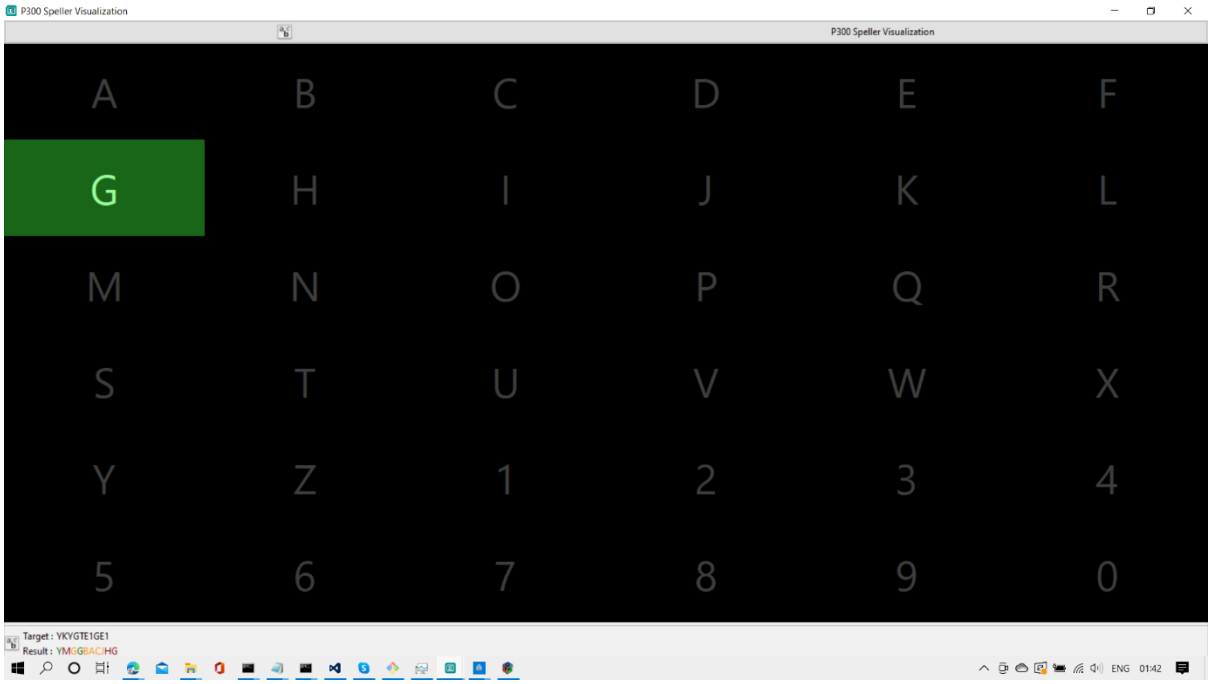
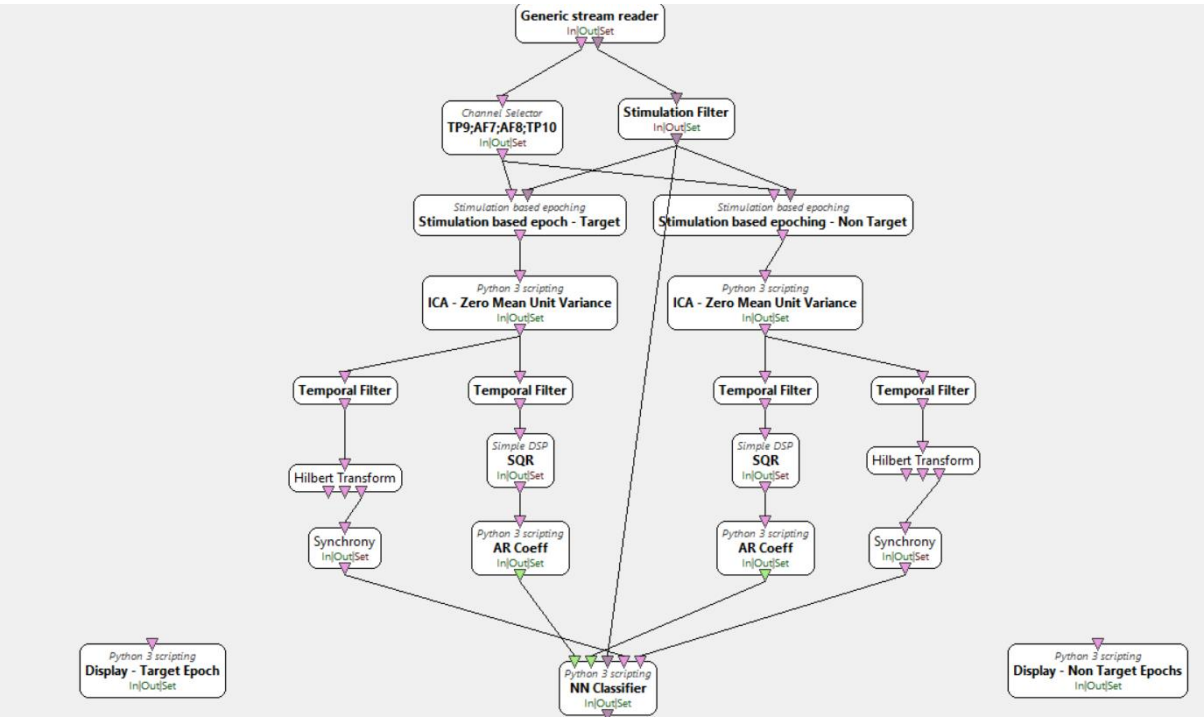
## Brief about Experiment Setup for Speller




1. The above Speller with characters A to Z and numbers 1 to 9 is displayed to the subject.
2. The target character, on which the subject needs to be focused during training, is highlighted in BLUE. The subject has to pay attention to the flashing of this character.
3. At a given time instance only one row or one column is flashed.
4. The flash continues for 200 ms, after which there is a no-flash interval for 600 ms. This gives a total epoch size = 200 ms + 600 ms = 800 ms. We make sure that one epoch contains only one flash.
5. After 800 ms, another row or column is picked up randomly and flashed.
6. In a single repetition, the there are 2 ***target*** flashes (1 row flash + 1 column flash). Also there are 10 ***non-target*** flashes (remaining 5 row flashes + 5 column flashes).
7. After each repetition, there comes a delay of 800 ms, when the screen stops flashing.
8. There are such 6 repetitions for a single target character during training. This leaves us with 12 ***target*** flashes and 60 ***non-target*** flashes
9. After 6 repetitions, there comes a delay of 2.4 seconds, when the screen stops flashing.
10. Let us count the time taken for each target character, during training:
    a. 12 target flashes x 800 ms = 9.6 s
    b. 60 non-target flashes x 800 ms = 48 s
    c. 6 inter-repetition delay(s) x 800 ms = 4.8 s
    d. Delay, when all repetitions for a single character get over = 2.4 s
    e. Sum up all the above = 64.8 seconds
    f. If you observe, it is all a multiple of 0.8. This is to make sure that each epoch will contain only one flash and there will not be any overlapping even for the subsequent characters.
11. I have 24 such characters as my training data for one subject.

## Feature Extraction and Classification based on Interaction Terms



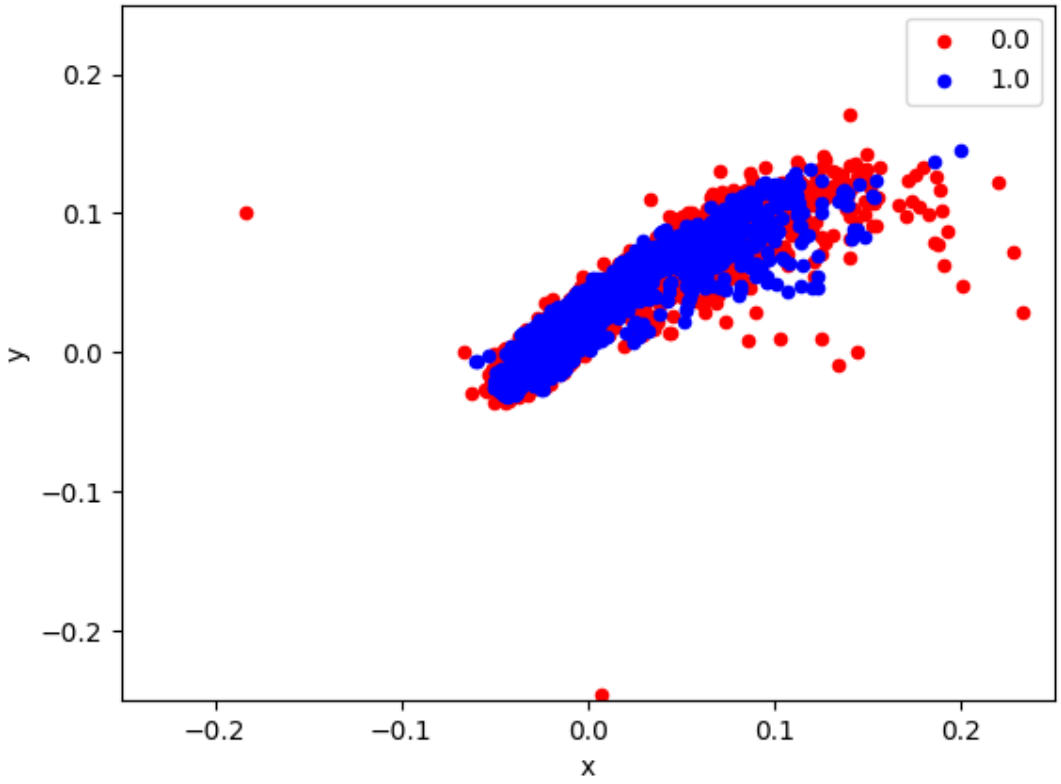

1. Extract ***target*** and ***non-target*** epoch from each of the EEG channel (TP9, TP10, AF7 and AF8)
2. Make each epoch to be of Zero Mean - Unit Variance separately.
3. Do the Independent Component Analysis (ICA) over each epoch separately. It creates 4 independent components. I choose 3 components out of 4 (The criteria to choose these is not clear yet. Might be a potential problem.)
4. Calculate the AR coefficient feature:
    a. On the ICA components, I apply temporal filter to get frequencies from 0.1Hz to 12Hz.
    b. After filtering, I square up each sample of the epoch (to calculate P300-square) and re-construct the epoch.
    c. Pass all the ***squared*** samples of the epochs to the AR function to calculate AR coefficients.
5. Calculate the Synchrony feature
    a. On the ICA components, I apply temporal filter to get frequencies in Gamma band from 25Hz to 45 Hz
    b. After filtering, I apply the Hilbert Transform to calculate instantaneous phase information
    c. I pass this phase information to synchrony module to calculate Phase Locking Value (PLV). I calculate the PLV across 6 different points on the epoch. Put them into an array. Treat it as a Synchrony feature.

Below is the scatter plot of ***AR coefficient features*** across target (blue) and non-target (red) environment.

I have 12 order AR coefficient model for each target/non-target epoch. Ideally it would be good to have a 12 dimensional visualization system if we want to plot each point. That is not possible yet. However, this is an attempt to visualize the system in two dimensions, considering a combination of two AR coefficients plotted against each other.

In the below picture, it displays the $6^{th}$ AR coefficient of each epoch (on y axis) plotted against the values of $5^{th}$ AR coefficient (on x axis).

I have plotted many such combinations of AR coefficients and saw that they all have this kind of overlapping structure.



Similar to the above 2 dimensional AR coefficient plot, I have plotted two slices of PLV against each other for target and non-target environment. As we can see, the PLV values fall between 0 and 1.