Activity Classification with Deep Neural networks using EOG data

--model explorations

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2019/4/7

data

7 participants

5 tasks(read, write, browse, video, copy) + rest(NULL) each lasts for 5 minutes

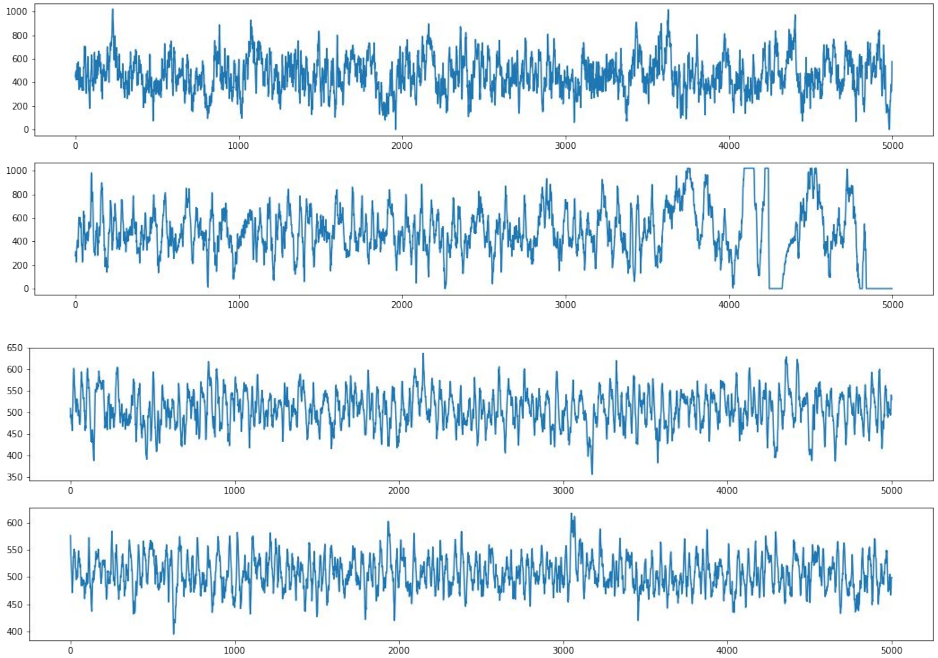
Each task was performed twice

Sampled EOG @ 1000Hz

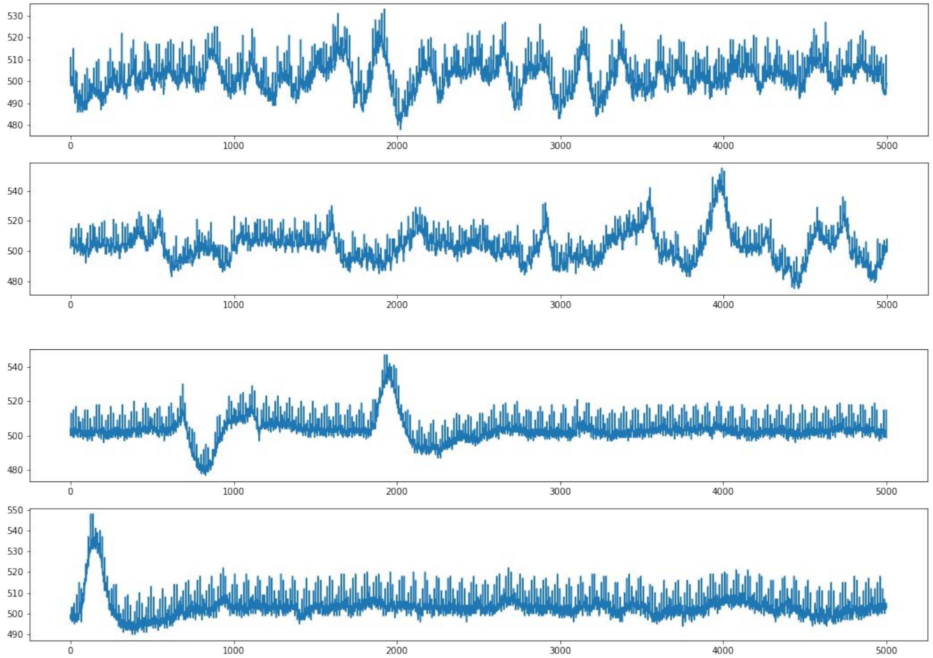
EOG and EEG wave recorded, here we focus on EOG wave

Some samples: (over 5 seconds)

person Y copying

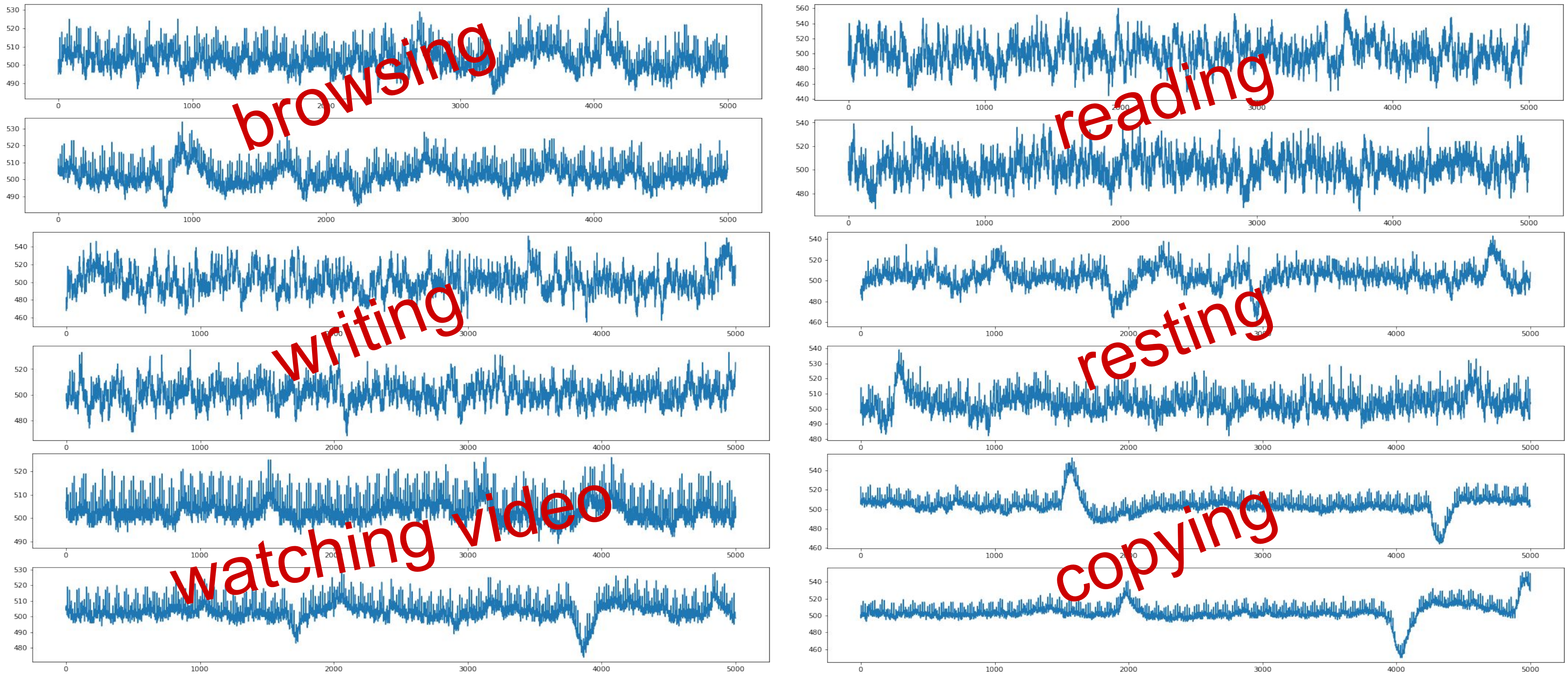


person E copying



Even performing the same task, the EOG wave differs from person to person

Person L : browsing, reading, writing, resting, watching video, copying



For the same person, different task could cause similar waves

e.g. resting and watching video are very similar, we cannot tell difference with bare observation

Our model

Mission:

- to predict the type of activity using EOG wave

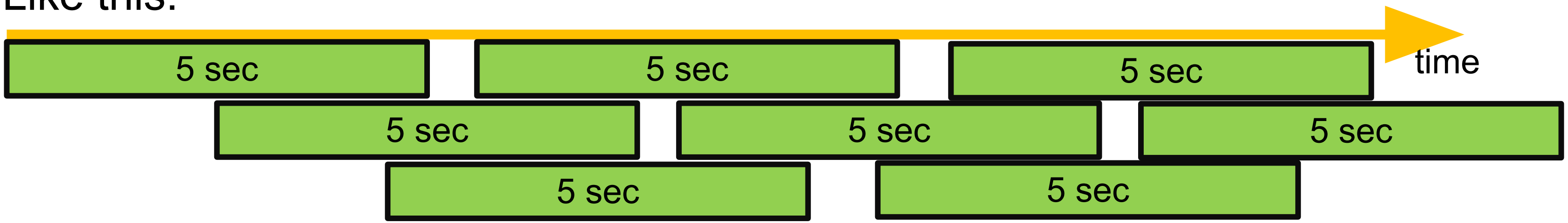
Assumptions:

- It is possible (at least theoretically) to distinguish a person’s activity within 5 seconds of observation
- EOG waves share the same distinguishable features among different people, as long as they are doing the same activity
- When a person claims to be doing one task, they are doing that task 100% percent of the time without distraction(because otherwise the wave will look like this person is resting)

Data augmentation

- Since each file contains ~400000 data points, we chop then into episodes of 5 seconds, with 5000 data points in them each.
- Prediction is invariant over a sliding window of time, which means we can get data from any sliding window of 5000 from our dataset:

Like this:



Scaling

- We scale each of the 5000-length data to mean~0, std~1, facilitating NN training

Train-test split

- We extracted 13565 episodes in total, stratified by activity, getting 12280 training samples and 1357 test samples

Training

- Optimizer: Adam
- Loss function: categorical cross entropy
- Batch size: 32
- 50 epochs (taking around 2 hours on GPU)

Deep Neural network Architecture

Layer (type)	Output Shape	Param #
conv1d_1 (Conv1D)	(None, 999, 32)	352
conv1d_2 (Conv1D)	(None, 997, 32)	3104
max_pooling1d_1 (MaxPooling1	(None, 332, 32)	0
conv1d_3 (Conv1D)	(None, 330, 32)	3104
conv1d_4 (Conv1D)	(None, 328, 32)	3104
max_pooling1d_2 (MaxPooling1	(None, 109, 32)	0
lstm_1 (LSTM)	(None, 109, 32)	8320
lstm_2 (LSTM)	(None, 16)	3136
dense_1 (Dense)	(None, 6)	102

CNN, for feature extraction

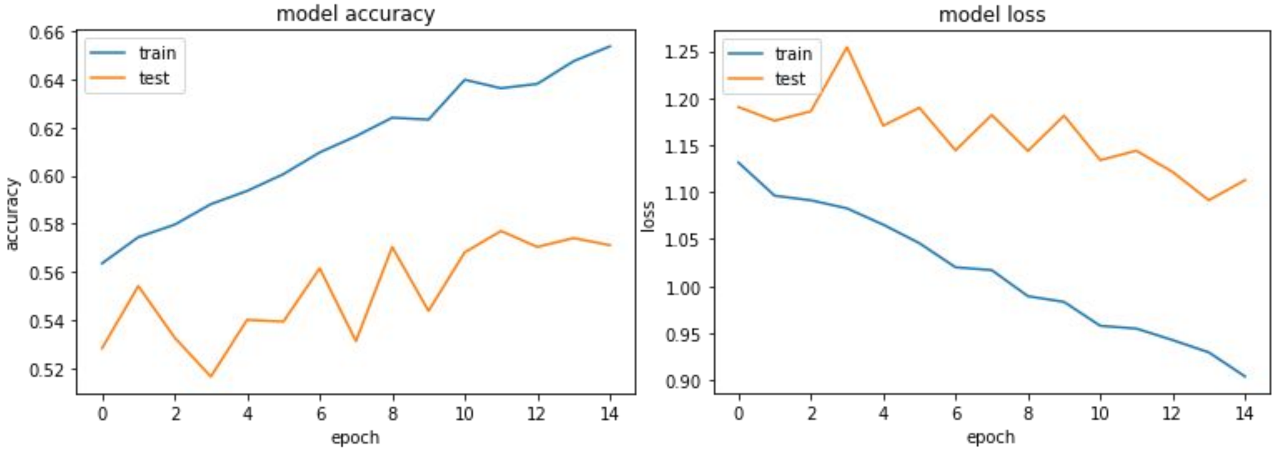
Deep LSTM classifier, for time-series predictions

Total params: 21,222
Trainable params: 21,222
Non-trainable params: 0

Result : accuracy~60%

training history

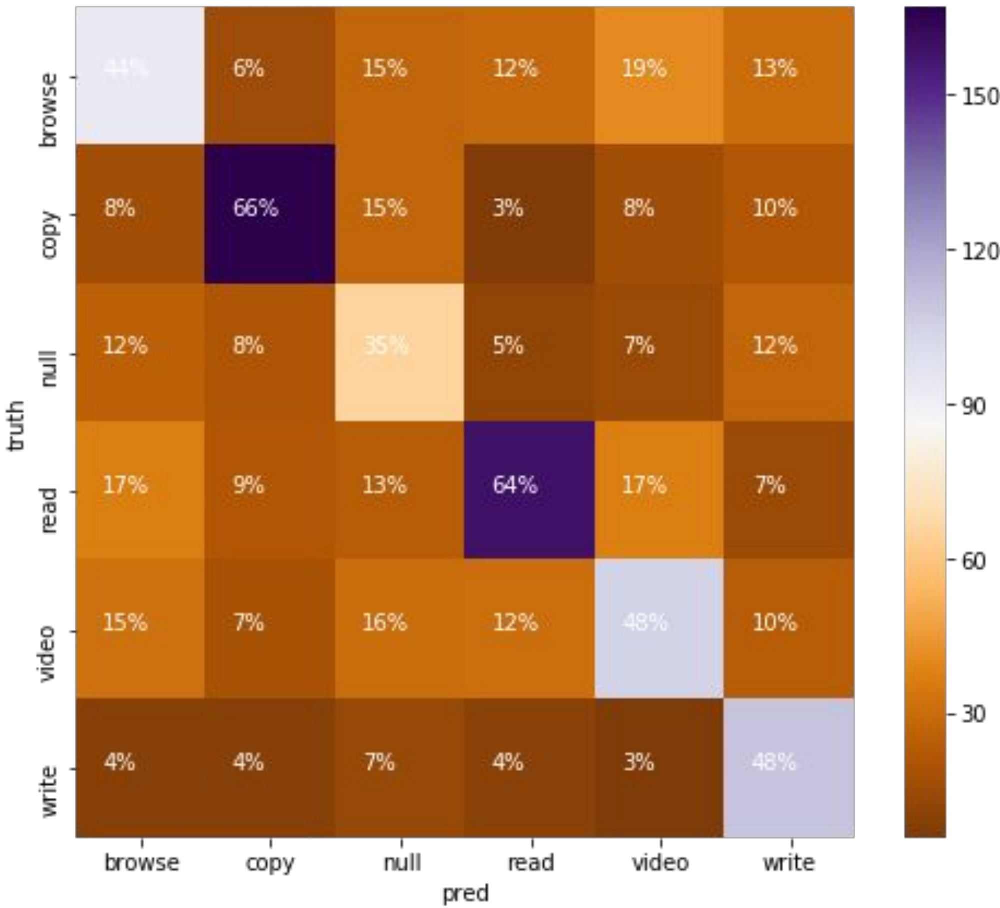
Last 15 epochs



Detailed analysis of result

1. Overall our model achieved 58% accuracy on the test set.
2. Our model does relatively well in predicting read and copy activities
3. null activity is the most confusing, hard to spot
4. Video-browsing, reading -browsing, null-browsing are three pairs of activities that often confuse with each other

Confusion matrix



Deep LSTM architecture

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Layer (type)             Output Shape        Param #
==============================================================
lstm_3 (LSTM)            (None, 5001, 32)    4352
lstm_4 (LSTM)            (None, 16)          3136
dense_2 (Dense)          (None, 6)           102
==============================================================
Total params: 7,590
Trainable params: 7,590
Non-trainable params: 0
```

Result training history