

## 2IIG0 Homework 3: Question 4

**a**

In the figure below, we show the MSEO against the amount of iterations with the default parameter settings. The X and Y are randomly initialized.

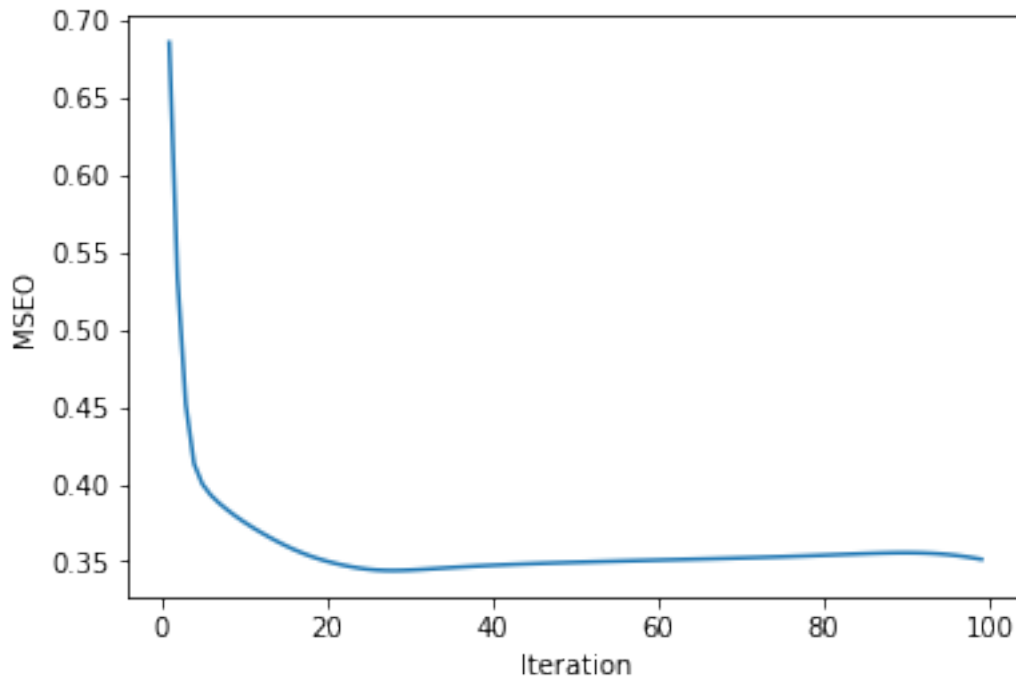


Figure 1: Plot of the iterations  $t$  against the MSEO

**b**

No, the stationary points are no minimizers of the block coordinate objectives, because when we calculate the hessian matrix and the eigenvalues of this matrix, we get positive and negative values. The points are only a minimizer when all the eigenvalues are positive.

**c**

As stopping criteria, we chose to take for the last 10 iterations the difference of the current iteration and the one before that and compute the mean of those 10 deltas. If we have that the value is negative, we choose to stop. With this as topping criteria, we stop after 35 iterations and get a mse0 of 0.346 instead of 0.351 when doing 100 iterations.

d

|    | 0        | 1        | 2        |
|----|----------|----------|----------|
| 0  | 4.213767 | 7.356965 | 3.859027 |
| 1  | 4.556833 | 2.210580 | 4.986626 |
| 2  | 4.196607 | 3.974001 | 4.062656 |
| 3  | 3.958377 | 0.462930 | 3.603375 |
| 4  | 4.453968 | 5.454990 | 3.416146 |
| 5  | 4.970981 | 5.088283 | 3.579911 |
| 6  | 4.231233 | 1.949941 | 4.615811 |
| 7  | 4.412301 | 7.093361 | 4.022278 |
| 8  | 3.676015 | 5.312356 | 3.583026 |
| 9  | 3.915953 | 2.988343 | 3.206072 |
| 10 | 4.874477 | 8.316928 | 3.878649 |
| 11 | 4.564130 | 2.076661 | 3.291876 |
| 12 | 4.063471 | 3.834477 | 4.160747 |
| 13 | 3.526478 | 4.383172 | 2.745898 |
| 14 | 5.010465 | 4.849028 | 3.622651 |
| 15 | 4.735209 | 1.107137 | 4.229757 |
| 16 | 5.036913 | 4.531725 | 5.163541 |
| 17 | 4.815643 | 2.130231 | 5.304252 |

(a) Labda = 1

|    | 0        | 1         | 2        |
|----|----------|-----------|----------|
| 0  | 4.100090 | 15.336882 | 3.871979 |
| 1  | 4.509526 | 2.212074  | 6.336406 |
| 2  | 4.152523 | 3.591927  | 4.085970 |
| 3  | 4.072404 | -1.602987 | 3.577388 |
| 4  | 4.433465 | 11.479607 | 3.679949 |
| 5  | 5.018864 | 5.189833  | 3.873187 |
| 6  | 4.240627 | 1.464406  | 4.986389 |
| 7  | 4.295411 | 9.623888  | 3.553992 |
| 8  | 3.690597 | 8.273712  | 2.657480 |
| 9  | 3.921443 | 3.916336  | 3.202268 |
| 10 | 4.957821 | 12.645088 | 4.019228 |
| 11 | 4.549087 | 0.912637  | 3.267336 |
| 12 | 4.029977 | 4.465554  | 4.016095 |
| 13 | 3.458693 | 7.566767  | 2.292442 |
| 14 | 5.049664 | 4.945067  | 3.814907 |
| 15 | 4.763988 | 0.863180  | 4.705366 |
| 16 | 5.093611 | 4.764395  | 7.447334 |
| 17 | 4.967122 | 2.047027  | 7.264083 |

(c) Labda = 0,1

|    | 0        | 1         | 2        |
|----|----------|-----------|----------|
| 0  | 4.129084 | 9.492447  | 3.892679 |
| 1  | 4.517449 | 2.203379  | 5.572912 |
| 2  | 4.168029 | 3.799058  | 4.046952 |
| 3  | 4.038558 | -0.124133 | 3.579969 |
| 4  | 4.452622 | 6.919775  | 3.567850 |
| 5  | 4.992183 | 5.146188  | 3.647490 |
| 6  | 4.232855 | 1.715294  | 4.797530 |
| 7  | 4.385210 | 8.300070  | 3.816864 |
| 8  | 3.685221 | 6.396653  | 3.201081 |
| 9  | 3.926188 | 3.366742  | 3.210313 |
| 10 | 4.945009 | 9.831408  | 3.926139 |
| 11 | 4.578210 | 1.780166  | 3.271418 |
| 12 | 4.027600 | 4.145972  | 4.098546 |
| 13 | 3.485562 | 5.667488  | 2.561762 |
| 14 | 5.030010 | 4.897846  | 3.662207 |
| 15 | 4.751670 | 0.979411  | 4.461401 |
| 16 | 5.099214 | 4.684279  | 6.123414 |
| 17 | 4.879368 | 2.049398  | 6.088336 |

(b) Labda = 0.5

|    | 0        | 1         | 2        |
|----|----------|-----------|----------|
| 0  | 4.100090 | 15.336882 | 3.871979 |
| 1  | 4.509526 | 2.212074  | 6.336406 |
| 2  | 4.152523 | 3.591927  | 4.085970 |
| 3  | 4.072404 | -1.602987 | 3.577388 |
| 4  | 4.433465 | 11.479607 | 3.679949 |
| 5  | 5.018864 | 5.189833  | 3.873187 |
| 6  | 4.240627 | 1.464406  | 4.986389 |
| 7  | 4.295411 | 9.623888  | 3.553992 |
| 8  | 3.690597 | 8.273712  | 2.657480 |
| 9  | 3.921443 | 3.916336  | 3.202268 |
| 10 | 4.957821 | 12.645088 | 4.019228 |
| 11 | 4.549087 | 0.912637  | 3.267336 |
| 12 | 4.029977 | 4.465554  | 4.016095 |
| 13 | 3.458693 | 7.566767  | 2.292442 |
| 14 | 5.049664 | 4.945067  | 3.814907 |
| 15 | 4.763988 | 0.863180  | 4.705366 |
| 16 | 5.093611 | 4.764395  | 7.447334 |
| 17 | 4.967122 | 2.047027  | 7.264083 |

(d) Labda = 0.0001

The higher the regularizing parameter, the faster the MSEO decreases in the first few iterations. As can be seen in the images above, decreasing the regularizing parameter causes the outliers to get to even higher recommendations. It would be best to choose labda as 1, since this reaches the lowest MSEO the fastest and there are less outliers in the recommendations.