CS 615 - Deep Learning

Assignment 3 - Convolutional Neural Networks
Spring 2020
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1 Theory

1. (2pts) Apply kernel K to data X. In other words, what is $X * K$?:

$$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \; K = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

   Its only valid value at the center: 165

2. Given the feature map filter output, $F = \begin{bmatrix} 1 & 2 & 3 & 4 & 1 & 3 \\ 4 & 5 & 6 & 0 & 0 & 12 \\ 7 & 8 & 9 & 1 & 0 & 4 \\ -100 & -100 & -100 & -100 & -100 & -100 \end{bmatrix}$, what is the output from a pooling layer with width of 2 and stride of 2 if we are using:

   - (3pts) Max-Pooling?
     $P = \begin{bmatrix} 5 & 6 & 12 \\ 8 & 9 & 4 \end{bmatrix}$
   - (3pts) Mean-Pooling?
     $P = \begin{bmatrix} 3 & \frac{13}{4} & 4 \\ -\frac{185}{4} & -\frac{95}{2} & -49 \end{bmatrix}$

3. (2pts) Given an image X, what would the kernel K be that can reproduce the image when convoluted with it? That is, what is K such that $X * K = X$?
   K should be the identity matrix with dimension 1

2 CNN for LSE Classification

What you will need for your report

1. Your hyperparameter choices.

   K is generated randomly with integers from -10 to 10, by seed 2278965

   learning rate: 0.0027

   L2 regularization rate: 0.01

2. Image representations of your initial and final kernels.

Figure 1: Initial K

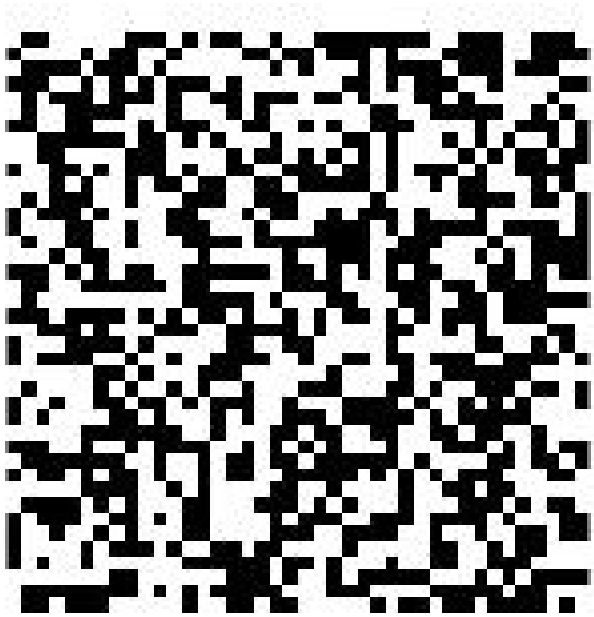

Figure 2: Final K

3. A plot of the RMSE as a function of the number of iterations.

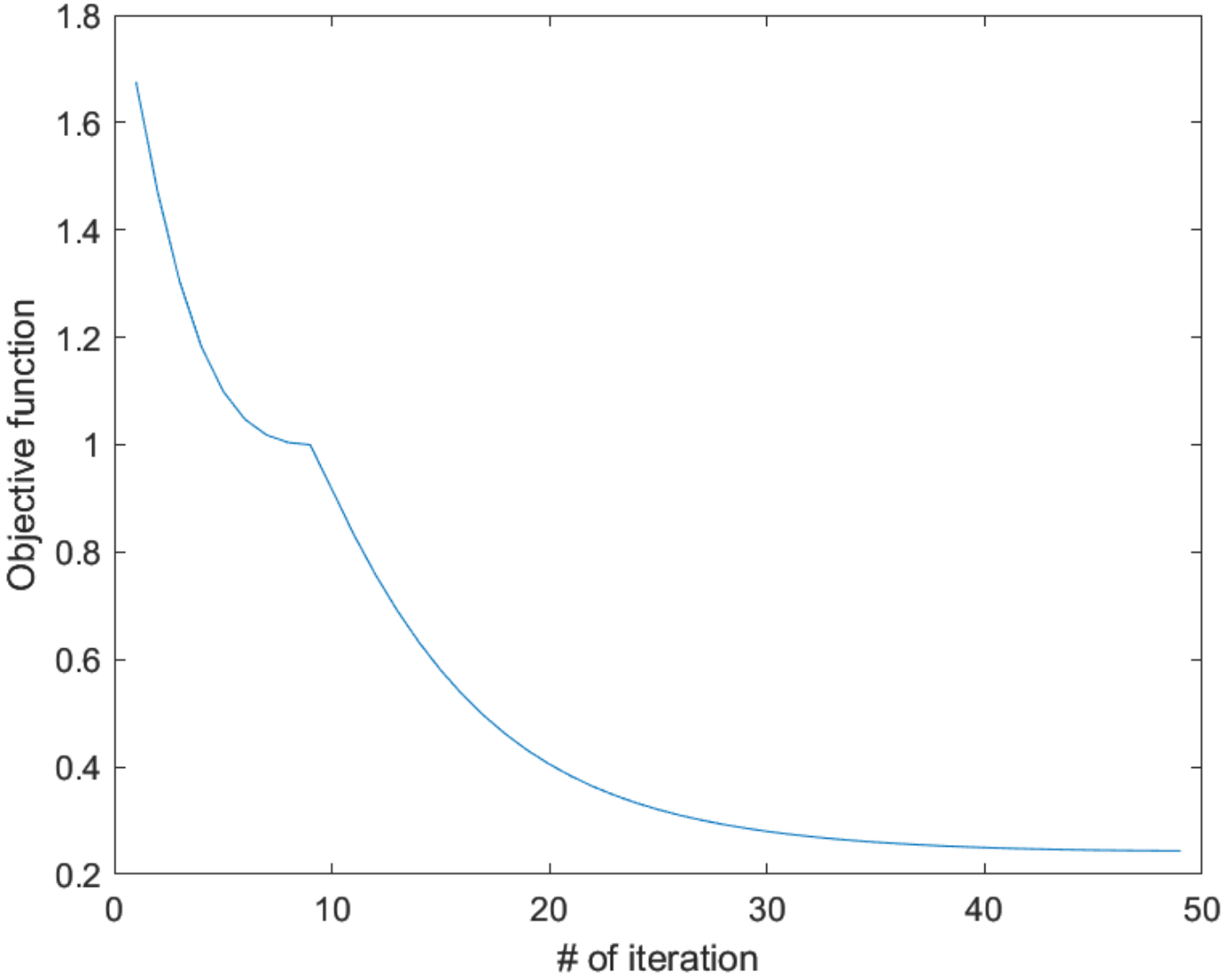

Figure 3: Square error over number of iterations

3 CNN for MLE Classification

1. Your hyperparameter choices.

   K is generated randomly with integers from -10 to 10, by seed 28

   learning rate: 0.0006

   L2 regularization rate: 0.001

2. Image representations of your initial and final kernels.

Figure 4: Initial K

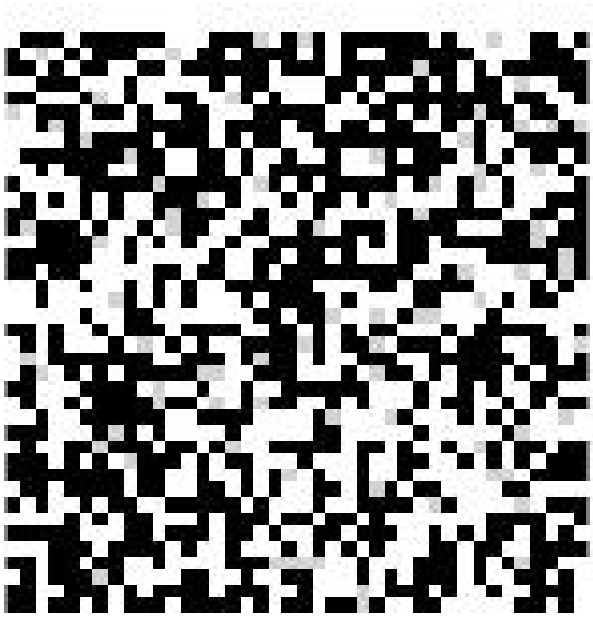

Figure 5: Final K

3. A plot of the RMSE as a function of the number of iterations.

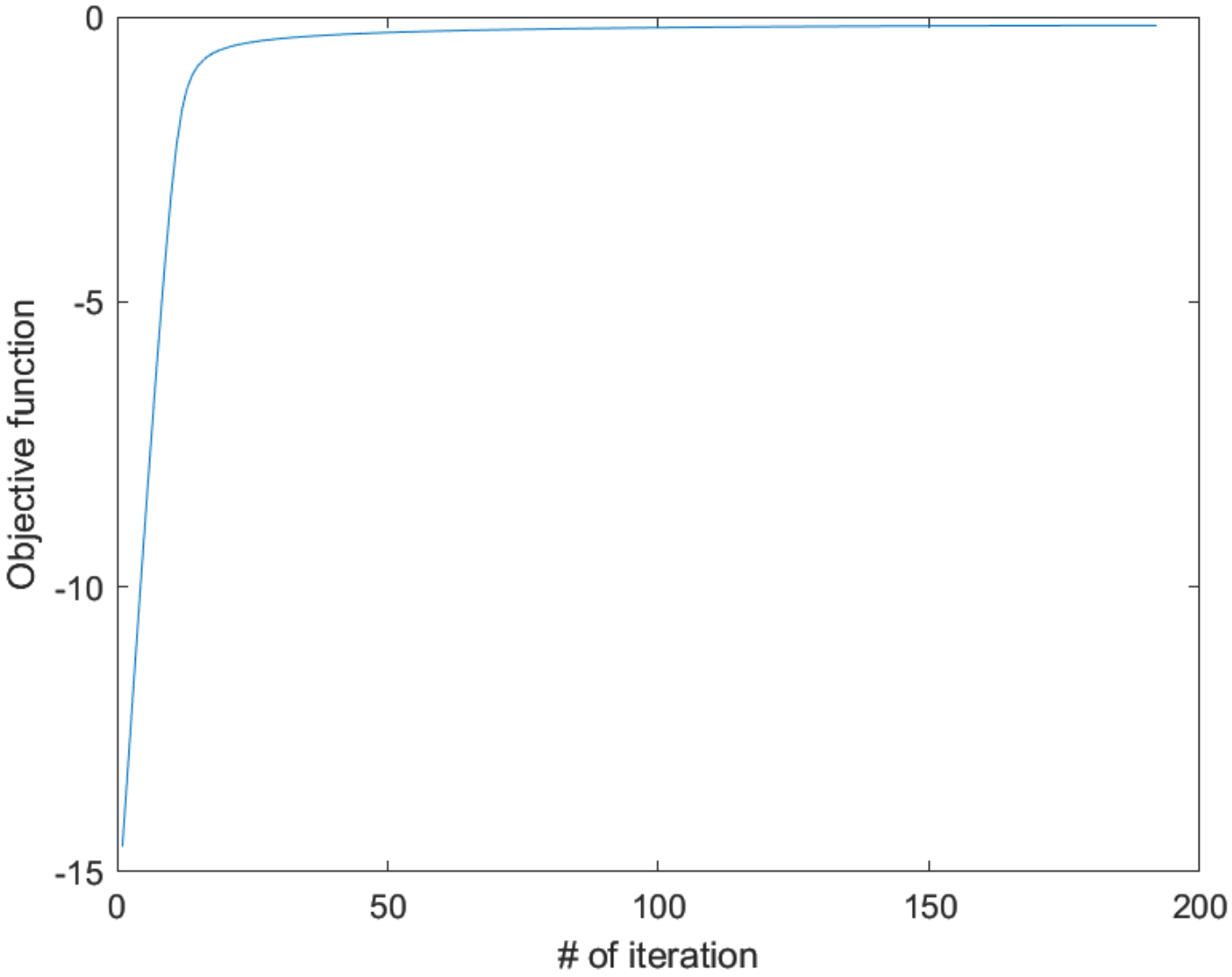

Figure 6: Log likelihood over number of iterations

4 CNN for LCE Classification

1. Your hyperparameter choices.

   K is generated randomly with integers from -10 to 10, by seed 1153

   learning rate: 0.01

   L2 regularization rate: 0.0001

2. Image representations of your initial and final kernels.

Figure 7: Initial K

Figure 8: Final K

3. A plot of the RMSE as a function of the number of iterations.

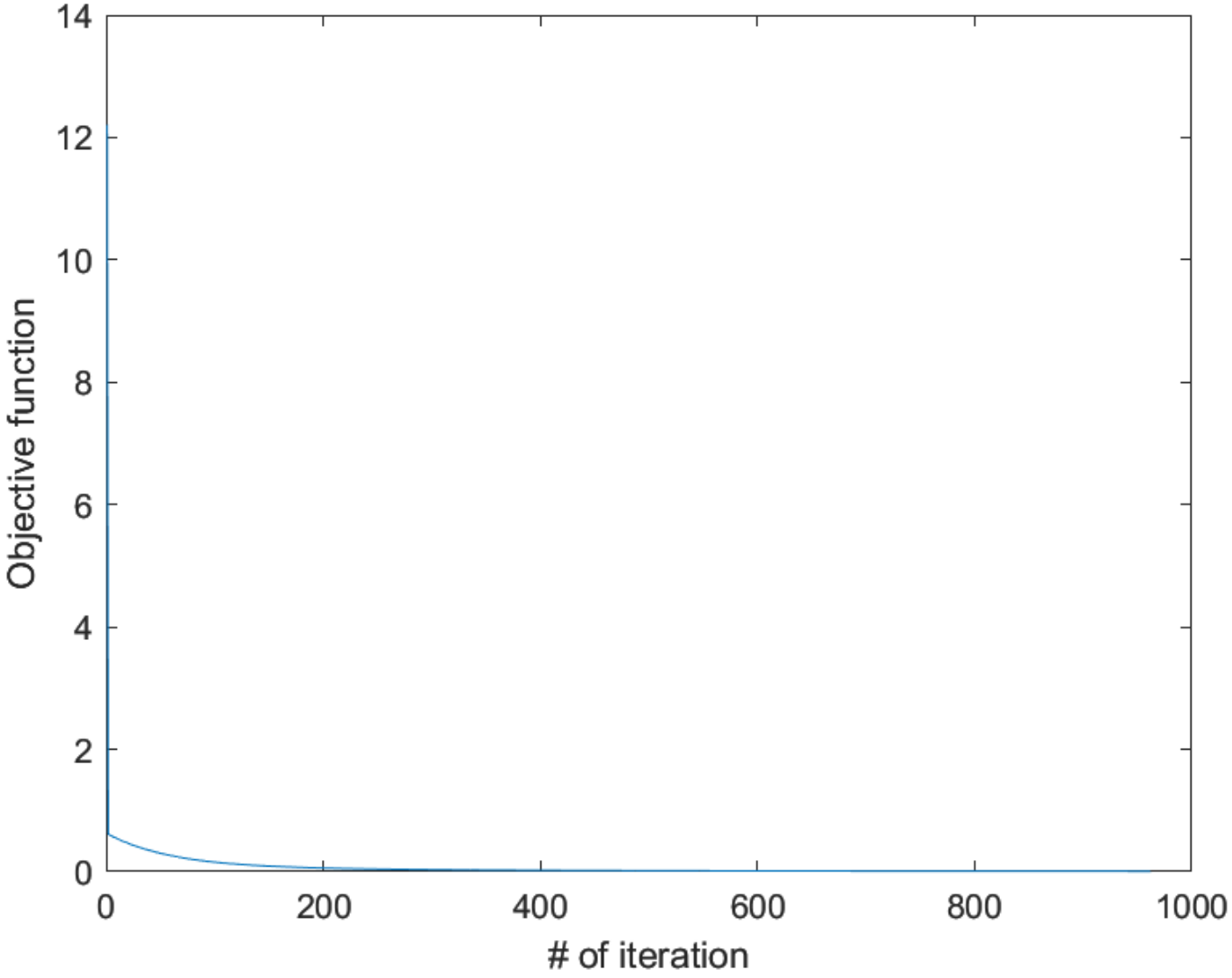

Figure 9: Cross entropy loss over number of iterations

5 CNN With Multiple Kernels

1. Your hyperparameter choices.

   K is generated randomly with integers from -10 to 10, by seed 32

   learning rate: 0.01

   L2 regularization rate: 0

2. Image representations of your initial and final kernels.

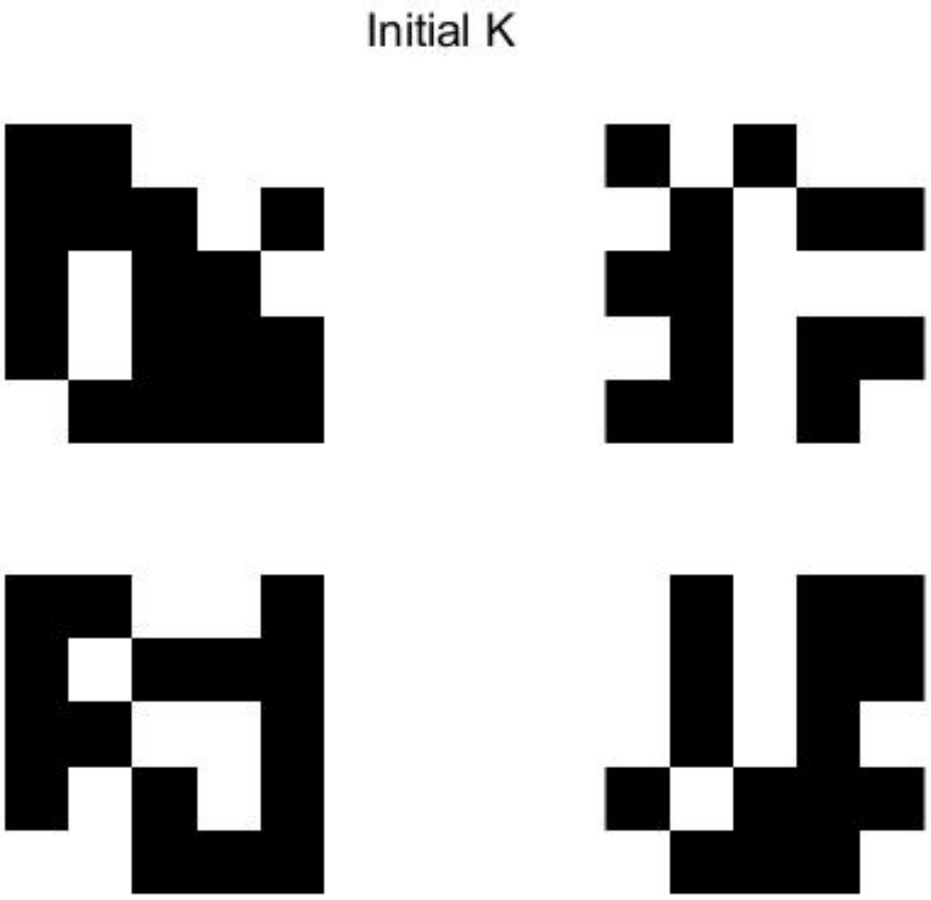

Figure 10: Initial K

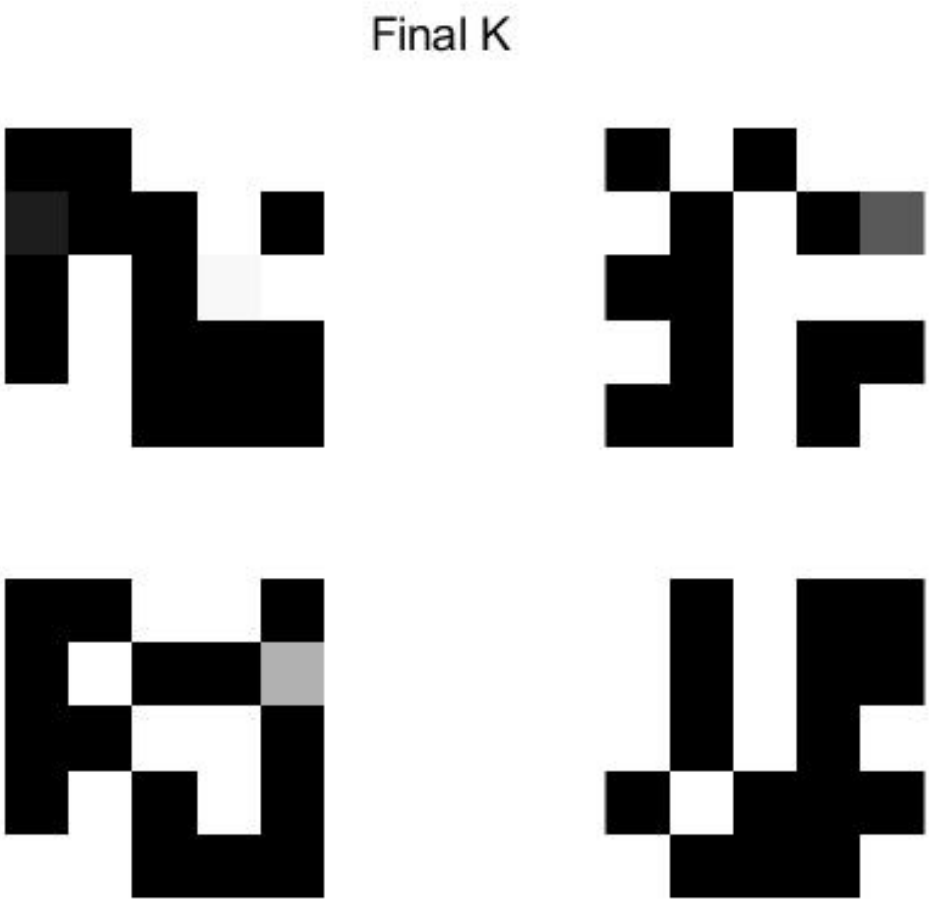

Figure 11: Final K

3. A plot of the RMSE as a function of the number of iterations.

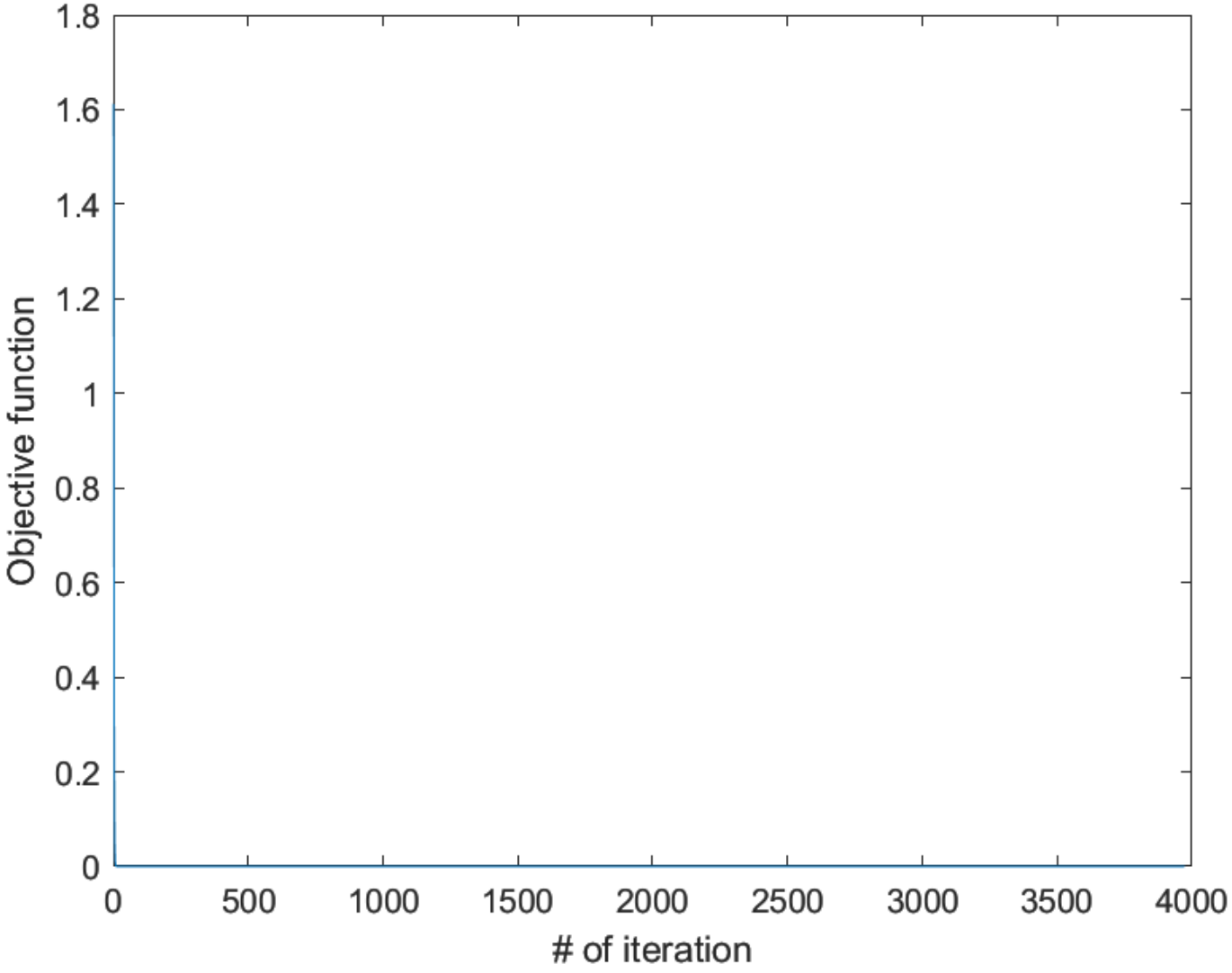

Figure 12: Square error over number of iterations

6 Multi-Kernel CNN For Image Classification

Architecture 1

1. The architecture.

   Activation function: linear

   Objective function: square error

   stride: 2

   Width of kernels: 5

   number of kernels: 4

2. The values of any additional hyperparameters that you chose (outside of the architecture decisions).

   K is generated randomly with integers from -10 to 10, by seed 32

   learning rate: 0.00007

   L2 regularization rate: 0.001

3. Plot of iteration vs objective function evaluation.

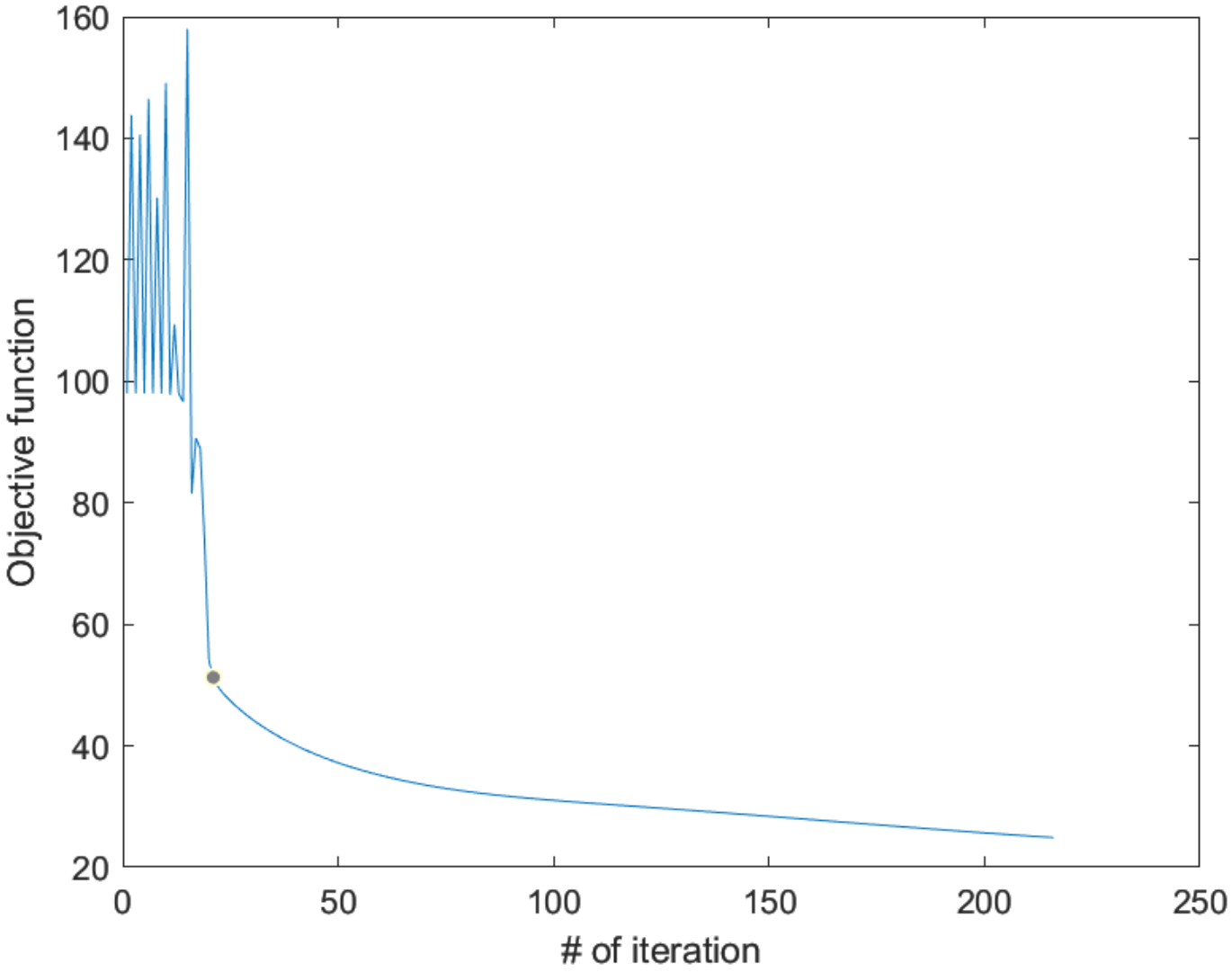

Figure 13: Square error over number of iterations

4. Final training and testing accuracies.
   train accuracy: 1
   trst accuracy: 0.93

Architecture 2

1. The architecture.

   Activation function: logistic

   Objective function: log likelihood

   stride: 2

   Width of kernels: 19

   number of kernels: 9

2. The values of any additional hyperparameters that you chose (outside of the architecture decisions).

K is generated randomly with integers from -10 to 10, by seed 354

learning rate: 3e-7

L2 regularization rate: 0.5

3. Plot of iteration vs objective function evaluation.

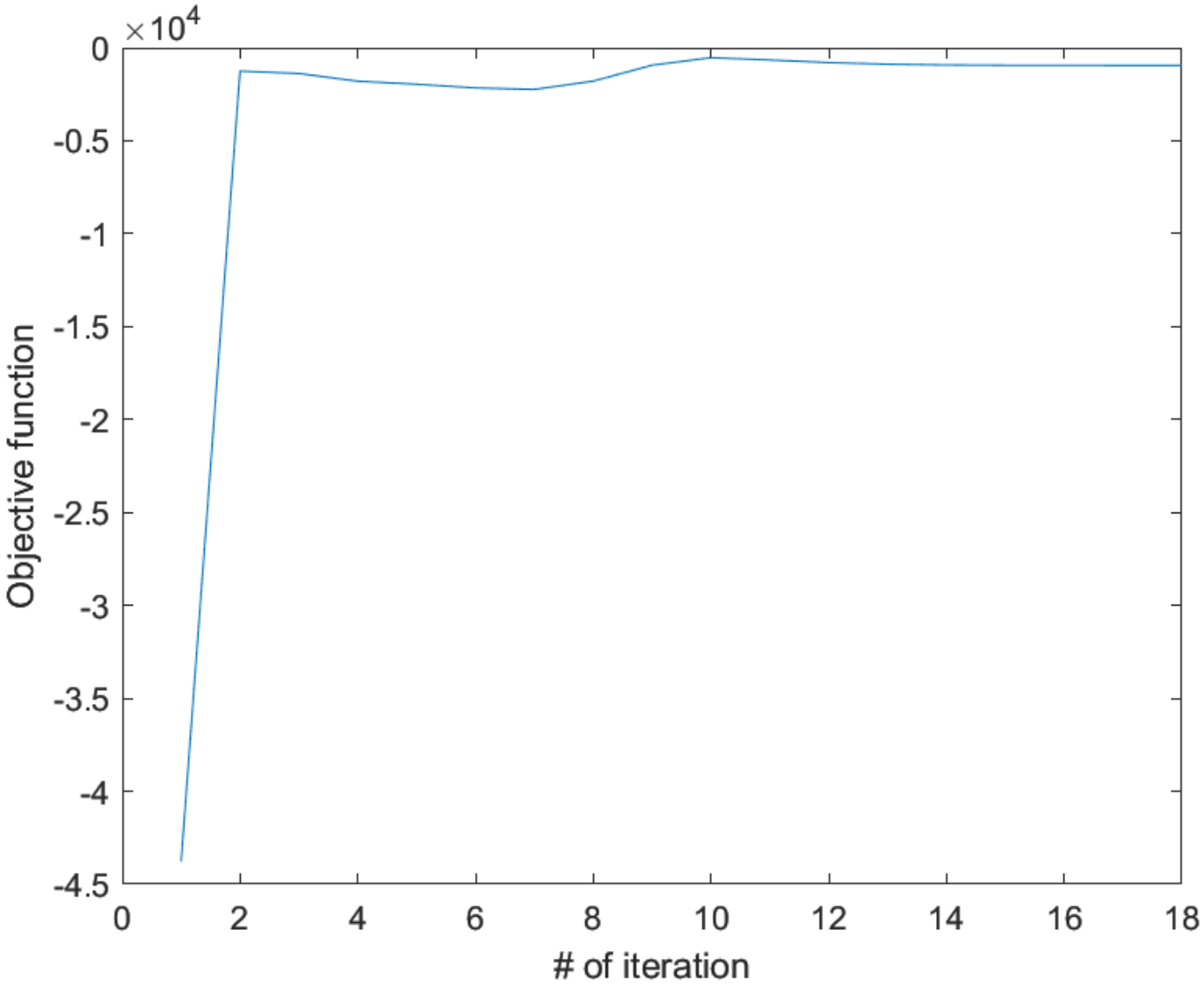

Figure 14: Square error over number of iterations

4. Final training and testing accuracies.
   train accuracy: 0.08
   trst accuracy: 0.07