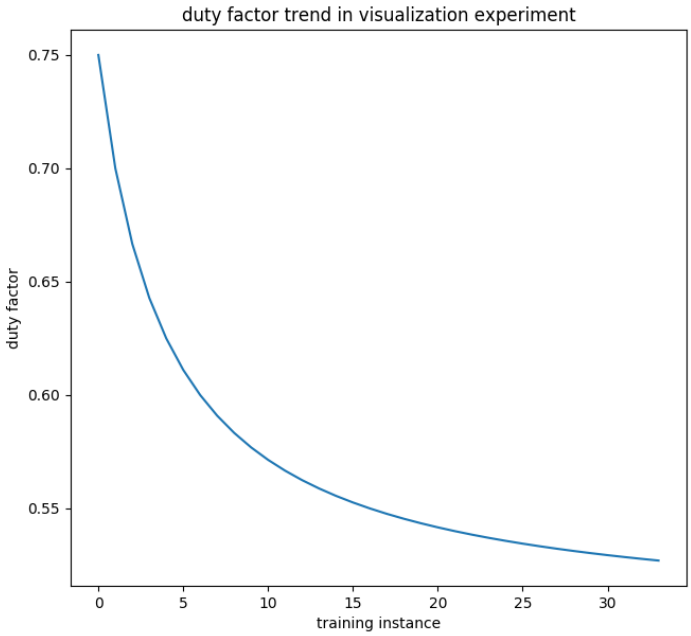
CPG Weight Analysis

This document present the results of the analysis of CPG weights obtained after the training of the gait generation CPG with 33 different gait patterns and subsequent comparison of weights for any discernible patterns. The analysis was performed for a CPG with the following parameters-

- Number of oscillators in reservoir layer - 20
- Number of hidden layer neurons - 50
- Number of output neurons (number of activation patterns generated) - 8
- dt - 0.001
- Learning rate - 0.001
- θ - 30°
- Weight initialisation strategy - random initialisation
- Number of epochs - 1000

The following plot captures the variation in the gait duty factor and speed across training instances.



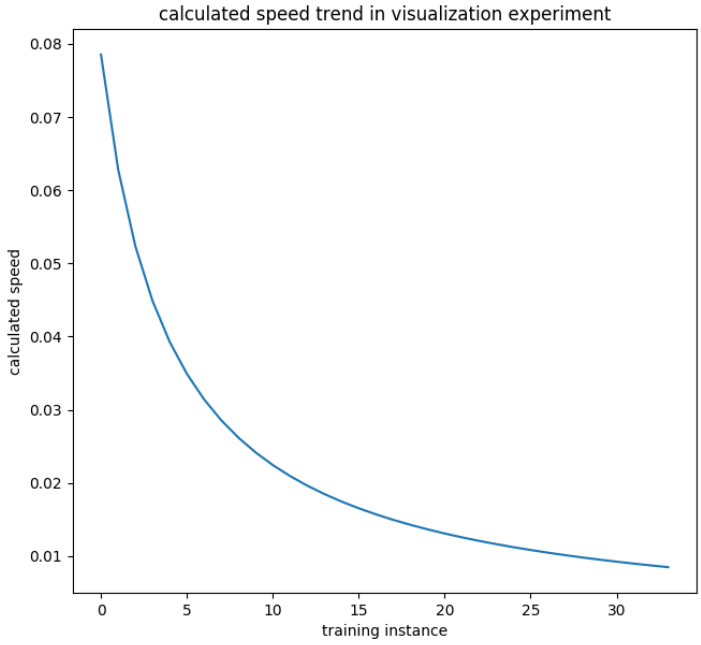
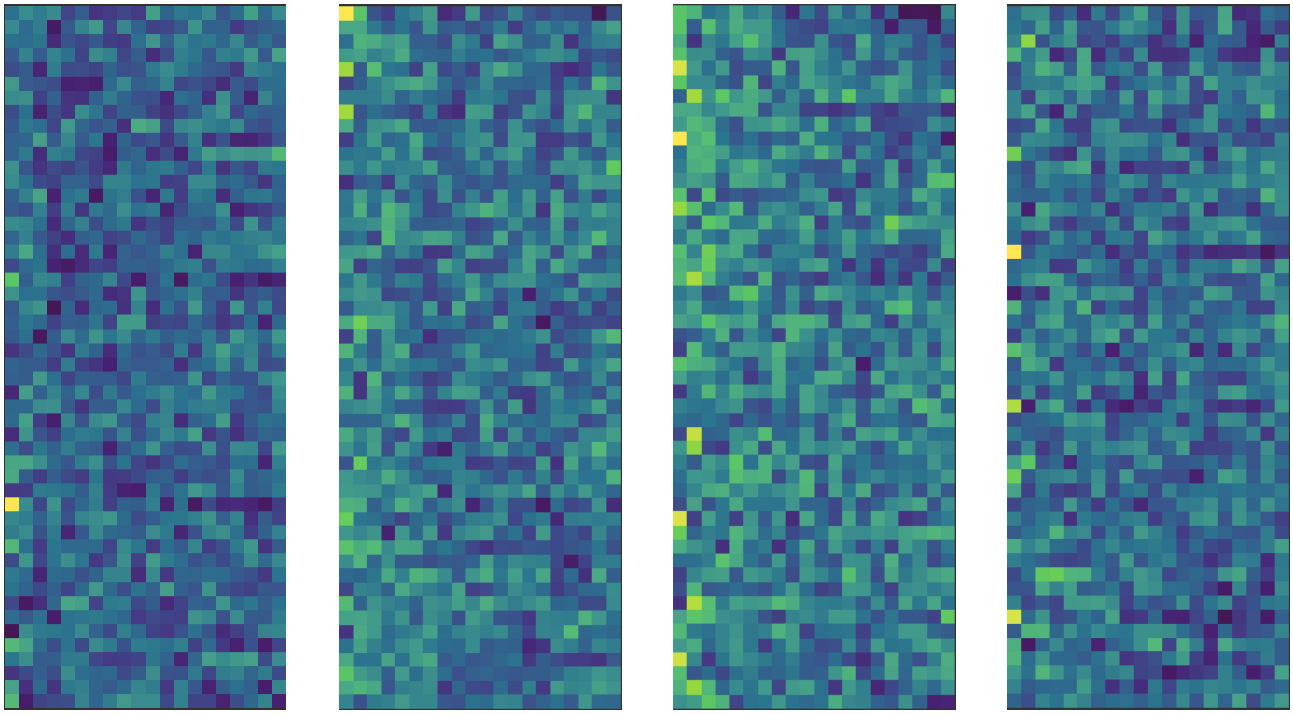


Image Feature Maps from Weights

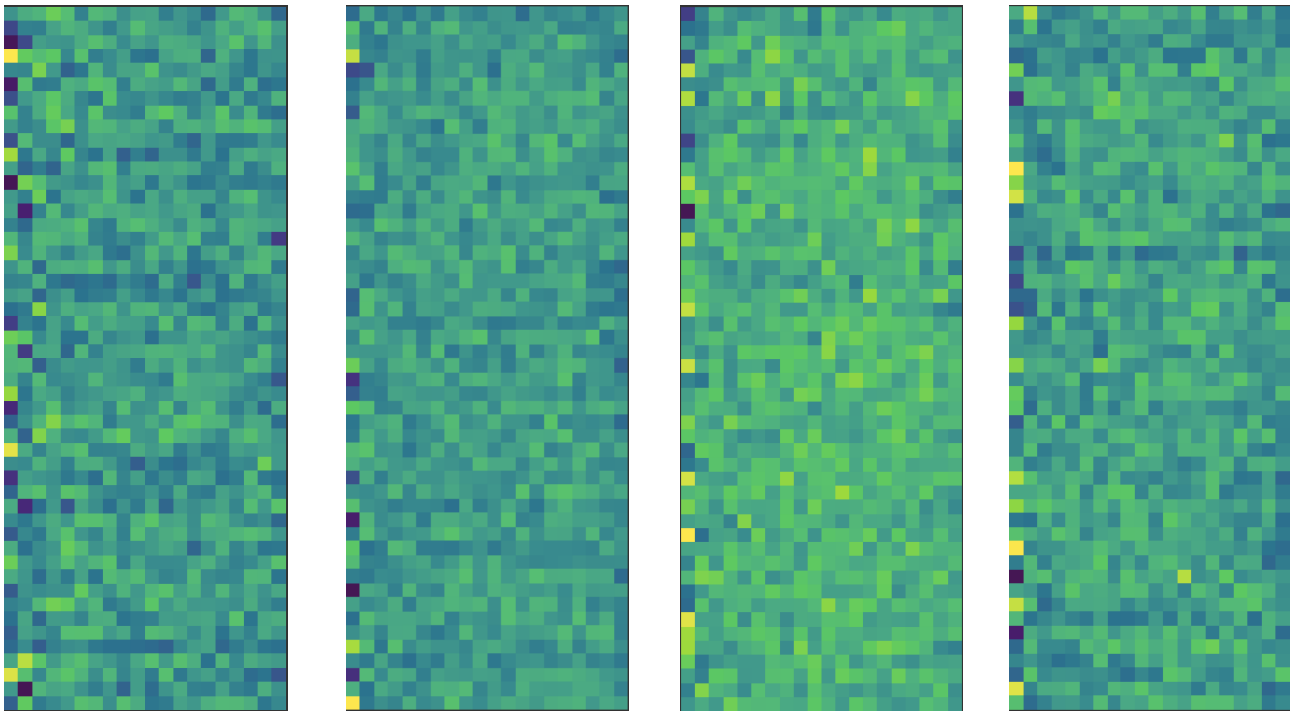
Preliminary analysis involved manual inspection of Image Feature Maps obtained by Saving the image weights as png images.

The following figures are the feature maps obtained from the imaginary part of layer 1 weights of the CPG for a gait period of 80 ms, 144 ms, 208 ms and 268 ms respectively.



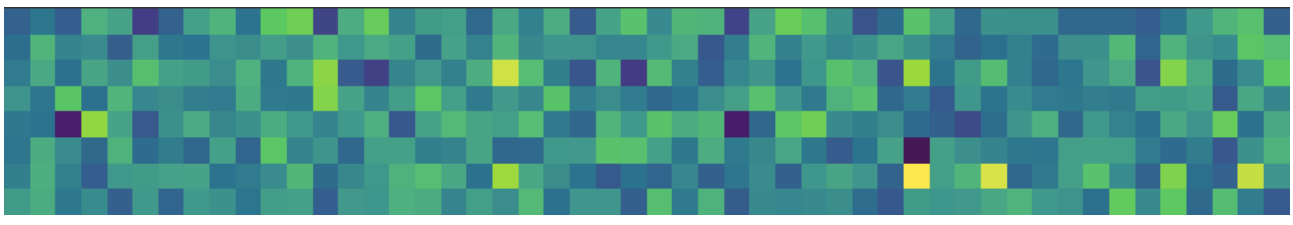
(a) (b) (c) (d)

The following figures are the feature maps obtained from the real part of layer 1 weights of the CPG for a gait period of 80 ms, 144 ms, 208 ms and 268 ms respectively.

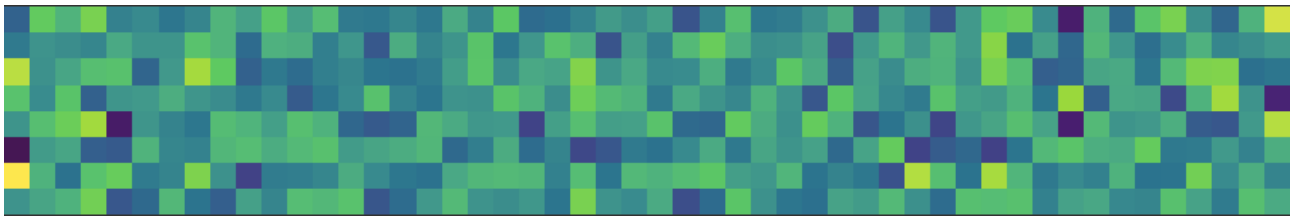


(a) (b) (c) (d)

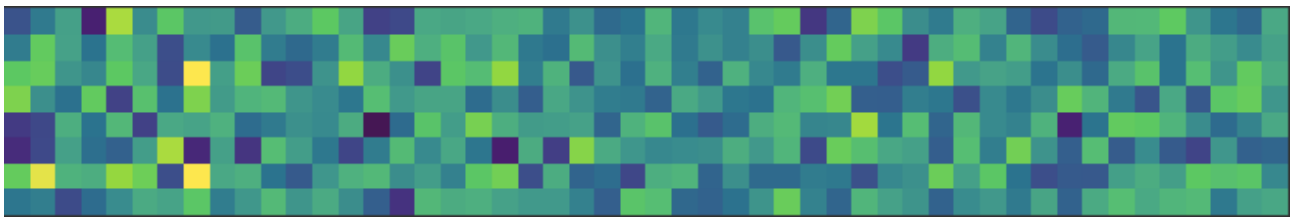
The following figures are the feature maps obtained from the imaginary part of layer 2 weights of the CPG for a gait period of 80 ms, 144 ms, 208 ms and 268 ms respectively.



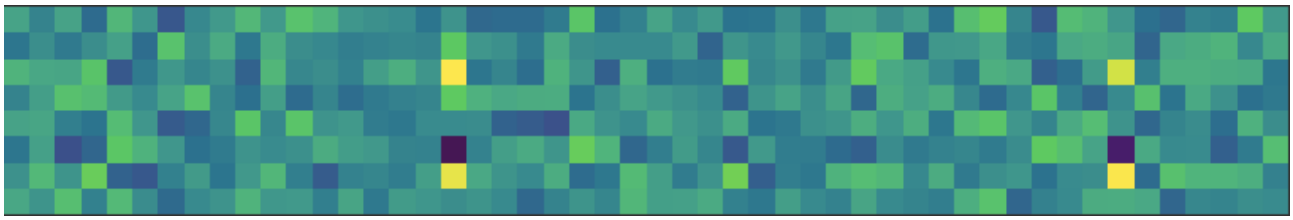
(a)



(b)

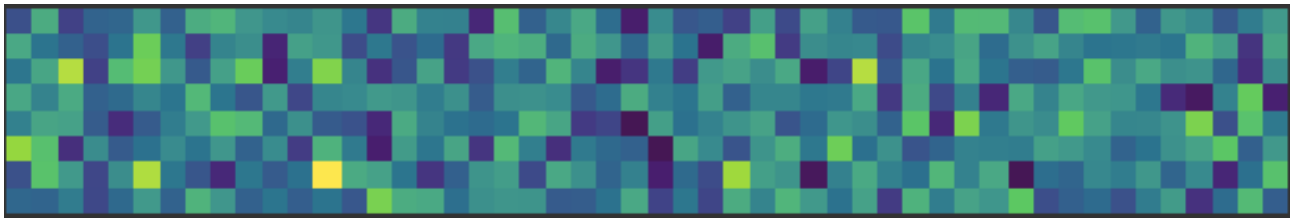


(c)

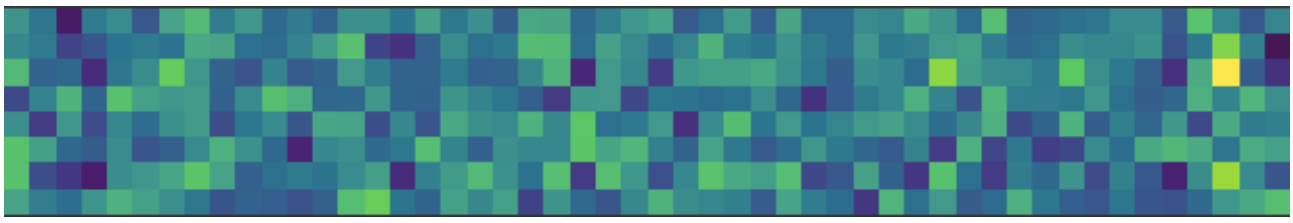


(d)

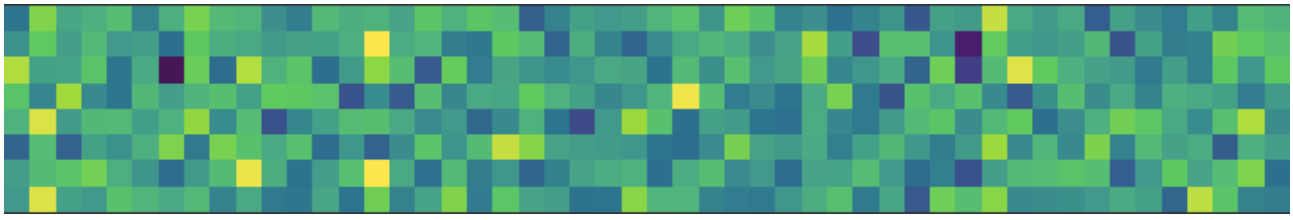
The following figures are the feature maps obtained from the real part of layer 2 weights of the CPG for a gait period of 80 ms, 144 ms, 208 ms and 268 ms respectively.



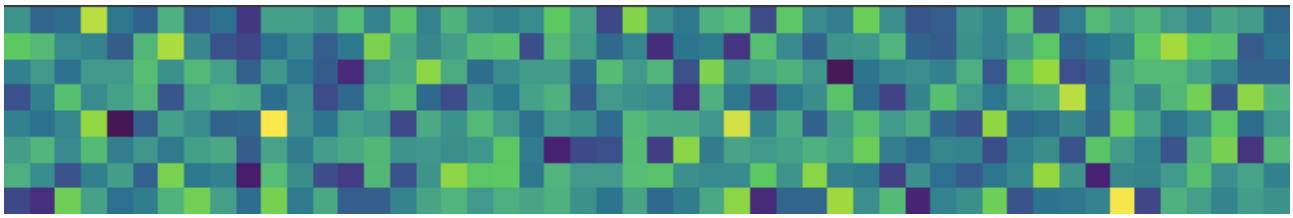
(a)



(b)



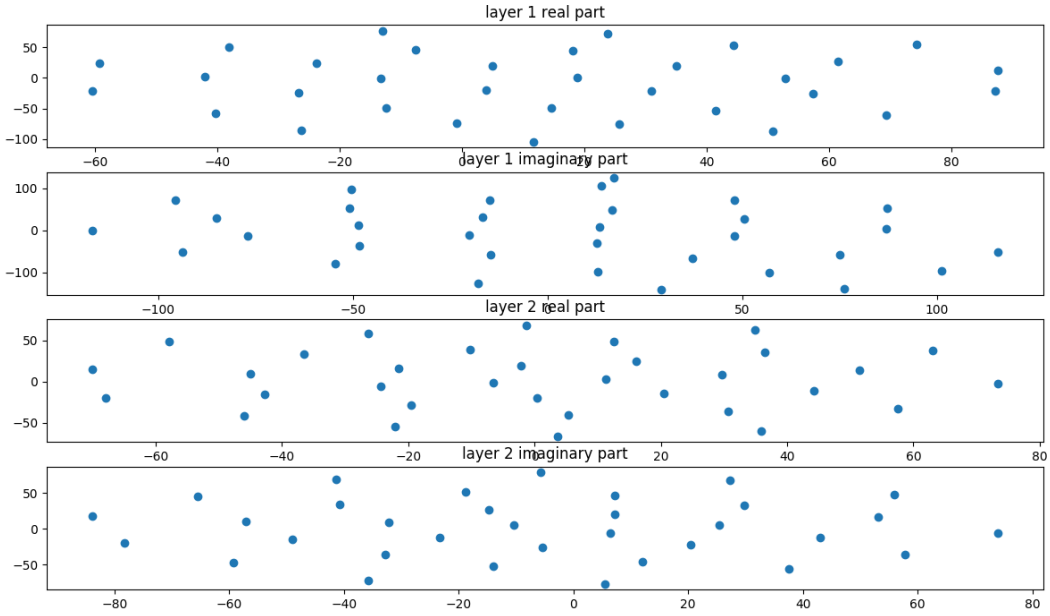
(c)



(d)

TSNE Plots

To further test for any discernible patterns, **PCA followed by TSNE**. PCA resolves the weight matrices in terms of the top 80% most relevant eigenvectors. TSNE then projects the dimension reduced weight matrices to a 2 dimensional space for analysis. Whereas PCA performs a **linear separation of dimensions**, TSNE is used for **non-linear separation** of dimensions. The two techniques combined together can be used to learn any relationship that might exist between weights for different gait activation patterns. These relationships manifest themselves in the form of clusters in the reduced 2 dimensional space obtained from TSNE. The following figure shows the TSNE plots for the 33 training instances.



There are no clusters observed in any of the weights. Thus, **it can be claimed that there is no discernible pattern between weights of the CPG trained with different gait patterns. Even if there is a relationship, a more fine grained analysis is required to identify such a relationship**.