Tensor Decomposition for Retina Data

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1 Retina Tensor 1

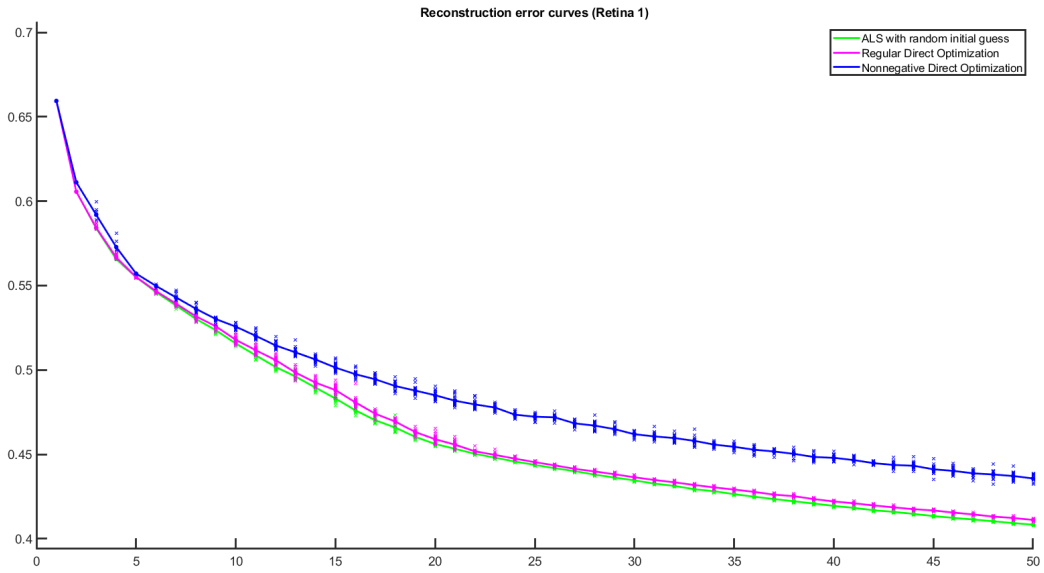

Figure 1: Comparing the reconstruction error of different tensor decomposition methods.

From the plot above, we conclude that the alternating least square method has the lowest error curve for every given number of factors and hence the best performance.

With that, we visualize the first six factors obtained from the alternating least square (ALS) method in Figure 2.

The first row shows the vectorized 2-D PSTH diagram for eight different orientations; the second row shows how neuron responds to the stimuli; the third row shows the bar plot of the specific composition of the input stimuli. For example, in the first column, the bar plot shows that we have the most amount of Stimulus 6 followed by Stimuli 5 and 3. When this is the case, the firing rate of the neuron increases, as indicated by the neuron firing plot. In the 2-D PSTH diagram, each row shows the response of the cell to the visual stimulus (perhaps an edge) in different orientations. We can see in the first column that the cell responds similarly for all orientations but it clearly has a preferred orientation at row 3 (the third orientation used in the experiment). In the last column, the bar plot shows that Stimulus 1 consists of most of the input stimulus. Given only Stimulus 1, the firing rate of the neuron increases, as indicated by the neuron firing plot. In the 2-D PSTH diagram, we see that the cell has a periodic response to this kind of input stimulus. Further, the preferred orientation is the second orientation used in the experiment.

We further compare the above factors obtained from the ALS method with the factors obtained from the the non-negative direct optimization method (Figure 3).

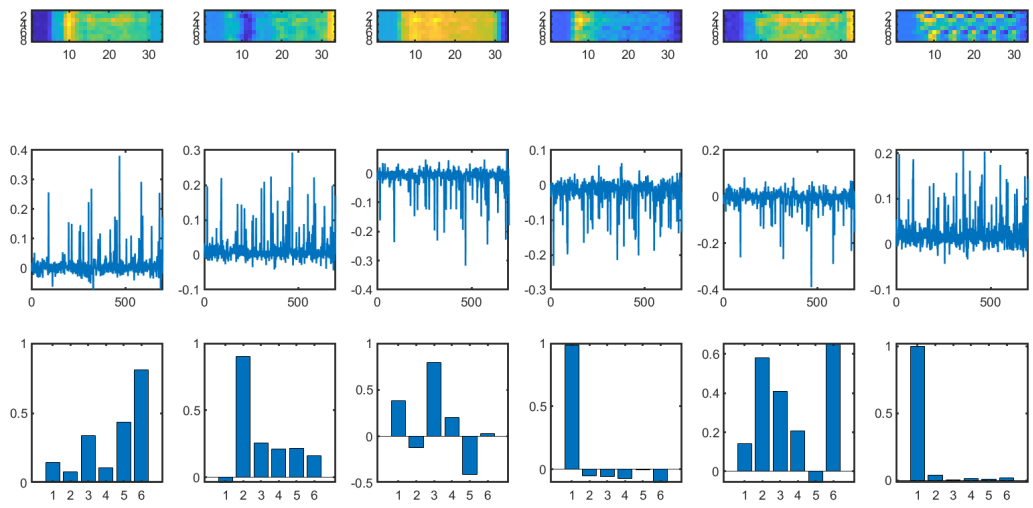

Figure 2: Visualizing the factors obtained from the ALS method.

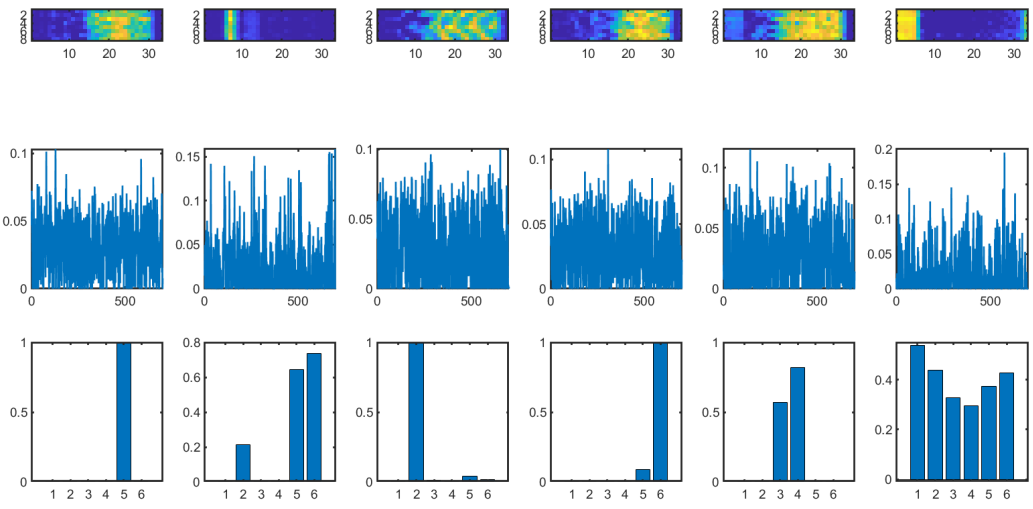

Figure 3: Visualizing the factors obtained from the non-negative non-negative direct optimization.

Interpret the factors in Figure 3.

(i) Factor 1: In response to the input that consists of Stimulus 5, the neurons fire the most at around time 22 and the preferred orientation is the third orientation.

(ii) Factor 2: In response to the input that consists mostly of Stimuli 5 and 6, and to a small proportion Stimulus 2, the neurons fire the most at around time 7 and there is no clear preferred orientation.

(iii) Factor 3: In response to the input that consists mostly of Stimulus 2, the neurons fire periodically at around time 17, 23, 28 and the preferred orientation is the first orientation.

(iv) Factor 4: In response to the input that consists of Stimulus 6, the neurons fire the most from around time 20 to 27 and the third and seventh orientations are preferred.

(v) Factor 5: In response to the input that consists of Stimulus 3 and 4, the neurons fire the most from around time 17 to 29 and the preferred orientation is the third orientation.

(vi) Factor 6: In response to the input that consists of all the stimuli 1 through 6, the neurons fire the most from around time 0 to 5 and there is no clear preferred orientation.

2 Retina Tensor 2

We now repeat the same experiments and analyses to the second retina tensor data.

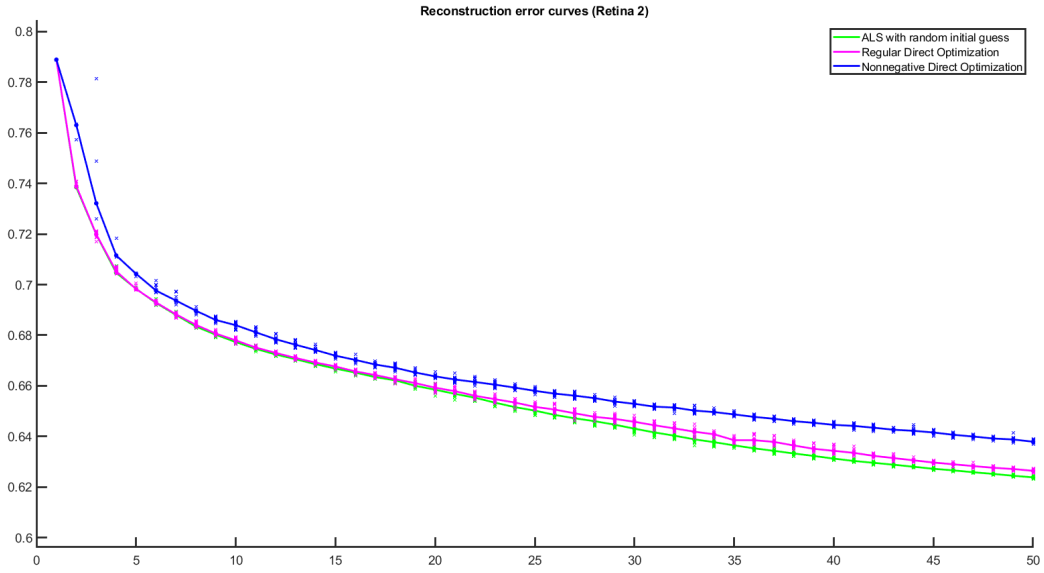

Figure 4: Comparing the reconstruction error of different tensor decomposition methods.

From the plot above, we conclude that the alternating least square method has the lowest error curve for every given number of factors and hence the best performance.

With that, we visualize the first six factors obtained from the ALS method (Figure 5) and compare them with the first six factors obtained from the non-negative direct optimization method (Figure 6).

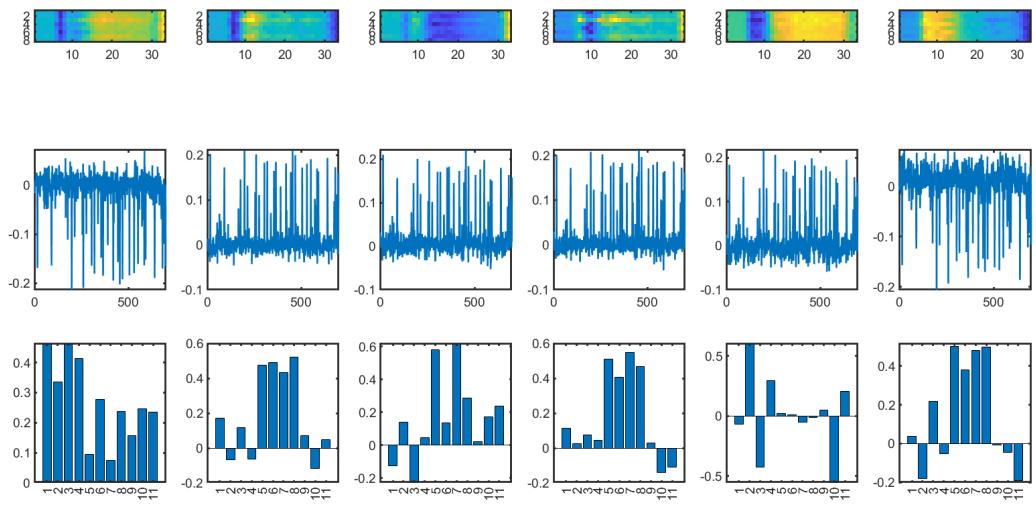

Figure 5: Visualizing the factors obtained from the ALS method.

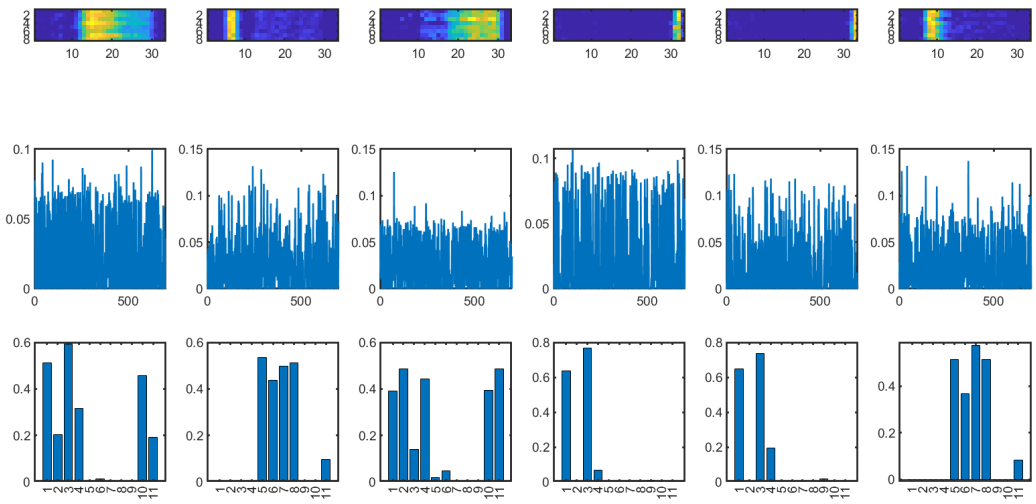

Figure 6: Visualizing the factors obtained from the non-negative direct optimization method.

Interpret the factors in Figure 6.

Assuming that the positions are arranged linearly, i.e., positions 5-8 are considered the "center" and the rest are considered the "surround." Then,

(i) Factor 1: In response to the input stimulus at the "surround," the neurons fire the most from around time 14 to 18 and the fourth and seventh orientations are preferred. This could be an "on-surround" cell.

(ii) Factor 2: In response to the input stimulus at the "center," the neurons fire the most at around time 6 and 7 and the preferred orientation is the sixth orientation. This could be an "off-center" cell since the firing time is very short.

(iii) Factor 3: In response to the input stimulus at the "surround,", the neurons fire from around time 24 to 29 and the preferred orientation is the third orientation. This could be an "on-surround" cell.

(iv) Factor 4: In response to the input stimulus at the "surround" on the left, the neurons fire the most at around time 32 and the first orientation is preferred. This could be an "off-surround" cell since the firing time is very short.

(v) Factor 5:In response to the input stimulus at the "surround" on the left, the neurons fire the most at around time 33 and there is no clear preferred orientation. This could be an "off-surround" cell since the firing time is very short.

(vi) Factor 6: In response to the input stimulus at the "center," the neurons fire the most from around time 8 to 9 and there is no clear preferred orientation. This could be an "on-center" cell.