities:

   Sitting - label 0
   Eric put the phone in his pocket while sitting on a wheeled chair at a table on a carpeted floor. We recorded the data for seven minutes. The first 440 points were deleted because there was noise from the phone being placed in the pocket. We had issues where the phone did not collect data (possibly due to a faulty connection with the server), so we reran the sitting data twice more to have enough samples. The second time, we deleted first 100 points due to noise, and the third we deleted first the 70 points and last 60 due to noise.

   Walking - label 1
   Ruifeng walked in a loop along the lower level of the library three times. He went from the team-based classroom to the bathroom to circulation desk, around the stairs, and back.

   Standing - label 2
   Shivangi put the phone in her “pocket” (under her waistband) and stood while eating her lunch and writing. W deleted first 180 points due to noise in getting the phone in the correct position.

   Stair Climbing/Descending - label 3
   Brittany walked up the stairs of DuBois, but data stopped collecting because there was no wifi connection. For about every 8 steps, there were about 4 steps of walking (turning the corner). First two minutes: screen was facing wrong direction. Next 4 minutes: phone was correct orientation
   Shivangi walked up and down the flight of stairs in DuBois from floor 1 to the lower level for 5 minutes. We may expect some discrepancy in the climbing data as Shivangi created her own pocket (phone was tucked at the waist). We deleted first 180 points because data hadn’t been collected yet.
   We used Shivangi’s data because we have the full five-minute dataset.

Jumping - label 3
Shivangi jumped for 5 minutes at the second floor of the LGRC library. The first 350 jumping data points have been deleted because the phone was not in her pocket and she hadn't started jumping yet. We made a new activity class because we weren't sure if there was a problem with the stair data being not being accurately collected, due to the lack of continuous stairs. Stairs kept getting confused with walking as well. This training data is a simulation of a jump rope. However, we ended up using the stairs data for the project instead of jumping.

We think that our training data for classifying walking vs stairs may be similar because we trained with both ascending and descending stairs. (The activities may produce similar data so our classifier was getting confused.)

A drawback of our data collection method was that we only had one subject perform each activity and just for a five-minute period. The data is most likely not representative of the general public because of the short duration and lack of diversity in the training set. For example: when testing our app, it classified Brittany's stair climbing as walking because her steps were not as hard as Shivangi's. If we wanted to make the app better, we would have more people performing for test data.

2. **Which classification algorithm and parameters did you select in your final system? Why?**

   We used decision tree with entropy criterion, max depth=5 and max feature=3 for our final system because it worked better than the others we tried (in terms of overall accuracy, precision, and recall). It was almost perfect in detecting sitting vs standing and better classified walking and stairs than others. See tables below.

3. **How did the classifier perform initially? Try at making at least two changes to the model (use different features or different parameters to the classifier) and report how the results change.**

The classifier with criteria 'entropy', max_depth=5 and max_features='None' often confused walking with climbing and descending stairs. It always correctly detected the sitting and standing activities. In practice walking was almost always detected as climbing/descending stairs.

```
clf = DecisionTreeClassifier(criterion="entropy", max_depth=5, max_features = None)
cv = cross_validation.KFold(n, n_folds=10, shuffle=True, random_state=None)
```

accuracy	precision sitting	precision walking	precision standing	precision stairs	recall sitting	recall walking	recall standing	recall stairs
0.88431601	1	0.78733287	0.9989899	0.8026161	1	0.8055859	1	0.80378715

When we had criteria =’entropy’, max_depth=5 and max_features=3, the classifier was able to detect the sitting and standing activities almost perfectly and worked better on classifying steps than the first classifier. However walking and climbing/descending stairs were still sometimes confused. This was the best out of the three.

```
clf = DecisionTreeClassifier(criterion="entropy", max_depth=5, max_features = 3)
cv = cross_validation.KFold(n, n_folds=10, shuffle=True, random_state=None)
```

accuracy	precision sitting	precision walking	precision standing	precision stairs	recall sitting	recall walking	recall standing	recall stairs
0.98979367	0.99107124	0.9812242	0.99895833	0.98887166	0.9972973	0.98426973	0.9989011	0.98109007

When we had criteria =’entropy’, max_depth=10 and max_features=3, our classifier confused walking with climbing and descending stairs more than max_depth=5. In practice, this classifier barely detected stairs, almost always identified it as walking.

```
clf = DecisionTreeClassifier(criterion="entropy", max_depth=10, max_features = 3)
cv = cross_validation.KFold(n, n_folds=10, shuffle=True, random_state=None)
```

accuracy	precision sitting	precision walking	precision standing	precision stairs	recall sitting	recall walking	recall standing	recall stairs
0.89737678	0.99583333	0.79468643	0.99885057	0.84521736	0.9925	0.83517837	0.999	0.80990169

We also tried some logistic regression classifiers, but the decision tree classifiers has better accuracy, precision, and recall.

4. **Describe your results. Report the accuracy, precision and recall metrics for the classifier and features you decided to use. How do the results compare to the results on the sample data? Briefly speak to how well your algorithm works in practice, drawing on the empirical results. Do they match up?**

   Our algorithm does a good job in identifying sitting and standing vs the others and is decent in differentiating walking from stairs. For the classifier and features we used, max_depth = 5 and max_feature = 3 work best. The accuracy for that is 0.98979367. The precision for each activity (sitting, walking, standing, stair climbing/descending) is 0.99107124, 0.9812242, 0.99895833 and 0.98887166 respectively. The recall for each activity (sitting, walking, standing, stair climbing/descending) is 0.9972973, 0.98426973, 0.9989011 and 0.98109007 respectively. This means that our classifier has about 98% accuracy on the second portion of our collected test data and at least 98% precision and recall for each activity. When we used the app in practice, sitting and standing are most often categorized correctly. Walking and running are sometimes confused for each other, but heavier steps on the stairs helped to get correct classification.