

Q4

For mean matrices, please see `mean.i.csv`, for digit `i`.

For covariance matrices, please see `covmat.i.csv`, for digit `i`.

For principal modes of variation of digit `i`, please see `eigenvector.i.csv`.

For maximum eigenvalues, please see `eigenvalues.csv`.

For documented code, please see `Q4.py` and `3imgs.py`

Starting on the next page are the graphs of all eigenvalues, and of top 100 eigenvalues, for each digit. We see from the graphs that for each digit, only around 90 eigenvalues are large compared to the others. The significant modes of variation are far less than 28^2 , because Arabic numerals are composed of few primitive graphic elements. This implies that each of the 28^2 pixels' intensities are highly dependent on each other. Barring any noise in the data, there cannot be, say, an image with high intensity at all four corners, because no such numeral (photographed with margins) is a part of the study.

The three images show us the average and the two extreme ways (by the principle mode of variation) of writing a digit. For '1,' the extremities are an almost vertical '1,' and a '1' at 60 degrees to the positive x-axis. Very few, if any, right this digit leaning left.

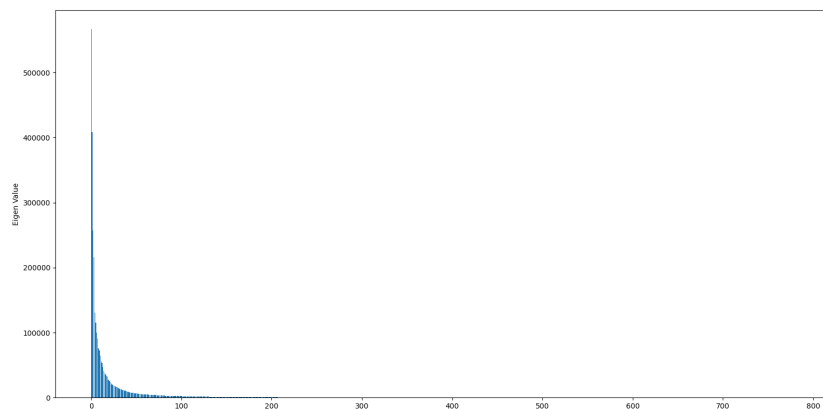


Figure 1: Bar Graph of all eigenvalues of digit 0 data.

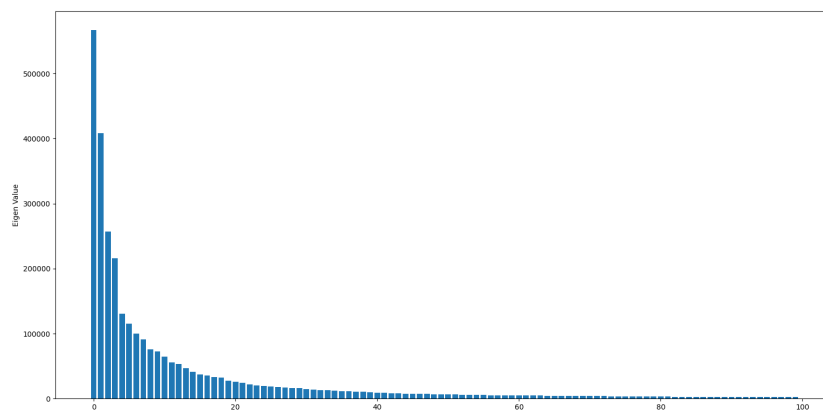


Figure 2: Bar Graph of top 100 eigenvalues of digit 0 data.

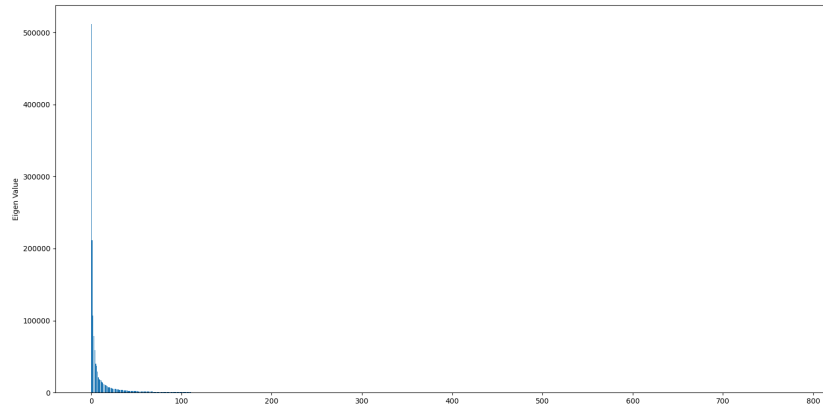


Figure 3: Bar Graph of all eigenvalues of digit 1 data.

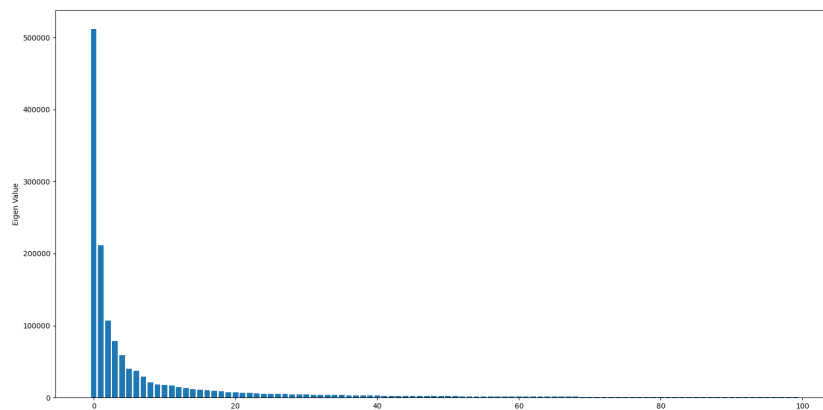


Figure 4: Bar Graph of top 100 eigenvalues of digit 1 data.

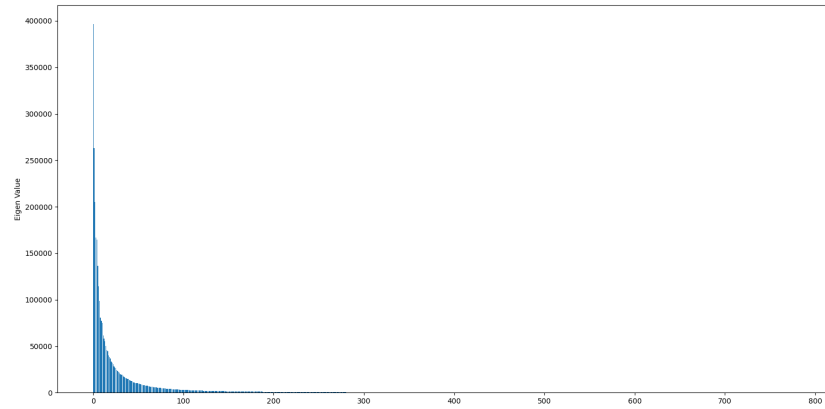


Figure 5: Bar Graph of all eigenvalues of digit 2 data.

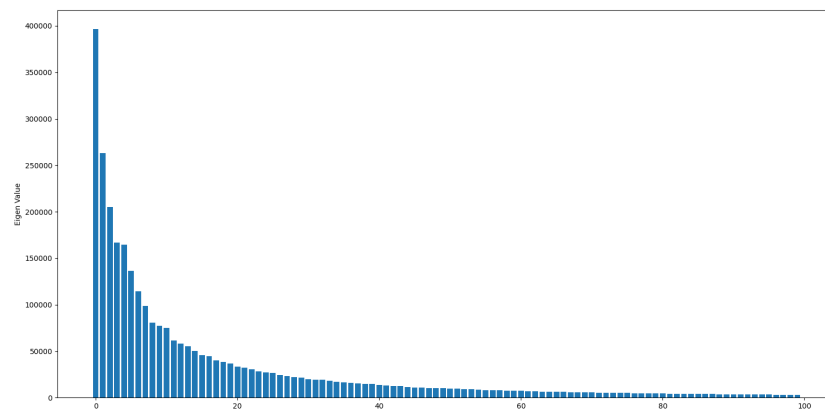


Figure 6: Bar Graph of top 100 eigenvalues of digit 2 data.

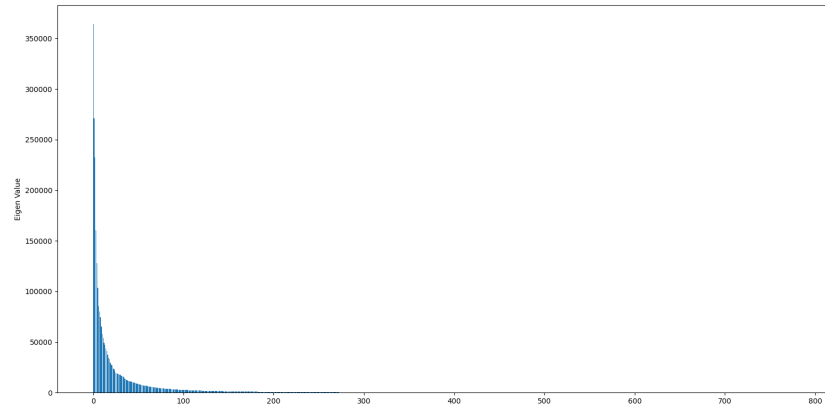


Figure 7: Bar Graph of all eigenvalues of digit 3 data.

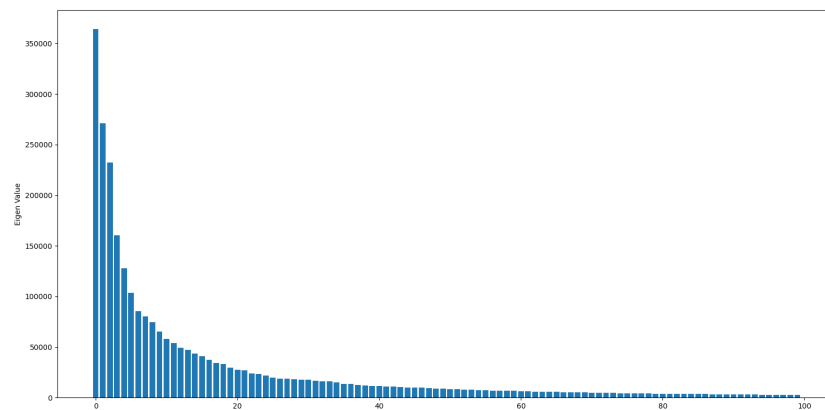


Figure 8: Bar Graph of top 100 eigenvalues of digit 3 data.

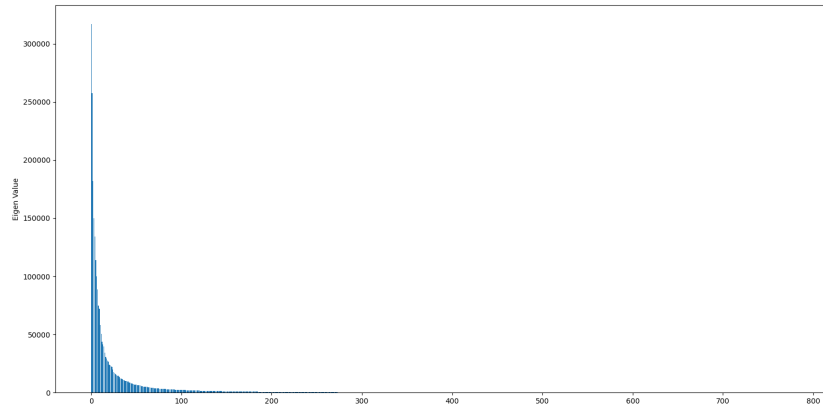


Figure 9: Bar Graph of all eigenvalues of digit 4 data.

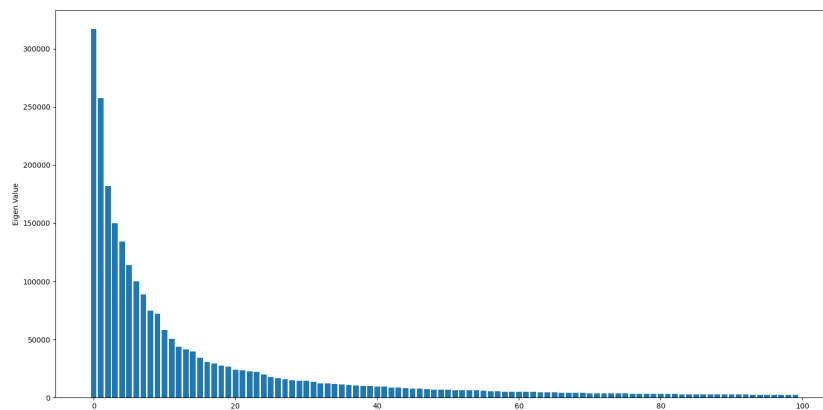


Figure 10: Bar Graph of top 100 eigenvalues of digit 4 data.

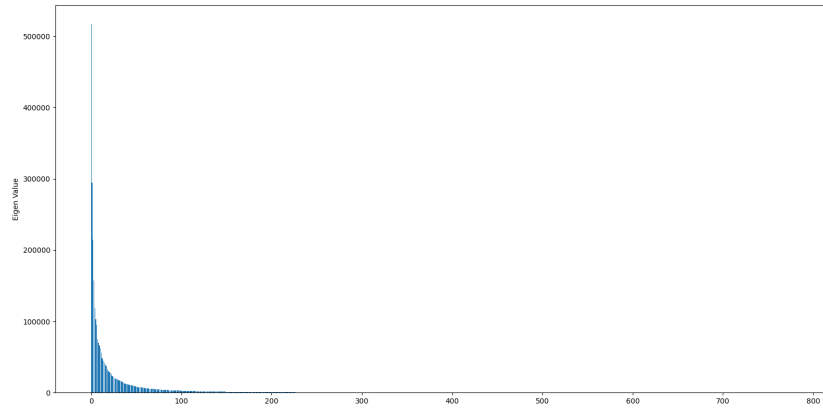


Figure 11: Bar Graph of all eigenvalues of digit 5 data.

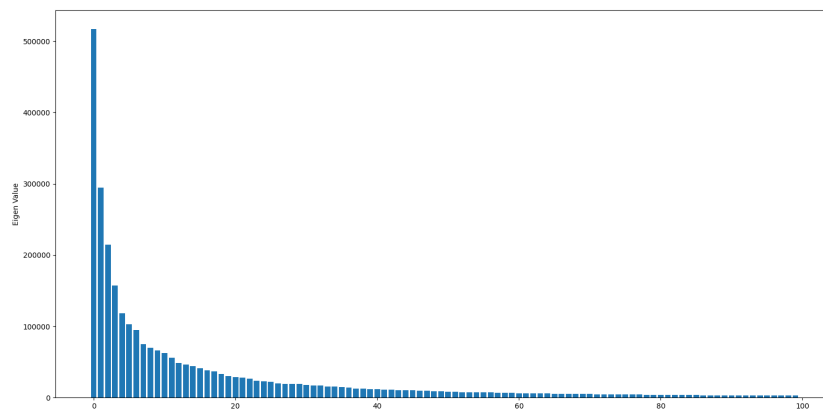


Figure 12: Bar Graph of top 100 eigenvalues of digit 5 data.

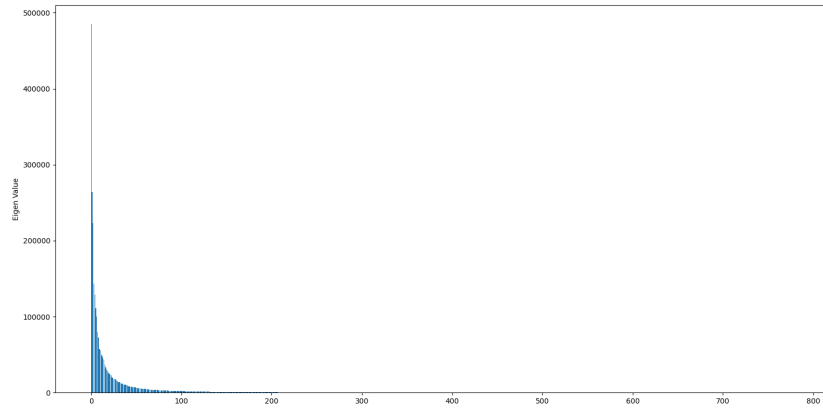


Figure 13: Bar Graph of all eigenvalues of digit 6 data.

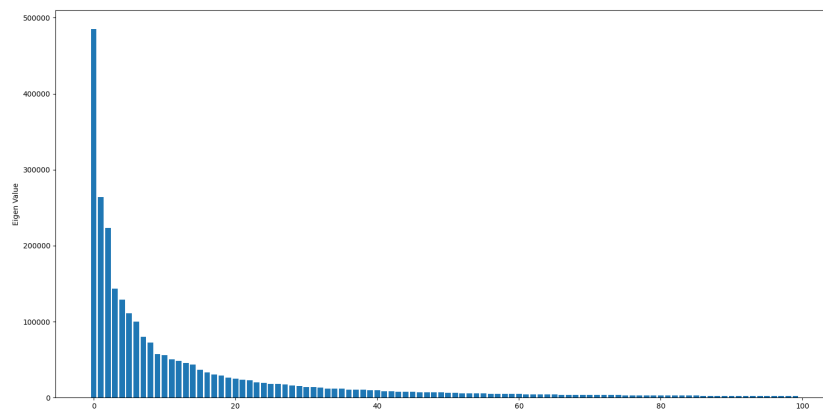


Figure 14: Bar Graph of top 100 eigenvalues of digit 6 data.

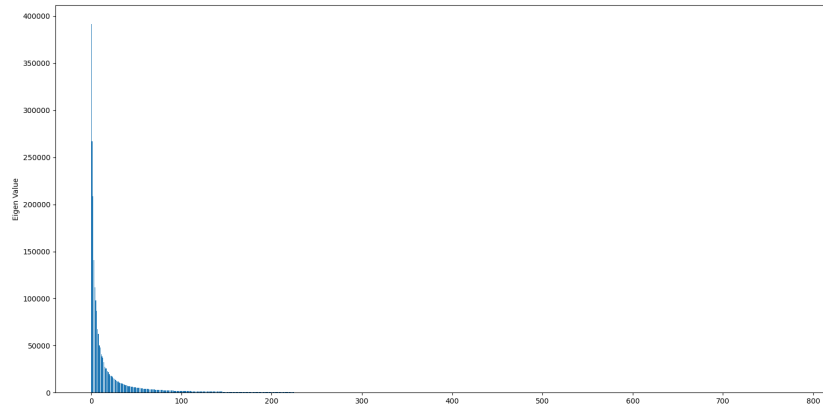


Figure 15: Bar Graph of all eigenvalues of digit 7 data.

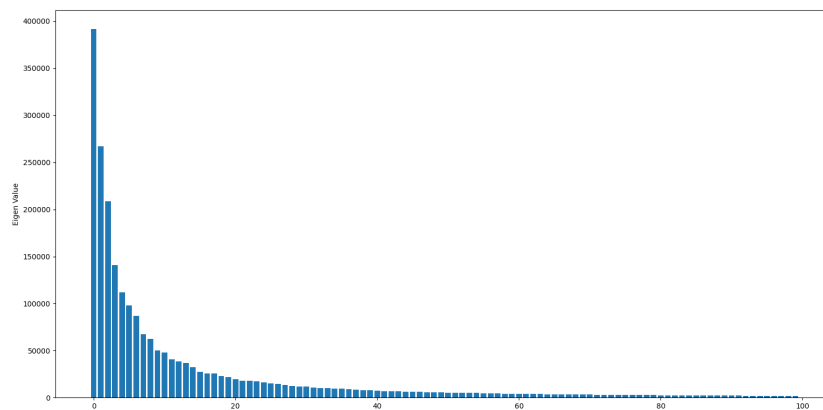


Figure 16: Bar Graph of top 100 eigenvalues of digit 7 data.

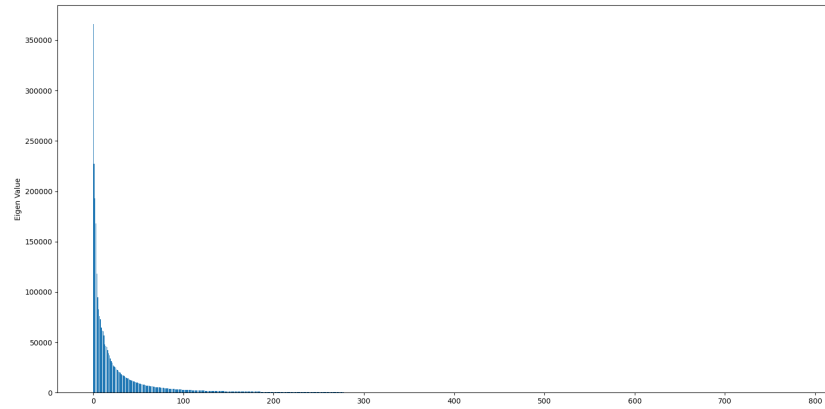


Figure 17: Bar Graph of all eigenvalues of digit 8 data.

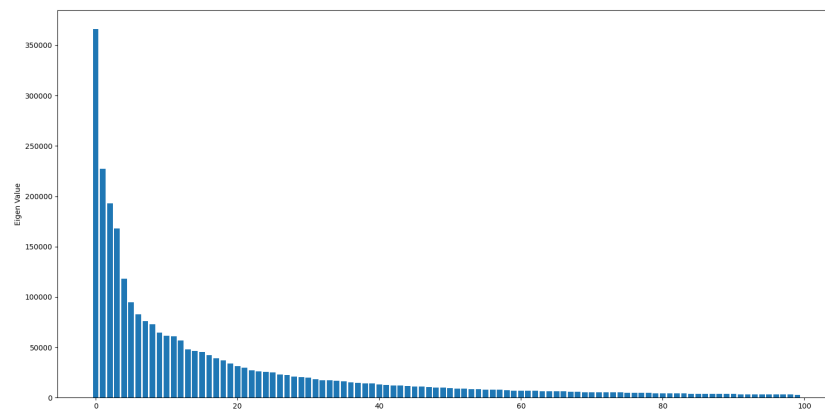


Figure 18: Bar Graph of top 100 eigenvalues of digit 8 data.

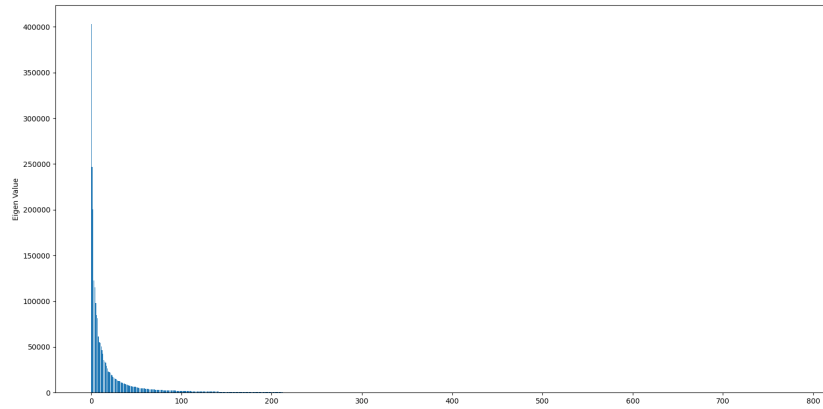


Figure 19: Bar Graph of all eigenvalues of digit 9 data.

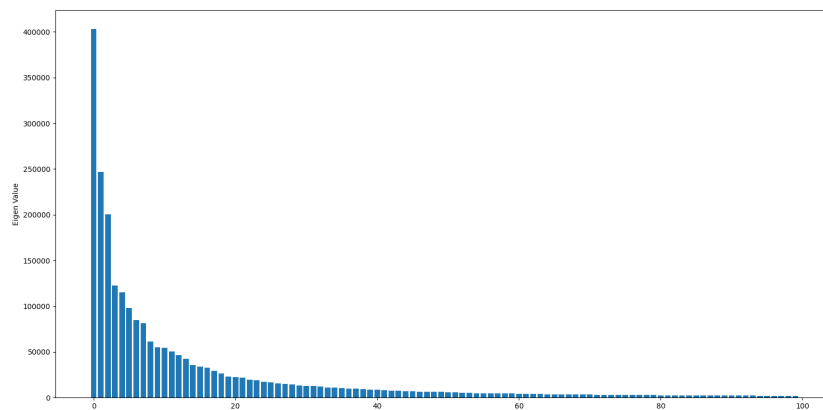


Figure 20: Bar Graph of top 100 eigenvalues of digit 9 data.

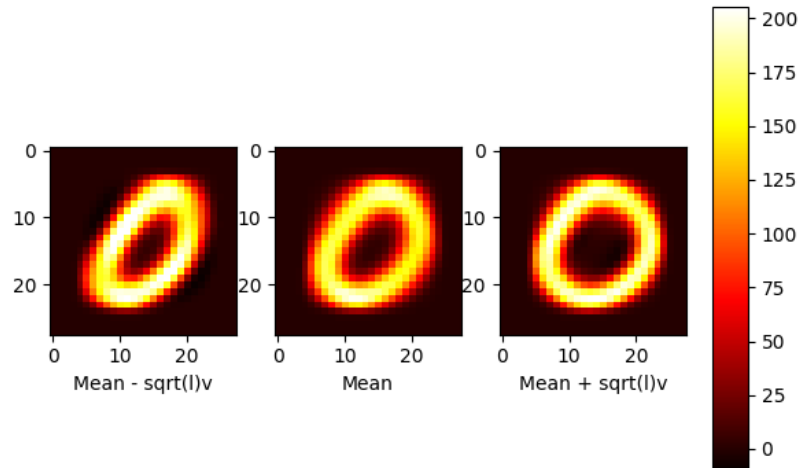


Figure 21: Heatmap (imshow) for digit 0 data.

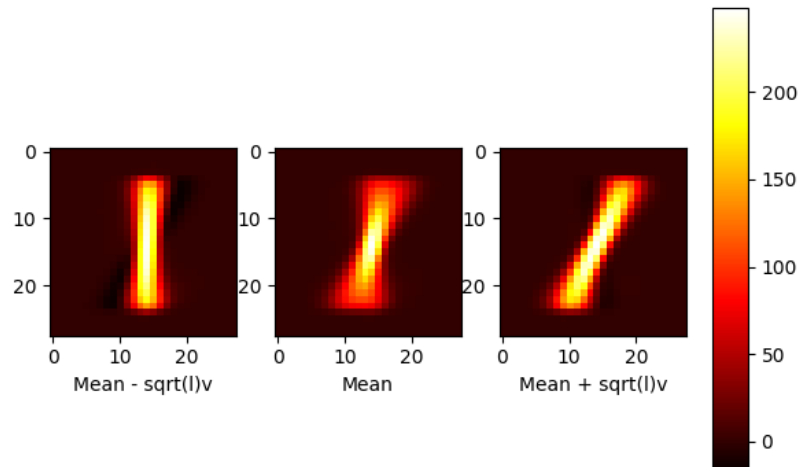


Figure 22: Heatmap (imshow) for digit 1 data.

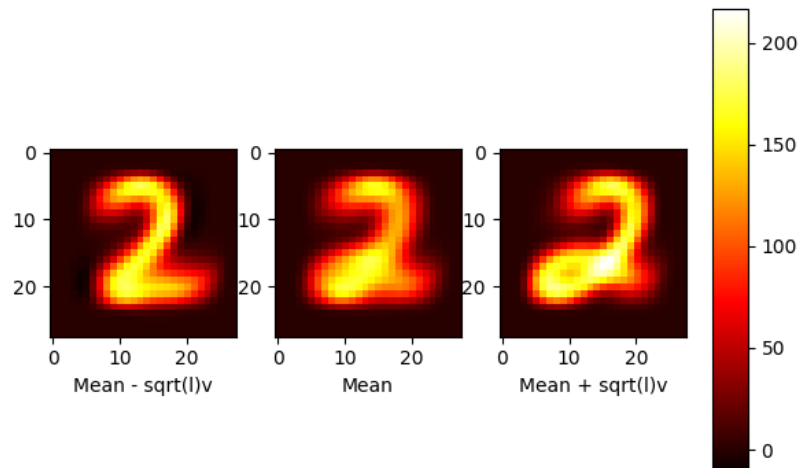


Figure 23: Heatmap (imshow) for digit 2 data.

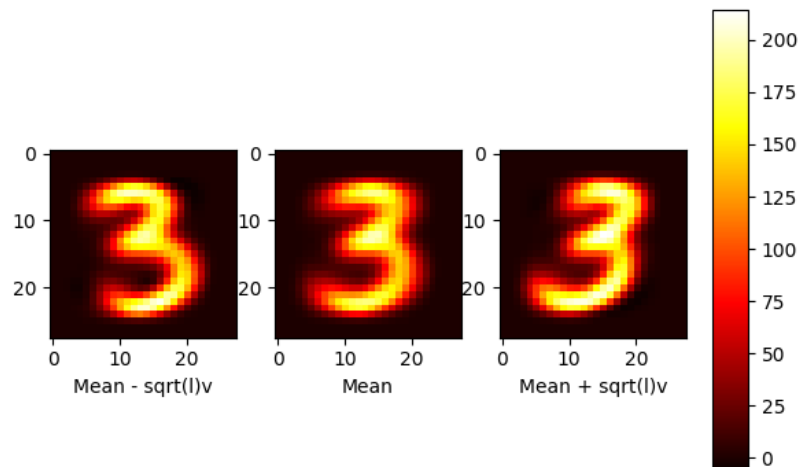


Figure 24: Heatmap (imshow) for digit 3 data.

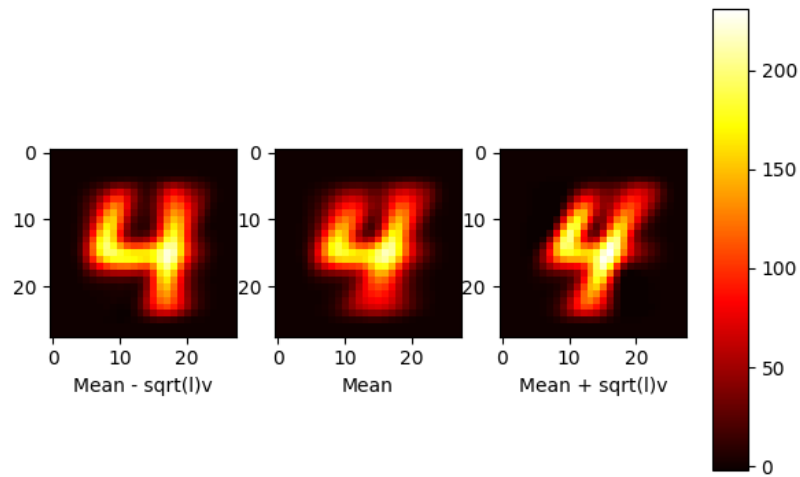


Figure 25: Heatmap (imshow) for digit 4 data.

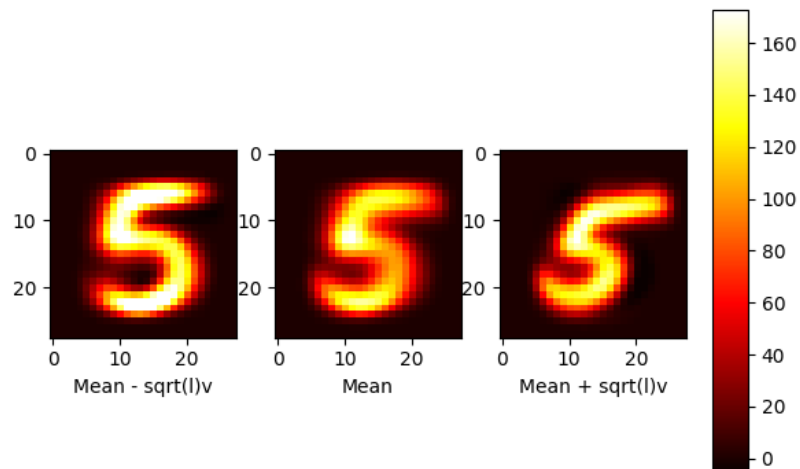


Figure 26: Heatmap (imshow) for digit 5 data.

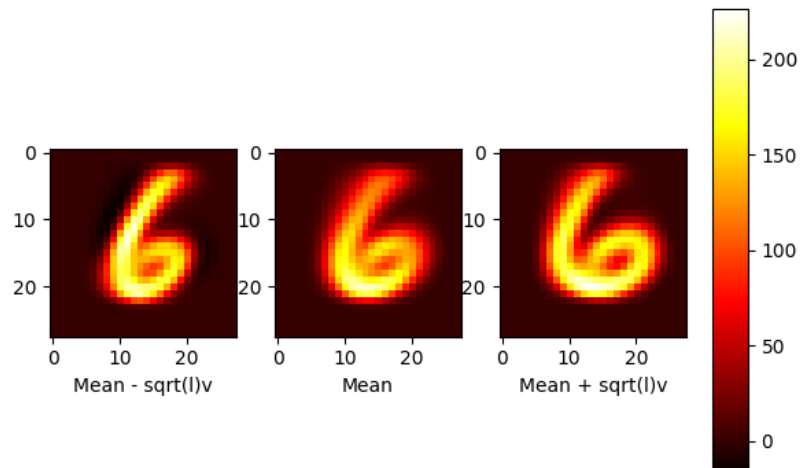


Figure 27: Heatmap (imshow) for digit 6 data.

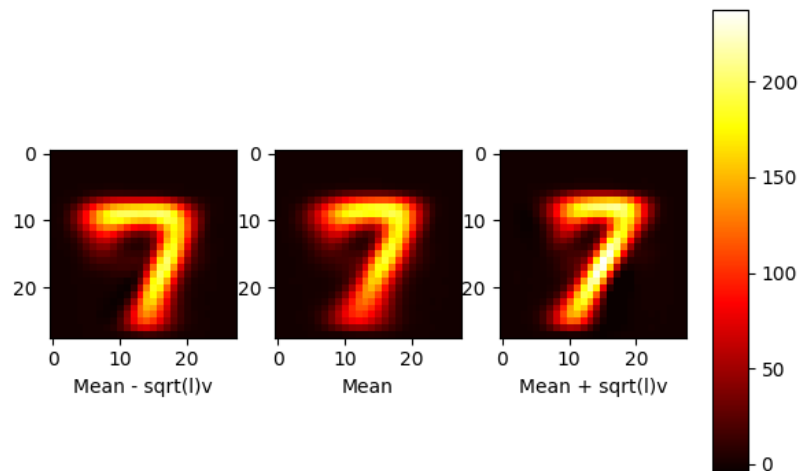


Figure 28: Heatmap (imshow) for digit 7 data.

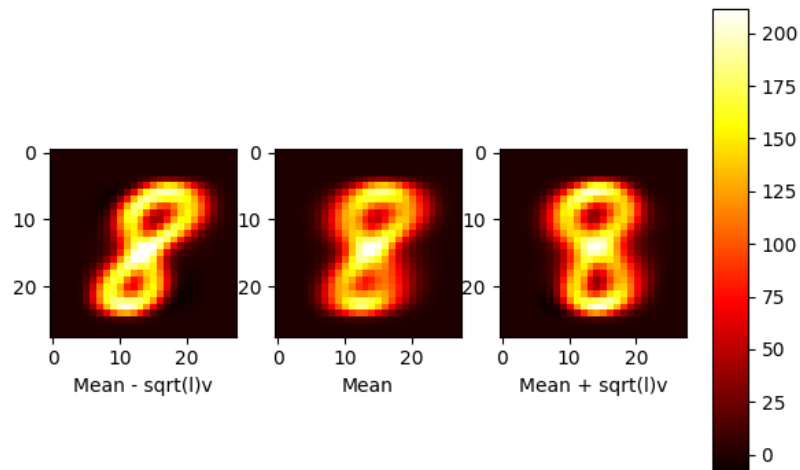


Figure 29: Heatmap (imshow) for digit 8 data.

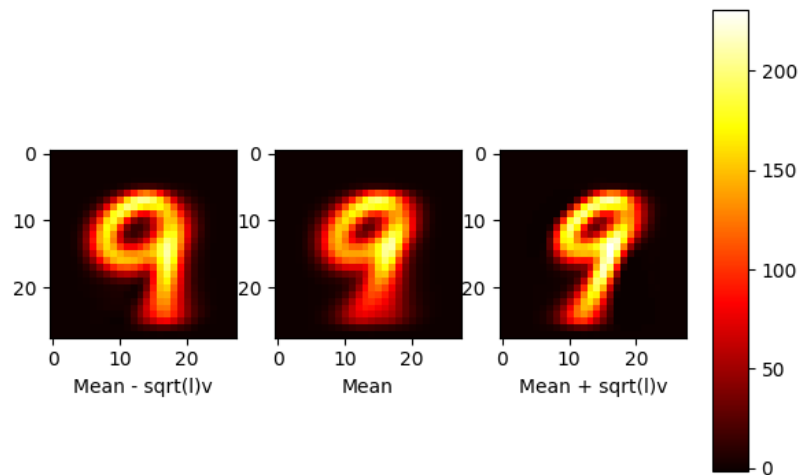


Figure 30: Heatmap (imshow) for digit 9 data.