Dumb Charades Project

Assignment 4

**DATA MINING**

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# Introduction

This is a project report for Assignment 4 of CSE 572 Data Mining course. The ultimate goal of this project is to develop a procedure to identify human gestures which includes:

a) Identifying known gestures

b) Segment sequence of gestures

c) Identifying unknown gestures

In the phase 3 of the project we calculated the accuracy, precision, recall and F1 score of all the groups combined together. In this phase we will be calculating the same performance metrics for each user. We consider the 14 groups whose data was found to be valid. The valid groups have been selected by observing the raw data and plotting the raw data. Groups with more than 46 timestamps for any gesture were eliminated along with the outliers or anomaly

We classify the data using Decision Tree, SVM and Neural Networks and compare their performance for each user. We have mainly measured the performance based on the following criteria:

 Accuracy

 Precision

 Recall

 F1 Score

NOTE : We had calculated the performance metrics for all users combined in the Assignment 3. We are calculating the performance metrics for each group in Assignment 4.

# DATA

We provide performance metrics tables i.e accuracy, precision, recall, F1 score for each of the 14 groups and for each gesture. We implement three methods of classification to calculate this performance metrics i.e decision tree, SVM and neural networks.

For doing this we have considered 80% of the user data as training set and remaining 20% as test set.

We have taken complete training data i.e N=1.



## Accuracy

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 97.67 | 97.56 | 92.5 | 95.65 | 90.90 | 97.61 | 97.56 | 100 | 93.33 | 97.61 | 100 | 95.23 | 100 |
| AND | 97.67 | 95.12 | 92.5 | 100 | 100 | 95.23 | 97.56 | 100 | 100 | 95.34 | 97.61 | 100 | 100 |
| CAN | 97.72 | 100 | 97.5 | 100 | 100 | 100 | 95.12 | 100 | 100 | 95.23 | 97.61 | 100 | 100 |
| COP | 97.67 | 97.56 | 100 | 95.65 | 97.72 | 97.61 | 100 | 97.5 | 96.66 | 100 | 100 | 95.23 | 100 |
| DEAF | 97.67 | 100 | 97.5 | 100 | 100 | 100 | 100 | 100 | 100 | 95.23 | 100 | 100 | 100 |
| DECIDE | 97.67 | 97.56 | 100 | 97.82 | 100 | 100 | 100 | 100 | 96.66 | 97.61 | 95.34 | 92.85 | 100 |
| FATHER | 97.67 | 100 | 100 | 95.65 | 95.45 | 95.23 | 100 | 100 | 100 | 100 | 100 | 100 | 92.5 |
| FIND | 100 | 92.68 | 97.5 | 95.65 | 100 | 90.47 | 92.68 | 100 | 86.66 | 90.47 | 95.23 | 100 | 97.5 |
| GO OUT | 100 | 100 | 97.5 | 100 | 97.67 | 100 | 95.12 | 95 | 100 | 100 | 100 | 100 | 100 |
| HEARING | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 96.66 | 95.23 | 100 | 100 | 100 |

**Table 1: Accuracy of each group using decision tree classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 90.69 | 90.24 | 90 | 89.13 | 86.36 | 95.23 | 92.68 | 90 | 90 | 90.47 | 90.47 | 88.09 | 90 |
| AND | 90.69 | 90.24 | 90 | 89.13 | 88.63 | 90.47 | 90.24 | 90 | 96.66 | 88.37 | 90.47 | 88.09 | 95 |
| CAN | 86.36 | 100 | 95 | 97.82 | 100 | 90.47 | 90.24 | 100 | 90 | 85.71 | 92.85 | 90.47 | 100 |
| COP | 90.69 | 90.24 | 90 | 91.30 | 90.90 | 90.47 | 90.24 | 90 | 90 | 90.47 | 90.69 | 90.47 | 90 |
| DEAF | 90.69 | 90.24 | 90 | 91.30 | 90.90 | 88.09 | 95.12 | 90 | 90 | 90.47 | 90.47 | 90.47 | 90 |
| DECIDE | 90.69 | 90.24 | 90 | 89.13 | 90.90 | 88.09 | 90.24 | 97.5 | 90 | 90.47 | 93.02 | 88.09 | 90 |
| FATHER | 90.69 | 100 | 97.5 | 97.82 | 90.90 | 90.47 | 100 | 97.5 | 100 | 90.47 | 90.47 | 90.47 | 90 |
| FIND | 100 | 90.24 | 90 | 89.13 | 90.90 | 90.47 | 90.24 | 92.5 | 90 | 90.47 | 90.47 | 95.23 | 90 |
| GO OUT | 97.72 | 90.24 | 97.5 | 91.30 | 95.34 | 90.47 | 90.24 | 90 | 93.33 | 90.47 | 90.47 | 100 | 90 |
| HEARING | 90.90 | 100 | 90 | 91.30 | 90.90 | 90.47 | 90.24 | 100 | 90 | 90.47 | 90.47 | 90.47 | 90 |

**Table 2: Accuracy of each group using SVM classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 73.91 | 81.82 | 80.77 | 80.77 | 91.67 | 95.65 | 86.36 | 88.24 | 100 | 95.65 | 83.33 | 100 |
| AND | 100 | 82.61 | 84.21 | 100 | 100 | 95.65 | 73.91 | 81.82 | 100 | 79.17 | 86.96 | 100 | 90.91 |
| CAN |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| COP |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| DEAF |  |  |  |  |  |  |  |  |  | 86.96 |  |  |  |
| DECIDE |  |  |  |  |  |  |  |  |  | 86.96 |  |  |  |
| FATHER |  |  |  |  |  |  |  |  |  | 95.65 |  |  |  |
| FIND |  |  |  |  |  |  |  |  |  | 95.65 |  |  |  |
| GO OUT |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| HEARING |  |  |  |  |  |  |  |  |  | 70 |  |  |  |

**Table 3: Accuracy of each group using Neural Network classifier.**



## Precision

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 92.85 | 92.5 | 94.59 | 90.90 | 92.5 | 90.24 | 90 | 90 | 96.42 | 92.68 | 90.47 | 92.5 | 90 |
| AND | 90.47 | 92.30 | 89.18 | 89.13 | 88.63 | 95 | 90 | 90 | 90 | 90.24 | 92.68 | 88.09 | 90 |
| CAN | 88.37 | 88.09 | 92.30 | 89.13 | 90.90 | 90.47 | 89.74 | 90 | 90 | 92.5 | 92.68 | 90.47 | 90 |
| COP | 92.85 | 92.5 | 90 | 93.18 | 90.69 | 90.24 | 90.24 | 92.30 | 93.10 | 90.47 | 90.69 | 95 | 90 |
| DEAF | 92.85 | 90.244 | 92.30 | 91.30 | 90.90 | 90.47 | 90.24 | 90 | 90 | 95 | 88.09 | 90.47 | 90 |
| DECIDE | 92.85 | 92.5 | 90 | 88.88 | 90.90 | 88.09 | 90.24 | 90 | 89.65 | 92.68 | 92.68 | 89.74 | 90 |
| FATHER | 92.85 | 90.24 | 90 | 93.33 | 95.23 | 95 | 90.24 | 90 | 90 | 90.47 | 90.47 | 90.47 | 97.29 |
| FIND | 90.90 | 97.36 | 92.30 | 88.63 | 88.63 | 94.73 | 90.47 | 90 | 96.15 | 89.47 | 90 | 90.47 | 89.74 |
| GO OUT | 90.90 | 90.24 | 92.30 | 91.30 | 92.85 | 90.47 | 90.87 | 94.73 | 93.33 | 90.47 | 90.47 | 90.47 | 90 |
| HEARING | 90.90 | 90.24 | 90 | 91.30 | 90.90 | 90.47 | 90.24 | 90 | 93.10 | 92.5 | 90.47 | 90.47 | 90 |

**Table 4: Precision of each group using decision tree classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 100 | 100 | 100 | 94.73 | 92.5 | 94.73 | 100 | 100 | 100 | 100 | 100 | 100 |
| AND | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 93.10 | 100 | 100 | 100 | 94.73 |
| CAN | 94.73 | 88.09 | 92.10 | 91.11 | 90.90 | 100 | 100 | 90 | 100 | 100 | 97.43 | 100 | 90 |
| COP | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| DEAF | 100 | 100 | 100 | 100 | 100 | 100 | 94.87 | 100 | 100 | 100 | 86.84 | 100 | 100 |
| DECIDE | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 92.30 | 100 | 100 | 95 | 100 | 100 |
| FATHER | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 92.30 | 90 | 100 | 100 | 100 | 100 |
| FIND | 90.90 | 100 | 100 | 100 | 90 | 97.36 | 100 | 97.29 | 100 | 100 | 100 | 92.5 | 100 |
| GO OUT | 93.02 | 100 | 92.30 | 100 | 95.12 | 100 | 100 | 100 | 100 | 100 | 100 | 90.47 | 100 |
| HEARING | 100 | 90.24 | 100 | 100 | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 100 | 100 |

**Table 5: Precision of each group using SVM classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 83.33 | 100 | 88.89 | 85.71 | 85.71 | 86.36 | 81.82 | 84.21 | 93.33 | 82.61 | 86.36 | 90 | 81.82 |
| AND | 83.33 | 100 | 84.21 | 80.77 | 80 | 81.82 | 100 | 100 | 87.50 | 100 | 85 | 79.17 | 90 |
| CAN |  |  |  |  |  |  |  |  |  | 82.61 |  |  |  |
| COP |  |  |  |  |  |  |  |  |  | 82.61 |  |  |  |
| DEAF |  |  |  |  |  |  |  |  |  | 90 |  |  |  |
| DECIDE |  |  |  |  |  |  |  |  |  | 90 |  |  |  |
| FATHER |  |  |  |  |  |  |  |  |  | 81.82 |  |  |  |
| FIND |  |  |  |  |  |  |  |  |  | 81.82 |  |  |  |
| GO OUT |  |  |  |  |  |  |  |  |  | 82.61 |  |  |  |
| HEARING |  |  |  |  |  |  |  |  |  | 90.4 |  |  |  |

**Table 6: Precision of each group using Neural Network classifier.**



## Recall

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 100 | 97.22 | 97.56 | 94.87 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AND | 97.43 | 97.29 | 91.66 | 100 | 100 | 100 | 97.29 | 100 | 100 | 97.36 | 100 | 100 | 100 |
| CAN | 100 | 100 | 100 | 100 | 100 | 100 | 94.59 | 100 | 100 | 97.36 | 100 | 100 | 100 |
| COP | 100 | 100 | 100 | 97.61 | 97.5 | 97.36 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| DEAF | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| DECIDE | 100 | 100 | 100 | 97.56 | 100 | 100 | 100 | 100 | 96.29 | 100 | 100 | 94.59 | 100 |
| FATHER | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| FIND | 100 | 100 | 100 | 95.12 | 100 | 94.73 | 91.89 | 100 | 92.59 | 89.47 | 94.73 | 100 | 97.22 |
| GO OUT | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| HEARING | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 97.36 | 100 | 100 | 100 |

**Table 7: Recall of each group using decision tree classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 100 | 100 | 100 | 93.30 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AND | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| CAN | 94.73 | 100 | 97.22 | 100 | 100 | 100 | 100 | 100 | 100 | 94.73 | 100 | 100 | 100 |
| COP | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| DEAF | 100 | 100 | 100 | 100 | 100 | 97.36 | 100 | 100 | 100 | 100 | 89.18 | 100 | 100 |
| DECIDE | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| FATHER | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| FIND | 100 | 100 | 100 | 100 | 92.30 | 97.36 | 100 | 100 | 100 | 100 | 100 | 97.36 | 100 |
| GO OUT | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| HEARING | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 8: Recall of each group using SVM classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 80.95 | 88.89 | 90 | 90 | 90.48 | 94.47 | 84.12 | 87.50 | 100 | 95 | 85.71 | 100 |
| AND | 100 | 82.61 | 94.12 | 100 | 100 | 100 | 80 | 81.82 | 100 | 79.17 | 94.44 | 100 | 90 |
| CAN |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| COP |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| DEAF |  |  |  |  |  |  |  |  |  | 90 |  |  |  |
| DECIDE |  |  |  |  |  |  |  |  |  | 90 |  |  |  |
| FATHER |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| FIND |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| GO OUT |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| HEARING |  |  |  |  |  |  |  |  |  | 67.87 |  |  |  |

**Table 9: Recall of each group using Neural Network classifier.**



## F1 Score

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 98.73 | 98.66 | 95.89 | 97.56 | 94.97 | 98.66 | 98.63 | 100 | 96.42 | 98.70 | 100 | 97.36 | 100 |
| AND | 98.70 | 97.29 | 95.65 | 100 | 100 | 97.43 | 98.63 | 100 | 100 | 97.36 | 98.70 | 100 | 100 |
| CAN | 98.70 | 100 | 98.63 | 100 | 100 | 100 | 97.22 | 100 | 100 | 97.36 | 98.70 | 100 | 100 |
| COP | 98.73 | 98.66 | 100 | 97.61 | 98.73 | 98.66 | 100 | 98.63 | 98.18 | 100 | 100 | 97.43 | 100 |
| DEAF | 98.73 | 100 | 98.63 | 100 | 100 | 100 | 100 | 100 | 100 | 97.43 | 100 | 100 | 100 |
| DECIDE | 98.73 | 98.66 | 100 | 98.76 | 100 | 100 | 100 | 100 | 98.11 | 98.70 | 97.43 | 95.89 | 100 |
| FATHER | 98.73 | 100 | 100 | 98.82 | 97.56 | 97.43 | 100 | 100 | 100 | 100 | 100 | 100 | 96 |
| FIND | 100 | 96.10 | 98.63 | 97.5 | 100 | 94.73 | 95.77 | 100 | 92.59 | 94.44 | 97.29 | 100 | 98.59 |
| GO OUT | 100 | 100 | 98.63 | 100 | 98.73 | 100 | 97.36 | 97.29 | 100 | 100 | 100 | 100 | 100 |
| HEARING | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 98.18 | 97.36 | 100 | 100 | 100 |

**Table 10: F1 Score of each group using decision tree classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G1 | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 95.12 | 94.87 | 94.73 | 94.25 | 92.30 | 97.36 | 96 | 94.73 | 94.73 | 95 | 95 | 93.67 | 94.73 |
| AND | 95.12 | 94.87 | 94.73 | 94.25 | 93.97 | 95 | 94.87 | 94.73 | 98.18 | 93.82 | 95 | 93.67 | 97.29 |
| CAN | 92.30 | 100 | 97.22 | 98.79 | 100 | 95 | 94.87 | 100 | 94.73 | 92.30 | 96.20 | 95 | 100 |
| COP | 95.12 | 94.87 | 94.73 | 95.45 | 95.23 | 95 | 94.87 | 94.73 | 94.73 | 95 | 95.12 | 95 | 94.73 |
| DEAF | 95.12 | 94.87 | 94.73 | 95.45 | 95.23 | 93.67 | 97.36 | 94.73 | 94.73 | 95 | 94.28 | 95 | 94.73 |
| DECIDE | 95.12 | 94.87 | 94.73 | 94.25 | 95.23 | 93.67 | 94.87 | 98.63 | 94.73 | 95 | 96.20 | 93.67 | 94.73 |
| FATHER | 95.12 | 94.87 | 94.73 | 95.45 | 95.23 | 95 | 94.87 | 98.63 | 100 | 100 | 95 | 95 | 94.73 |
| FIND | 100 | 94.87 | 94.73 | 94.25 | 94.73 | 94.87 | 94.87 | 96 | 94.73 | 95 | 95 | 97.36 | 94.73 |
| GO OUT | 98.76 | 94.87 | 98.63 | 95.45 | 97.5 | 95 | 94.87 | 94.73 | 96.55 | 95 | 95 | 100 | 94.73 |
| HEARING | 95.23 | 100 | 94.73 | 95.45 | 95.23 | 95 | 94.87 | 100 | 94.73 | 95 | 95 | 95 | 94.73 |

**Table 11: F1 Score of each group using SVM classifier.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GESTURE | G | G9 | G13 | G16 | G19 | G20 | G22 | G23 | G26 | G27 | G31 | G32 | G34 |
| ABOUT | 100 | 85 | 88.89 | 87.80 | 87.80 | 95 | 97.30 | 91.43 | 93.33 | 100 | 97.44 | 90 | 100 |
| AND | 100 | 90.48 | 91.43 | 100 | 100 | 97.30 | 85 | 90 | 100 | 88.37 | 91.89 | 100 | 94.74 |
| CAN |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| COP |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| DEAF |  |  |  |  |  |  |  |  |  | 92.31 |  |  |  |
| DECIDE |  |  |  |  |  |  |  |  |  | 92.31 |  |  |  |
| FATHER |  |  |  |  |  |  |  |  |  | 97.3 |  |  |  |
| FIND |  |  |  |  |  |  |  |  |  | 97.3 |  |  |  |
| GO OUT |  |  |  |  |  |  |  |  |  | 100 |  |  |  |
| HEARING |  |  |  |  |  |  |  |  |  | 80.89 |  |  |  |

**Table 12: F1 Score of each group using Neural Network classifier.**

# Plots

We provide the following figures for each gesture of group no. 27

1. Decision tree
2. ROC curve

# Conclusion

We did not calculate all values for the neural networks. But, from the result, we can see that all the measures are pretty high. It is probably because we have used each user’s data individually and took training and test data from each user. The amount of data for each user is very low, that’s why it showed a very high accuracy. The result would be more accurate if we had more data for each pair of training and test data set.