Classification of Individual KeyStrokes with Smartwatch Sensors

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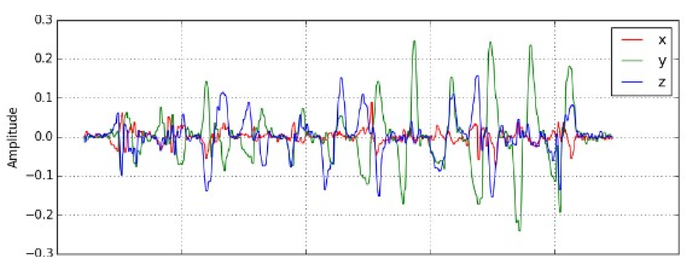
Problem

- Smartwatch based classification of the keyboard taps by a user
- Use embedded sensors on two smartwatches worn on each hand to capture keystrokes
- Build ensemble of Neural Nets to create keystroke labelling tool
- Helpful in eliminating keyboard and making possible typing on any surface

Dataset

- 9 axis sensors: 3 accelerometer, 3 gyroscope, 3 gravity
- 26 alphabets and 2 special key characters (LShift and BkSpc)
  - Total data taken for 10000 characters
  - Non-uniform distribution over characters
- Sensor data smoothed and thresholded
- Ground truth recorded with key logger



Gyroscope Data Smoothened with Median Filtering

Approach

- Total 18 statistical features used : Mean, Std Dev, Skewness, Kurtosis, Cross-Correlation, etc
- Calculated on configurable window duration around key-press activity
- Computed in real as well as Fourier space
- PCA: Dimension reduced to 20
- Data sampling random while training
- Affine neural network with 4 hidden layers
- Hidden Dim of 512
- Batch Normalization
- ReLU activations
- Dropout
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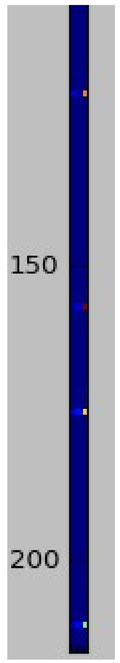
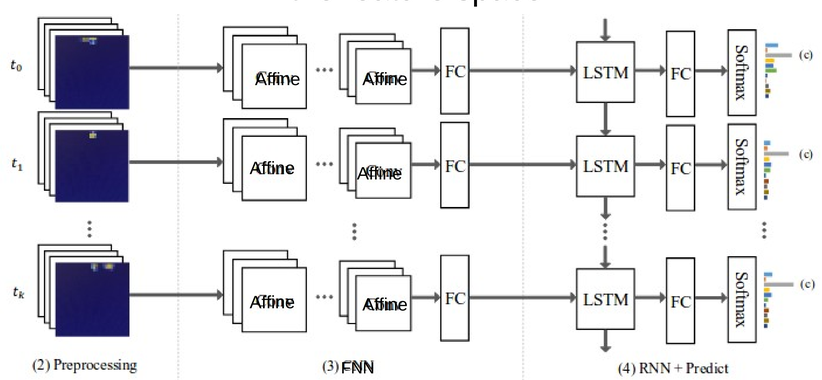
- Since data is sampled by typing words,
- we can treat each char as charVector
- Use RNN on the temporal sample
- Ensemble with affine to improve prediction
- Use affine as a feature extractor for input
- to RNN



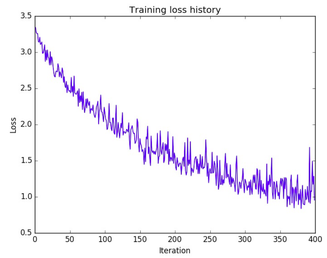
KeyStrokes show up as blips in the feature space

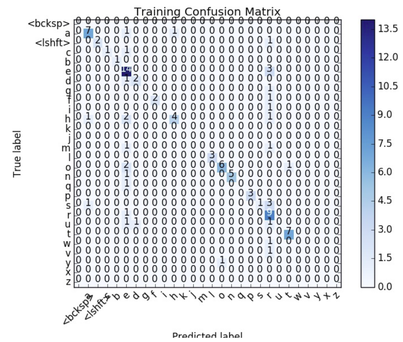


Fully Connected Neural Networks can be used to learn features which can then be passed to an RNN

Results

- Generalized model has accuracy of 26%
- Random classifier would be at 3.5%
- Classification shows bias towards frequent data
- Overfit model on 100 training samples:





Future Work

- Larger and more uniform dataset
- Take data from different
- Improve FNN classification
- Implement RNN for prediction
- Take ensemble with FNNs for classification
- Build live tool to detect, classify and predict typed character

References

1. Anindya Maiti, Oscar Armbruster, Murtuza Jadliwala, Jibo He, Smartwatch-Based Keystroke Inference Attacks and Context-Aware Protection Mechanisms, ISWC ’15
2. He Wang, Ted Tsung-Te Lai, Romit Roy Choudhary, MoLe: Motion Leaks through Smartwatch Sensors, MobiCom’15