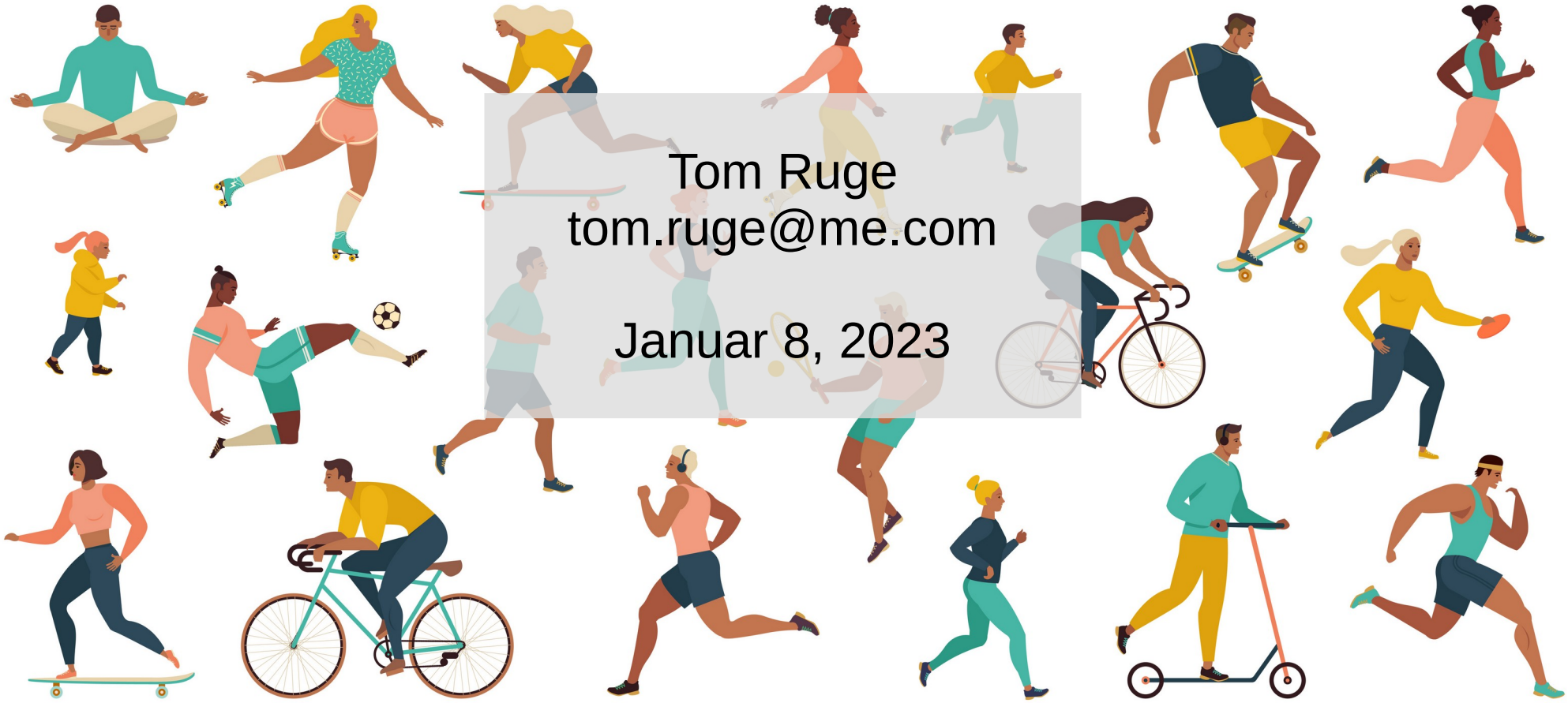
Physical Activity Classification



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Why and where?

kaggle

Literature

Webpage:

- Dataset with 6 different activities
- Accelerometer and gyroscopic data from smart phone available
- With simple 2 Layer neural network 89% Accuracy could be archieved
- With LSTM a acccuracy of 91 could be reached.

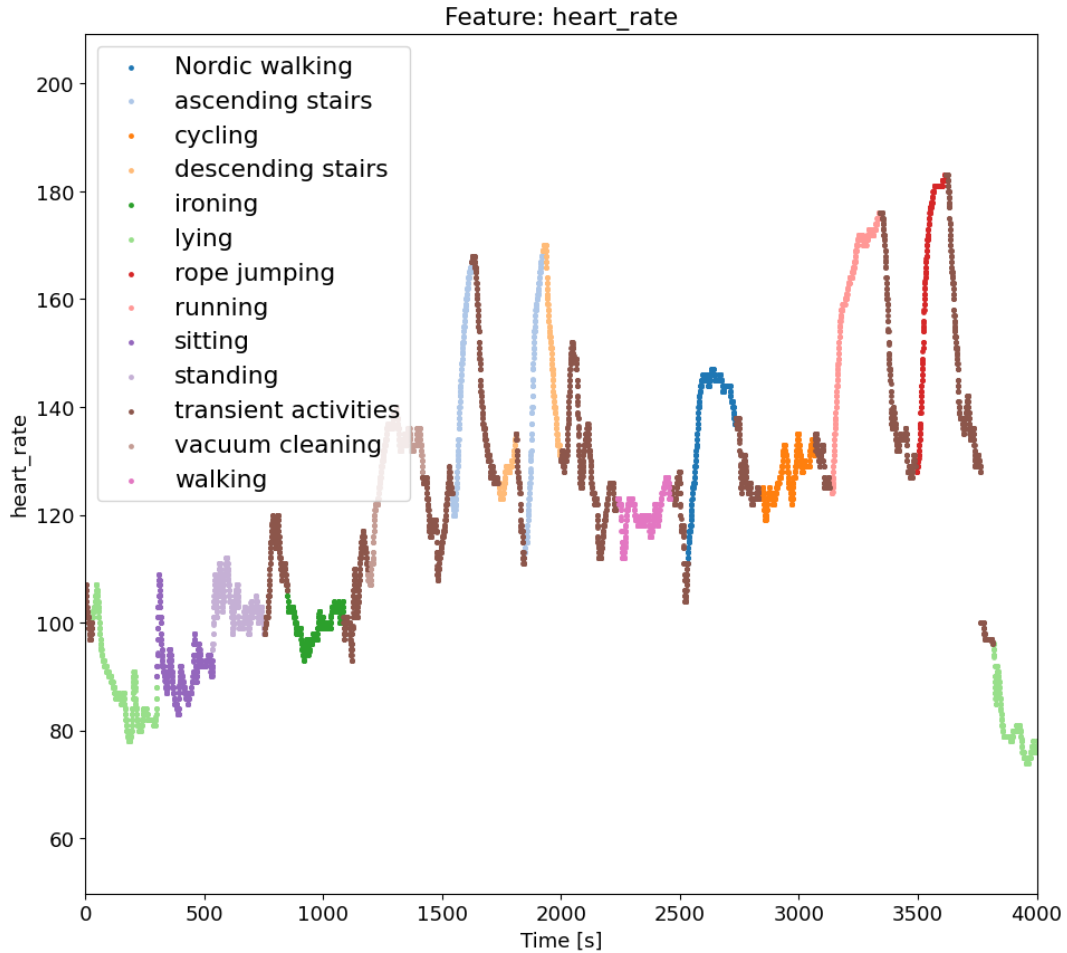
Kaggle Notebook:

- Same Dataset
- Achieved a 99% Accuracy but testing is not realistic
- All other Kaggle notebooks had the same flaw.

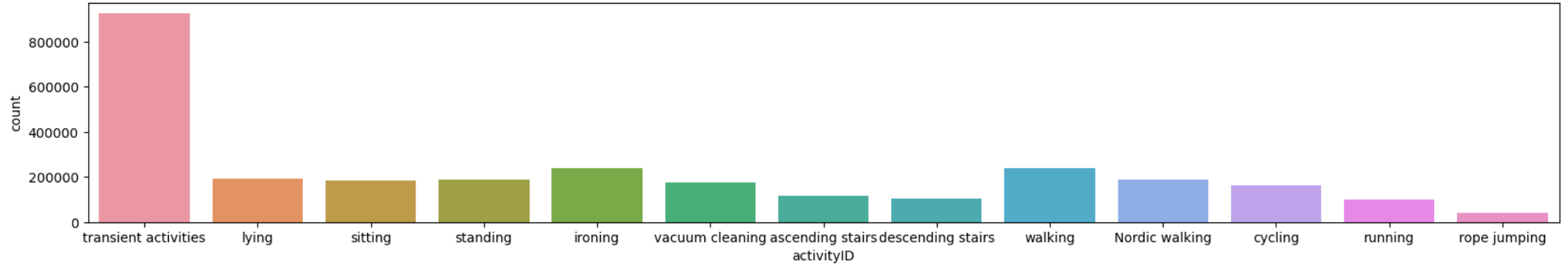
Dataset Characteristics

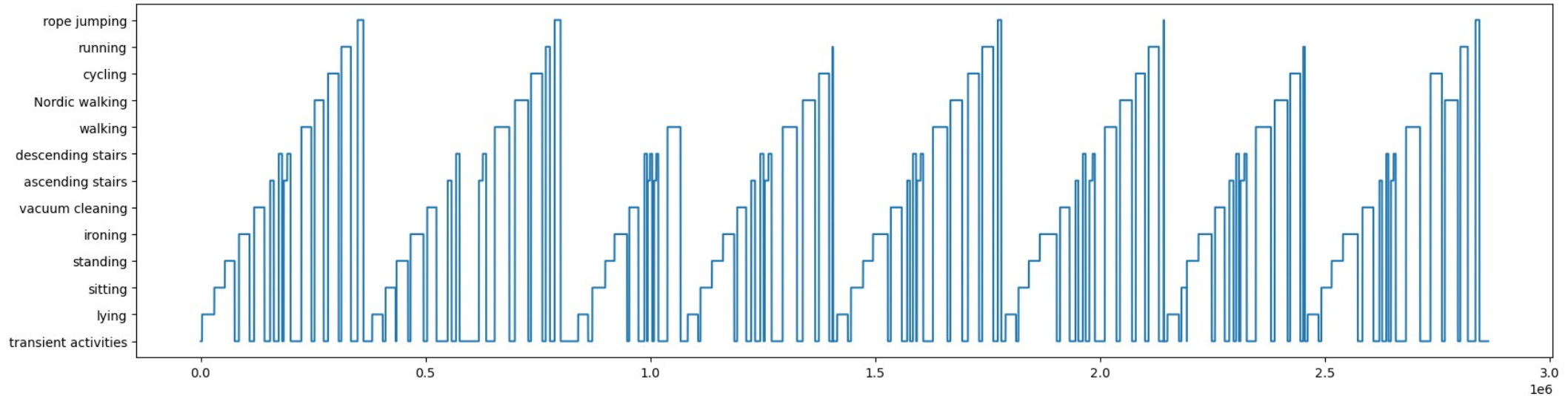
Dataset:

- From Kaggle
- 31 Features(heartbeat, accelerometer, gyroscope, …)
- 13 labels(walking, lying, transient activities, etc …)
- Data measured by 8 different people
- Around 2 million rows



Biases:


count
800000
600000
400000
200000
0
transient activities
lying
sitting
standing
ironing
vacuum cleaning
ascending stairs
descending stairs
walking
Nordic walking
cycling
running
rope jumping
activityID


rope jumping
running
cycling
Nordic walking
walking
descending stairs
ascending stairs
vacuum cleaning
ironing
standing
sitting
lying
transient activities
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1e6

Baseline Model: Data Prep. and Evaluation

- Data undersampled, so that the activities are balanced.

- 1 person test and 7 person train. Iterate over all people

- Because of undersample, accuracys vary → do fitting 5 times and take average accuracy

Baseline Model: Results

```
# Create and train the logistic regression model
model = LogisticRegression(multi_class='multinomial', max_iter=100000)
model.fit(X_train_scaled, y_train)
```

Average accuracy of 47%

Test People ID: 6
Accuracy around 63%

Test People ID: 5
Accuracy around 33%

Model 1 with Simple NN: Data Prep. and Evaluation

- Data undersampled, so activitys are balanced
- random shuffle to prevent sampling bias
- 1 person test and 7 person train. Iterate over all people
- take the best validation accuracy from all epochs
- Because of undersample, accuracys vary → do fitting 5 times and take average accuracy

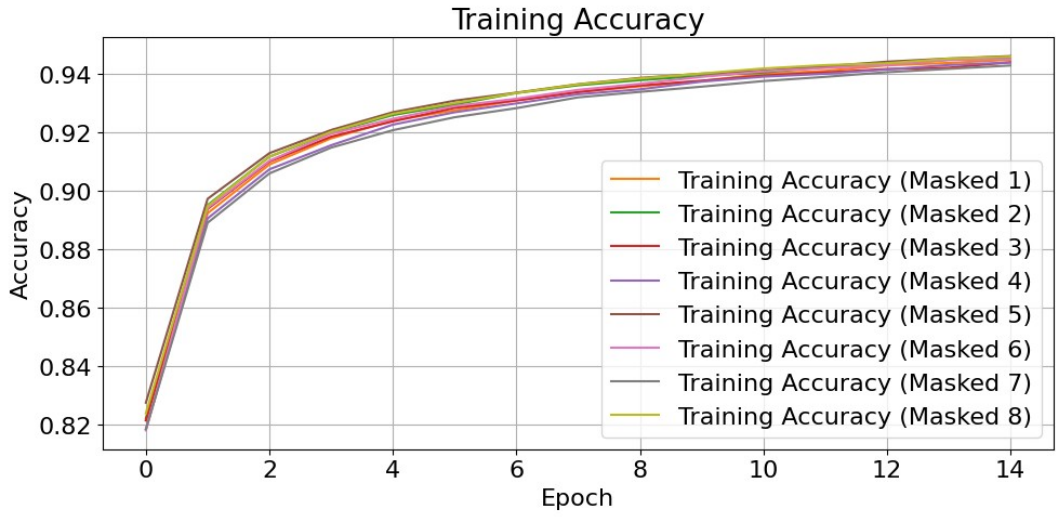
Model 1 with Simple NN: Results

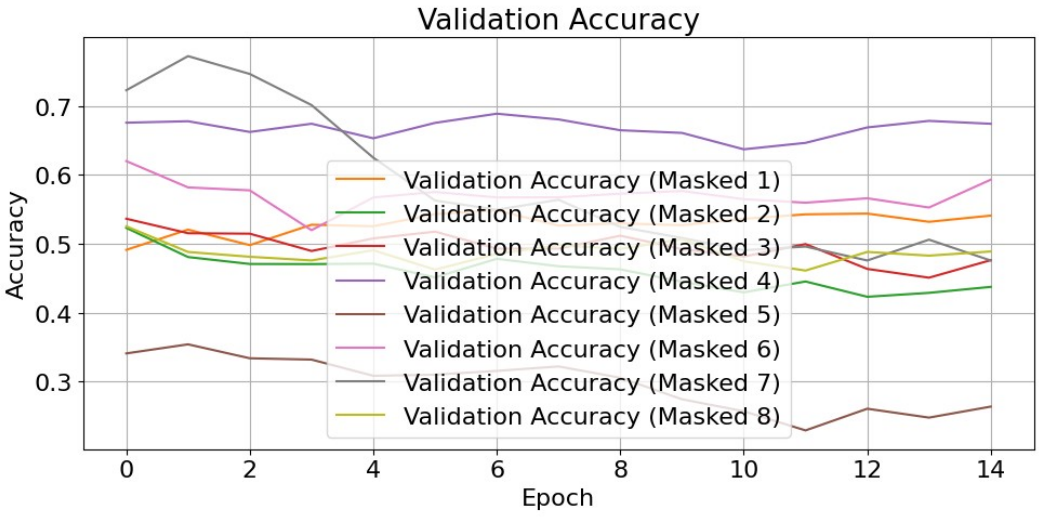
```
# Build a neural network with Leaky ReLU and Batch Normalization
model = Sequential([
    BatchNormalization(input_shape=(X_train.shape[1],)),  # Batch Normalization as the first layer
    Dense(300),
    LeakyReLU(alpha=0.01),  # You can adjust the alpha parameter as needed
    Dropout(0.5),
    Dense(100),
    LeakyReLU(alpha=0.01),
    Dense(y_train.shape[1], activation='softmax')
])
```

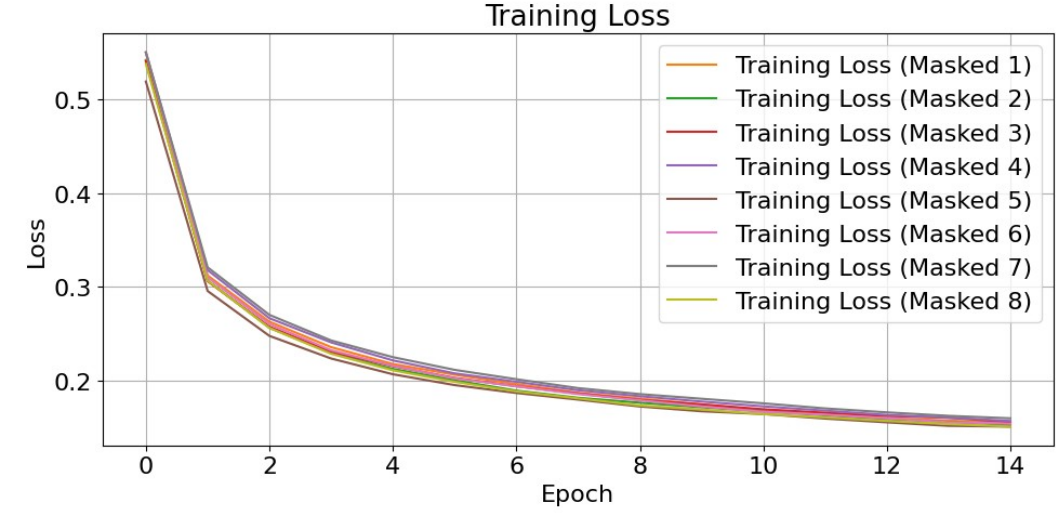
```
# Train the model with the ModelCheckpoint callback
history = model.fit(X_train, y_train,
                    epochs=20,
                    batch_size=300,
                    validation_data=[X_test, y_test])
```

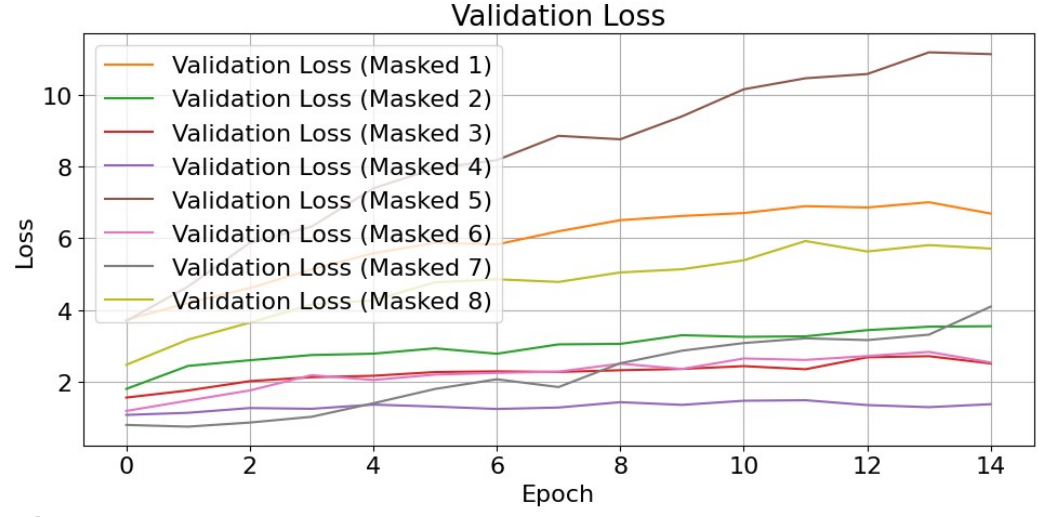
Average accuracy of 57.1%
Standart deviation of 0.2%

→ Already better!


Training Accuracy
Accuracy
Epoch
Training Accuracy (Masked 1)
Training Accuracy (Masked 2)
Training Accuracy (Masked 3)
Training Accuracy (Masked 4)
Training Accuracy (Masked 5)
Training Accuracy (Masked 6)
Training Accuracy (Masked 7)
Training Accuracy (Masked 8)


Validation Accuracy
Accuracy
Epoch
Validation Accuracy (Masked 1)
Validation Accuracy (Masked 2)
Validation Accuracy (Masked 3)
Validation Accuracy (Masked 4)
Validation Accuracy (Masked 5)
Validation Accuracy (Masked 6)
Validation Accuracy (Masked 7)
Validation Accuracy (Masked 8)


Training Loss
Loss
Epoch
Training Loss (Masked 1)
Training Loss (Masked 2)
Training Loss (Masked 3)
Training Loss (Masked 4)
Training Loss (Masked 5)
Training Loss (Masked 6)
Training Loss (Masked 7)
Training Loss (Masked 8)


Validation Loss
Loss
Epoch
Validation Loss (Masked 1)
Validation Loss (Masked 2)
Validation Loss (Masked 3)
Validation Loss (Masked 4)
Validation Loss (Masked 5)
Validation Loss (Masked 6)
Validation Loss (Masked 7)
Validation Loss (Masked 8)

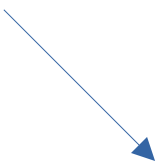
Model 2 with LSTM: Data Prep. and Evaluation

- Data undersampled, so activitys are balanced
- random shuffle of windows, to prevent sampling bias
- 1 person test and 7 person train. Iterate over all people
- take the best validation accuracy from all epochs
- Because of undersample, accuracys vary → do fitting 5 times and take average accuracy

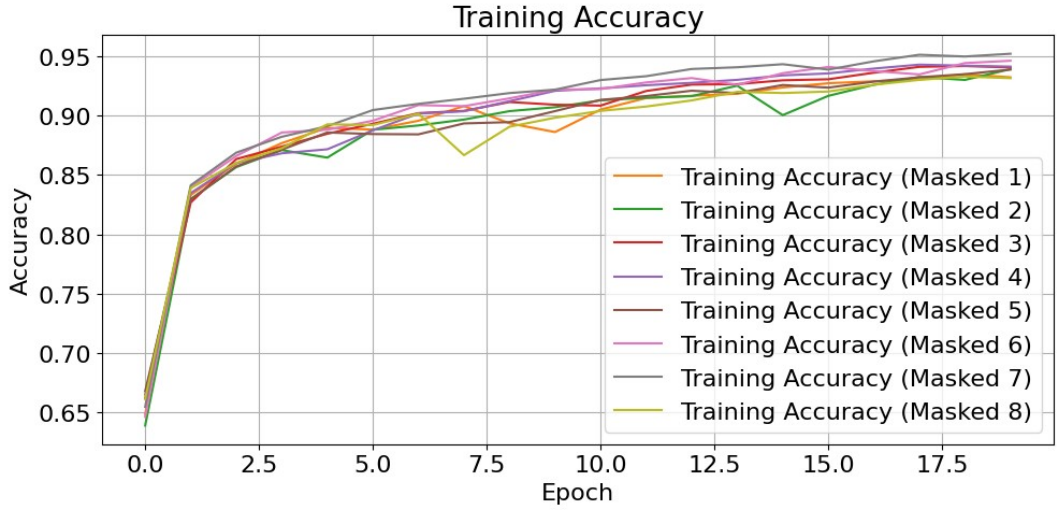
Model 2 with LSTM: Results

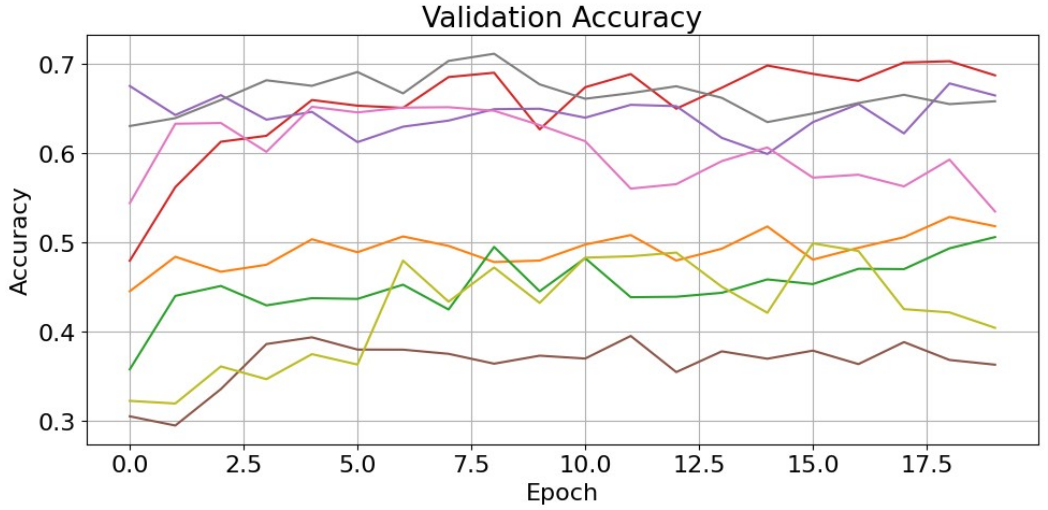
```
model = Sequential()
model.add(BatchNormalization(input_shape=(window_size, 31)))
model.add(LSTM(32, activation='tanh'))
model.add(Dropout(0.2))
model.add(Dense(50, activation='relu'))
model.add(Dense(13, activation='softmax'))
```

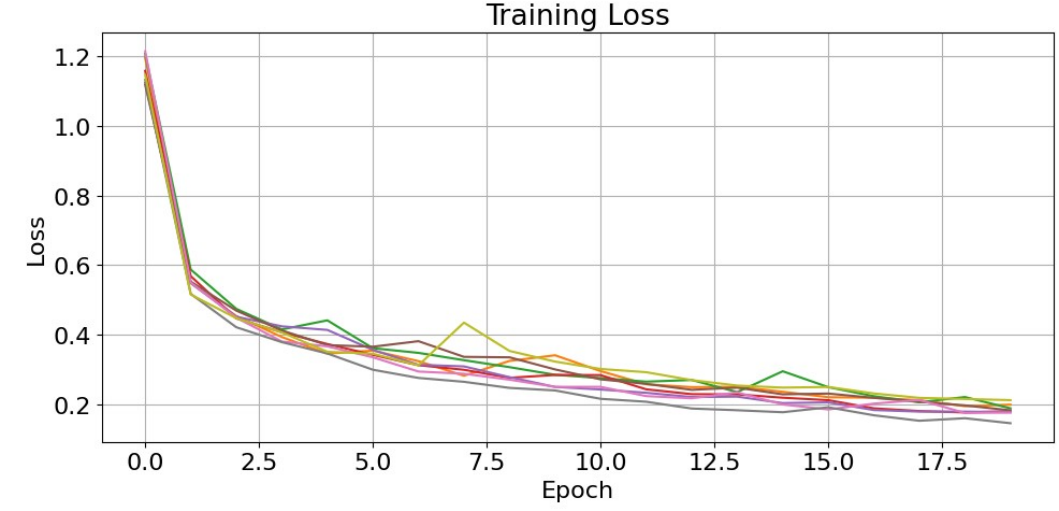
```
history = model.fit(X_train_lstm, Y_train_lstm, epochs=20,
                    validation_data = (X_val_lstm, Y_val_lstm), verbose = 1, batch_size=50)
```

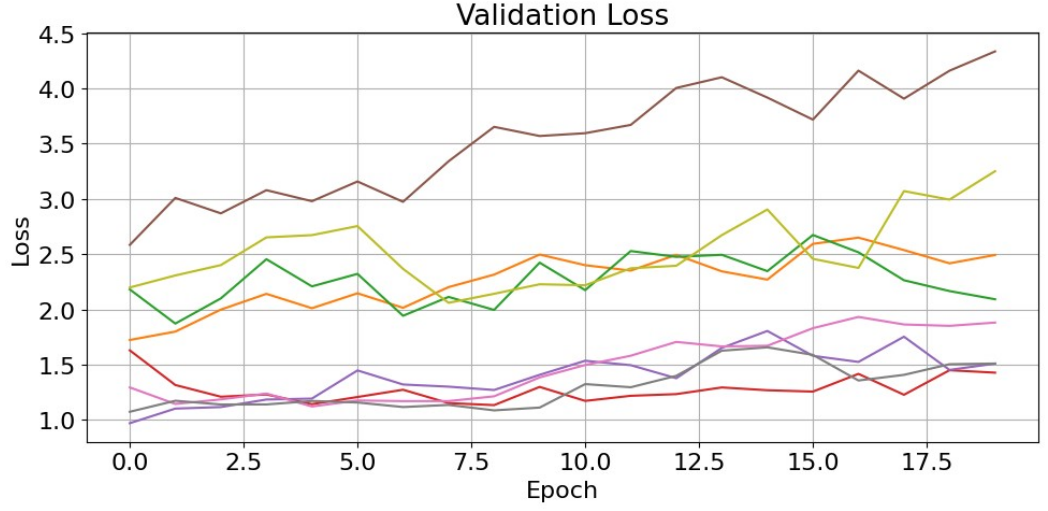


Average accuracy of 59%
Standard deviation of 1%









01.01.24

Tom Ruge

Results

- Both neural nets performed at least 20% better then the logistical regression.

- The first model performed with an accuracy around 71%

    - Activations ReLu and Leaky ReLU perfromed the same

- The LSTM performed even better!

    - changing units from LSTM did not change much. Maybe overfitting

Challenges and Errors

- The dataset contains many biases.

- Running time….

Conclusion and Outlook

Conclusion:

- As expected LSTM performed better then simple neural net better then logistic regression.

Outlook:

- Better investigation of Hyperparameters
- reduce number of features
- average the classifications to improve accuracy.

Questions, Comments?