CLASSIFICATION OF SMARTWATCH MOTION USING MACHINE LEARNING

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WeLi Application
Research Question

How accurately can a student’s behavior be automatically classified based on the available sensors in the devices used in the Wearable LIFE project?
Challenges

- Making dataset reflective
- Missing datapoints/labels
- Tutorial Code
ExtraSensory Dataset Repository

Both graphs taken from the ExtraSensory Dataset:
http://extrasensory.ucsd.edu/
### Relevant Sensors

#### ExtraSensory Dataset Sensors:
- Phone Accelerometer
- Phone Gyroscope
- Phone Magnetometer
- Watch Accelerometer
- Watch Compass
- Location/ Location(quick)
- Audio/ Audio Magnitude
- Phone State
- Other

#### Sony SmartWatch 3 Sensors:
- Ambient Light Sensors
- Accelerometer
- Compass
- Gyroscope
- GPS

#### Huawei Watch 2 Sensors:
- GPS and Glonass
- Speaker/Microphone
- Accelerometer and Gyroscope
- Sensor
- Compass
- Heart Rate Sensor
- Barometer
- Capacitive Sensor
- Ambient Light Sensor
 Relevant Labels

- Lying down
- Sitting
- Walking/Running
- Sleeping
- Watching TV
- Using the Internet
- Doing computer work
- Singing
- Talking
- Eating
- Grooming
- Elevator
- Stairs
- With Friends

```python
import numpy as np;
import gzip;
import StringIO;

def parse_header_of_csv(csv_str):
    # Isolate the headline columns:
    headline = csv_str[:csv_str.index('
')];
    columns = headline.split(',');

    # The first column should be timestamp:
    assert columns[0] == 'timestamp';
    # The last column should be label_source:
    assert columns[-1] == 'label_source';

    # Search for the column of the first label:
    for (i, col) in enumerate(columns):
        if col.startswith('label: '):
            first_label_ind = i;
            break;
    pass;

    # Feature columns come after timestamp and before the labels:
    feature_names = columns[1:first_label_ind];
```
How to Handle Missing Data

• Decided keeping missing data points could skew data
• Accuracy and relevancy → Delete missing data points from set
ExtraSensory Dataset Tutorial
Models

- Random Forest
- Logistic Regression
- Voted perceptron
- Naive Bayes
Results (Weka)
Results (Code)

<table>
<thead>
<tr>
<th></th>
<th>Logistic Regression (Code)</th>
<th>Random Forest (Code)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Precision</td>
<td>Accuracy</td>
</tr>
<tr>
<td>Lying Down</td>
<td>0.66</td>
<td>0.85</td>
</tr>
<tr>
<td>Sitting</td>
<td>0.71</td>
<td>0.73</td>
</tr>
<tr>
<td>Walking</td>
<td>0.27</td>
<td>0.79</td>
</tr>
<tr>
<td>Running</td>
<td>0.09</td>
<td>0.9</td>
</tr>
<tr>
<td>Sleeping</td>
<td>0.64</td>
<td>0.89</td>
</tr>
<tr>
<td>Lab Work</td>
<td>0.48</td>
<td>0.87</td>
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<tr>
<td>Phone in Pocket</td>
<td>0.45</td>
<td>0.76</td>
</tr>
<tr>
<td>Watching TV</td>
<td>0.21</td>
<td>0.73</td>
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<tr>
<td>Surfing the Internet</td>
<td>0.23</td>
<td>0.7</td>
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<tr>
<td>Singing</td>
<td>0.18</td>
<td>0.92</td>
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<tr>
<td>Talking</td>
<td>0.29</td>
<td>0.69</td>
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<tr>
<td>Computer Work</td>
<td>0.3</td>
<td>0.69</td>
</tr>
<tr>
<td>Eating</td>
<td>0.12</td>
<td>0.67</td>
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<tr>
<td>Toilet</td>
<td>0.03</td>
<td>0.74</td>
</tr>
<tr>
<td>Grooming</td>
<td>0.05</td>
<td>0.75</td>
</tr>
<tr>
<td>Stairs Going Up</td>
<td>0.04</td>
<td>0.82</td>
</tr>
<tr>
<td>Stairs Going Down</td>
<td>0.04</td>
<td>0.82</td>
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<tr>
<td>Elevator</td>
<td>0.06</td>
<td>0.98</td>
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<tr>
<td>Standing</td>
<td>0.28</td>
<td>0.71</td>
</tr>
<tr>
<td>At School</td>
<td>0.33</td>
<td>0.71</td>
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<tr>
<td>Phone in Hand</td>
<td>0.17</td>
<td>0.69</td>
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<tr>
<td>Phone in Bag</td>
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</tr>
<tr>
<td>Phone on Table</td>
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<td>0.76</td>
</tr>
<tr>
<td>With Friends</td>
<td>0.36</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Balanced Accuracy

- Random Forest (Code) Balanced Accuracy
- Logistic Regression (Code) Balanced Accuracy
Future Work

• Collect more data to test models
• Map specific motions to interventions
• Incorporate model into WeLi application
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