Algorithm sL-BFGS-TR on Fashion

os = 500 // |J| = 1000

l = 20 //

epoch = 10 //

Load Data

Train and Test (images): 4D double

Train and Test (label): categorical

```
clear
clc
close all
rng default


[XTrain, yTrain, XTest, yTest] = loadData_FashionMnist;
```

```
Read MNIST image data...
Number of images in the dataset:  60000 ...
Each image is of 28 by 28 pixels...
The image data is read to a matrix of dimensions:     28 by   28...
End of reading image data.

Read MNIST label data...
Number of labels in the dataset:  60000 ...
The label data is read to a matrix of dimensions:  60000 by  1...
End of reading label data.

Read MNIST image data...
Number of images in the dataset:  10000 ...
Each image is of 28 by 28 pixels...
The image data is read to a matrix of dimensions:     28 by   28...
End of reading image data.

Read MNIST label data...
Number of labels in the dataset:  10000 ...
The label data is read to a matrix of dimensions:  10000 by  1...
End of reading label data.
```

```
classes                     = categories(yTrain);
numClasses                  = numel(classes);       % 10
input_image_size            = [28 28 1];
num_of_Train_Images         = size(XTrain, 4);
num_of_Test_Images          = size(XTest, 4);
```

One-hot label

```
% One-hot labels:

YTrain = zeros(numClasses, num_of_Train_Images, 'single');
for c  = 2:10
    YTrain( c-1, yTrain == classes(c)) = 1;
end
YTrain( 10, yTrain == classes(1)) = 1;


% One-hot labels:

YTest = zeros(numClasses, num_of_Test_Images, 'single');
for c = 2:10
    YTest( c-1, yTest == classes(c) ) = 1;
end
YTest( 10, yTest == classes(1) ) = 1;
```

Convert Test set from 4D double to 4D / single / dlArray / gpuArray

Since Test set is 10000, we can do here.

```
executionEnvironment = "auto";

XTest   = dlarray(single(XTest),'SSCB');
if (executionEnvironment == "auto" && canUseGPU) || executionEnvironment == "gpu"
    XTest = gpuArray(XTest);
end
```

Architecture of Network

```
lgraph = layerGraph();

tempLayers = [

imageInputLayer(input_image_size, 'Name', 'imageinput', 'Normalization','zscore',...
'Mean', mean(XTrain,4), 'StandardDeviation', std(XTrain, 0, 4))
convolution2dLayer([3 3],16,"Name","conv_1","Padding",[1 1 1 1])
reluLayer("Name","relu_1")];
lgraph = addLayers(lgraph,tempLayers);

% B1:

tempLayers = [
    convolution2dLayer([3 3],16,"Name","conv_2","Padding",[1 1 1 1])
    reluLayer("Name","relu_2")
    convolution2dLayer([3 3],16,"Name","conv_3","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);
```

```
tempLayers = [
    additionLayer(2,"Name","addition_1")
    reluLayer("Name","relu_3")];
lgraph = addLayers(lgraph,tempLayers);


% B2:

tempLayers = [
    convolution2dLayer([3 3],16,"Name","conv_4","Padding",[1 1 1 1])
    reluLayer("Name","relu_4")
    convolution2dLayer([3 3],16,"Name","conv_5","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_2")
    reluLayer("Name","relu_5")];
lgraph = addLayers(lgraph,tempLayers);


% B3:

tempLayers = [
    convolution2dLayer([3 3],16,"Name","conv_6","Padding",[1 1 1 1])
    reluLayer("Name","relu_6")
    convolution2dLayer([3 3],16,"Name","conv_7","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_3")
    reluLayer("Name","relu_7")];
lgraph = addLayers(lgraph,tempLayers);

%==========================================================
%B1:

tempLayers = [
    convolution2dLayer([3 3],32,"Name","conv_8","Padding",[1 1 1 1],"Stride",[2 2])
    reluLayer("Name","relu_8")
    convolution2dLayer([3 3],32,"Name","conv_9","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    convolution2dLayer([1 1],32,"Name","conv_10","Stride",[2 2])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_4")
    reluLayer("Name","relu_9")];
lgraph = addLayers(lgraph,tempLayers);


% B2:
```

```
tempLayers = [
    convolution2dLayer([3 3],32,"Name","conv_11","Padding",[1 1 1 1])

    reluLayer("Name","relu_10")
    convolution2dLayer([3 3],32,"Name","conv_12","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_5")
    reluLayer("Name","relu_11")];
lgraph = addLayers(lgraph,tempLayers);


% B3:

tempLayers = [
    convolution2dLayer([3 3],32,"Name","conv_13","Padding",[1 1 1 1])
    reluLayer("Name","relu_12")
    convolution2dLayer([3 3],32,"Name","conv_14","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_6")
    reluLayer("Name","relu_13")];
lgraph = addLayers(lgraph,tempLayers);

%==========================================================

% B1:

tempLayers = [
    convolution2dLayer([3 3],64,"Name","conv_15","Padding",[1 1 1 1],"Stride",[2 2])

    reluLayer("Name","relu_14")
    convolution2dLayer([3 3],64,"Name","conv_16","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);


tempLayers = [
    convolution2dLayer([1 1],64,"Name","conv_17","Stride",[2 2])];
lgraph = addLayers(lgraph,tempLayers);



tempLayers = [
    additionLayer(2,"Name","addition_7")
    reluLayer("Name","relu_15")];
lgraph = addLayers(lgraph,tempLayers);

% B2:
```

```
tempLayers = [
    convolution2dLayer([3 3],64,"Name","conv_18","Padding",[1 1 1 1])
    reluLayer("Name","relu_16")
    convolution2dLayer([3 3],64,"Name","conv_19","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_8")
    reluLayer("Name","relu_17")];
lgraph = addLayers(lgraph,tempLayers);


% B3:

tempLayers = [
    convolution2dLayer([3 3],64,"Name","conv_20","Padding",[1 1 1 1])
    reluLayer("Name","relu_18")
    convolution2dLayer([3 3],64,"Name","conv_21","Padding",[1 1 1 1])];
lgraph = addLayers(lgraph,tempLayers);

tempLayers = [
    additionLayer(2,"Name","addition_9")
    reluLayer("Name","relu_19")
    globalAveragePooling2dLayer("Name","gapool")
    fullyConnectedLayer(10,"Name","fc")
    softmaxLayer("Name","softmax")];
lgraph = addLayers(lgraph,tempLayers);

% clean up helper variable
clear tempLayers;

lgraph = connectLayers(lgraph,"relu_1","conv_2");
lgraph = connectLayers(lgraph,"relu_1","addition_1/in2");
lgraph = connectLayers(lgraph,"conv_3","addition_1/in1");


lgraph = connectLayers(lgraph,"relu_3","conv_4");
lgraph = connectLayers(lgraph,"relu_3","addition_2/in2");
lgraph = connectLayers(lgraph,"conv_5","addition_2/in1");


lgraph = connectLayers(lgraph,"relu_5","conv_6");
lgraph = connectLayers(lgraph,"relu_5","addition_3/in2");
lgraph = connectLayers(lgraph,"conv_7","addition_3/in1");


lgraph = connectLayers(lgraph,"relu_7","conv_8");
lgraph = connectLayers(lgraph,"relu_7","conv_10");
lgraph = connectLayers(lgraph,"conv_10","addition_4/in2");
lgraph = connectLayers(lgraph,"conv_9","addition_4/in1");


lgraph = connectLayers(lgraph,"relu_9","conv_11");
lgraph = connectLayers(lgraph,"relu_9","addition_5/in2");
```

```
lgraph = connectLayers(lgraph,"conv_12","addition_5/in1");


lgraph = connectLayers(lgraph,"relu_11","conv_13");
lgraph = connectLayers(lgraph,"relu_11","addition_6/in2");
lgraph = connectLayers(lgraph,"conv_14","addition_6/in1");


lgraph = connectLayers(lgraph,"relu_13","conv_17");
lgraph = connectLayers(lgraph,"relu_13","conv_15");
lgraph = connectLayers(lgraph,"conv_16","addition_7/in1");
lgraph = connectLayers(lgraph,"conv_17","addition_7/in2");


lgraph = connectLayers(lgraph,"relu_15","conv_18");
lgraph = connectLayers(lgraph,"relu_15","addition_8/in2");
lgraph = connectLayers(lgraph,"conv_19","addition_8/in1");


lgraph = connectLayers(lgraph,"relu_17","conv_20");
lgraph = connectLayers(lgraph,"relu_17","addition_9/in2");
lgraph = connectLayers(lgraph,"conv_21","addition_9/in1");
```

Creat Network and Initialize

```
dlNet  = dlnetwork(lgraph);

dlNet.Layers
```

```
ans =
  53×1 Layer array with layers:

     1   'imageinput'   Image Input             28×28×1 images with 'zscore' normalization
     2   'conv_1'       Convolution             16 3×3×1 convolutions with stride [1  1] and padding [1  1  1  1]
     3   'relu_1'       ReLU                    ReLU
     4   'conv_2'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
     5   'relu_2'       ReLU                    ReLU
     6   'conv_3'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
     7   'addition_1'   Addition                Element-wise addition of 2 inputs
     8   'relu_3'       ReLU                    ReLU
     9   'conv_4'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
    10   'relu_4'       ReLU                    ReLU
    11   'conv_5'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
    12   'addition_2'   Addition                Element-wise addition of 2 inputs
    13   'relu_5'       ReLU                    ReLU
    14   'conv_6'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
    15   'relu_6'       ReLU                    ReLU
    16   'conv_7'       Convolution             16 3×3×16 convolutions with stride [1  1] and padding [1  1  1  1]
    17   'addition_3'   Addition                Element-wise addition of 2 inputs
    18   'relu_7'       ReLU                    ReLU
    19   'conv_8'       Convolution             32 3×3×16 convolutions with stride [2  2] and padding [1  1  1  1]
    20   'relu_8'       ReLU                    ReLU
    21   'conv_9'       Convolution             32 3×3×32 convolutions with stride [1  1] and padding [1  1  1  1]
    22   'conv_10'      Convolution             32 1×1×16 convolutions with stride [2  2] and padding [0  0  0  0]
    23   'addition_4'   Addition                Element-wise addition of 2 inputs
    24   'relu_9'       ReLU                    ReLU
```

```
25   'conv_11'      Convolution              32 3×3×32 convolutions with stride [1  1] and padding [1  1  1  1]
26   'relu_10'      ReLU                     ReLU
27   'conv_12'      Convolution              32 3×3×32 convolutions with stride [1  1] and padding [1  1  1  1]
28   'addition_5'   Addition                 Element-wise addition of 2 inputs
29   'relu_11'      ReLU                     ReLU
30   'conv_13'      Convolution              32 3×3×32 convolutions with stride [1  1] and padding [1  1  1  1]
31   'relu_12'      ReLU                     ReLU
32   'conv_14'      Convolution              32 3×3×32 convolutions with stride [1  1] and padding [1  1  1  1]
33   'addition_6'   Addition                 Element-wise addition of 2 inputs
34   'relu_13'      ReLU                     ReLU
35   'conv_15'      Convolution              64 3×3×32 convolutions with stride [2  2] and padding [1  1  1  1]
36   'relu_14'      ReLU                     ReLU
37   'conv_16'      Convolution              64 3×3×64 convolutions with stride [1  1] and padding [1  1  1  1]
38   'conv_17'      Convolution              64 1×1×32 convolutions with stride [2  2] and padding [0  0  0  0]
39   'addition_7'   Addition                 Element-wise addition of 2 inputs
40   'relu_15'      ReLU                     ReLU
41   'conv_18'      Convolution              64 3×3×64 convolutions with stride [1  1] and padding [1  1  1  1]
42   'relu_16'      ReLU                     ReLU
43   'conv_19'      Convolution              64 3×3×64 convolutions with stride [1  1] and padding [1  1  1  1]
44   'addition_8'   Addition                 Element-wise addition of 2 inputs
45   'relu_17'      ReLU                     ReLU
46   'conv_20'      Convolution              64 3×3×64 convolutions with stride [1  1] and padding [1  1  1  1]
47   'relu_18'      ReLU                     ReLU
48   'conv_21'      Convolution              64 3×3×64 convolutions with stride [1  1] and padding [1  1  1  1]
49   'addition_9'   Addition                 Element-wise addition of 2 inputs
50   'relu_19'      ReLU                     ReLU
51   'gapool'       Global Average Pooling   Global average pooling
52   'fc'           Fully Connected          10 fully connected layer
53   'softmax'      Softmax                  softmax
```

```
dlNet.Learnables
```

```
ans = 44×3 table
```

	Layer	Parameter	Value
1	"conv_1"	"Weights"	3×3×1×16 ...
2	"conv_1"	"Bias"	1×1×16 ...
3	"conv_2"	"Weights"	3×3×16×16 ...
4	"conv_2"	"Bias"	1×1×16 ...
5	"conv_3"	"Weights"	3×3×16×16 ...
6	"conv_3"	"Bias"	1×1×16 ...
7	"conv_4"	"Weights"	3×3×16×16 ...
8	"conv_4"	"Bias"	1×1×16 ...
9	"conv_5"	"Weights"	3×3×16×16 ...
10	"conv_5"	"Bias"	1×1×16 ...
11	"conv_6"	"Weights"	3×3×16×16 ...
12	"conv_6"	"Bias"	1×1×16 ...
13	"conv_7"	"Weights"	3×3×16×16 ...
14	"conv_7"	"Bias"	1×1×16 ...

⋮

```
dlNet.State
```

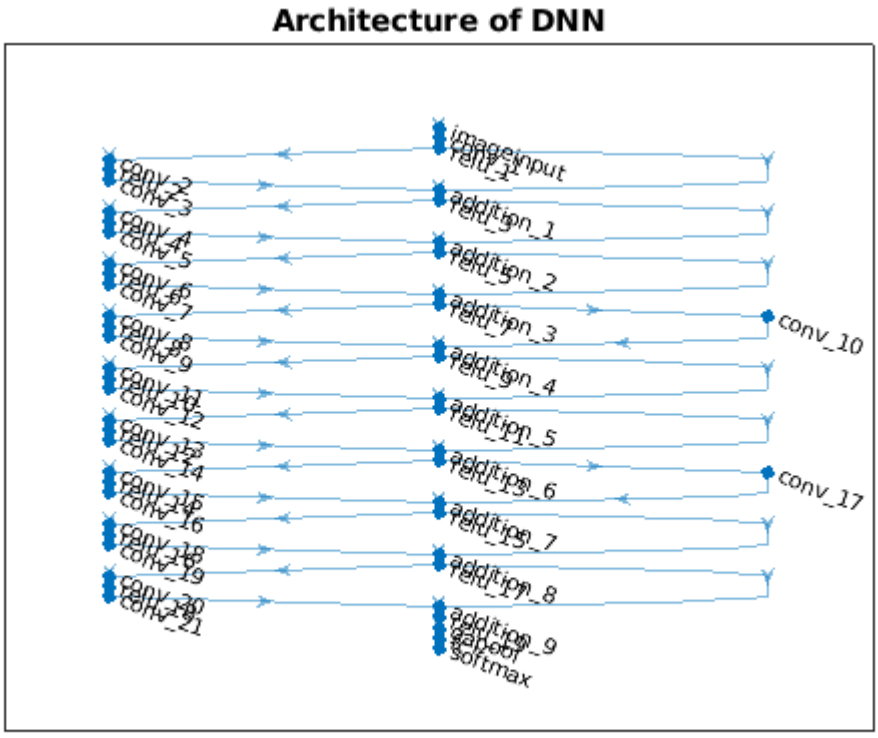
```
ans =

  0×3 empty table
```

```
figure(1),
plot(lgraph),
```

```
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software OpenGL. For more information, click here.
```

```
title("Architecture of DNN")
```




```
[total, detailes] = find_num_parameters(dlNet);
fprintf('\n The number of learnable parameters: '), disp(total)
```

```
 The number of learnable parameters:       271402
```

Training Options

```
global show
show                = 0;

tol                 = 1e-5; % stopping tol
eta                 = 1e-4; % acceptance tol
S                   = [];
Y                   = [];
delta               = 1;
gamma               = 1;

skip_number         = 0;
```

```
k                   = 0;                                % counter of iteration
j                   = 1;

numEpochs           = 10;
lim_m               = 20;

bs                  = 1000;                             % size of batch
Nb                  = floor( num_of_Train_Images /bs ); % number of batches

Jac                 = zeros(total, Nb);                 % storage matrix for reduced memory Jac
N                   = zeros(Nb, bs);                    % storage matrix for indeces of batches
```

Train Network

Convert to SSCB and gpuArray in multi-batch formation

```
fprintf("\n=====================================================================\n")
```

```
=====================================================================
```

```
fprintf("Start Training...")
```

```
Start Training...
```

```
fprintf("\n=====================================================================\n"), start = ti
```

```
=====================================================================
```

```
t0 = tic;
idx      = randperm(num_of_Train_Images);

fprintf('time0: %d \n', toc(t0))
```

```
time0: 7.675000e-03
```

```
fprintf("\n Computing first Jacobian and avarage...\n"), time_Nb_grads = tic;
```

```
 Computing first Jacobian and avarage...
```

```
for iter = 1: Nb
    N(iter, :)                    = idx((iter-1)*bs + 1 : iter*bs);
    X_batch                       = XTrain(:,:,:, N(iter, :) );
    dlX_batch                     = dlarray(single( X_batch ),'SSCB');
    Y_batch                       = YTrain(:, N(iter, :));
    [loss_batch, grad_batch]      = dlfeval(@model_Forward_Backward, dlNet, dlX_batch, Y_batch)

    g_batch                       = layeredVec_2_vec( grad_batch.Value );
    Jac(:,iter)                   = g_batch;
    g_bar                         = mean(Jac,2);
end
fprintf("\n Time: %d \n", toc(time_Nb_grads))
```

```
Time: 3.352694e+02
```

```
%----------------------------> Main loops
for epoch = 1:numEpochs
    fprintf("\n =============> Shuffeling of batches for gradient ...\n")

    idx_Nb = randperm(Nb);
    for iter = 1: Nb

        t1 = tic;
        fprintf('\n =============> Iteration k : %d \n', k)

        batch_iter                = idx_Nb(iter)
        X_batch                   = XTrain(:,:,:, N(batch_iter,:));
        dlX_batch                 = dlarray(single(X_batch),'SSCB');
        Y_batch                   = YTrain(:, N(batch_iter,:));

        [loss, grad, acc]         = dlfeval(@model_Forward_Backward, dlNet, dlX_batch, Y_ba

        f                         = double(gather(extractdata( loss )));
        g                         = layeredVec_2_vec( grad.Value );

        %----------------------------> SAGA Computation

        aux                       = g - Jac(:, batch_iter);
        g_saga                    = g_bar + aux;
        g_bar                     = g_bar + aux/Nb;
        Jac(:, batch_iter)        = g;

        fprintf('time1: %d \n', toc(t1))
        %----------------------------> Exit condition:

        llg_sagall                = norm(g_saga);

        if llg_sagall < tol || acc >= 100
            fprintf('\n ====> Training Stopped! \n')
        end

        %----------------------------> Solve: TR subproblem
        t2 = tic;
```

```
if k == 0 || size(S,2) == 0
    p                   = -delta*(g_saga/llg_sagall);
    llpll               = norm(p);
    Bp                  = gamma*p;                % B0*p
    Q_p                 = p'*(g_saga + 0.5*Bp);  % Q(p) = p'*g_saga + 1/2 p'*B0*p

else

    p                   = TRsubproblem_solver_OBS(delta, gamma, g_saga, Psi, Minv);
    llpll               = norm(p);
    Bp                  = gamma*p + Psi*(Minv\(Psi'*p));        % Bk*p
    Q_p                 = p'*(g_saga + 0.5*Bp);                 % Q(p) = p'*g * 1/2 p'*
end

fprintf('time2: %d \n', toc(t2))
%----------------------------> Trial parameter
t3 = tic;

dlDir           = vec_2_layeredVec(dlNet, p);    % p (vector direction) ==> dlDir (dl
dlNet_trial     = update_dlNet(dlNet, dlDir);    % dlNet_trial = dlNet + dlDir

fprintf('time3: %d \n', toc(t3))
%----------------------------> Computation at trial parameter

t4 = tic;

[loss_t, grad_t]      = dlfeval(@ model_Forward_Backward, dlNet_trial, dlX_batch, Y_bat
f_t                   = double(gather(extractdata( loss_t )));
g_t                   = layeredVec_2_vec( grad_t.Value );


fprintf('time4: %d \n', toc(t4))

t5 = tic;
%----------------------------> Compute: Rho

rho             = ( f_t - f ) / Q_p;

%----------------------------> Update: Acceptance Step

if rho > eta
    dlNet       = dlNet_trial;
else
    skip_number = skip_number + 1;
end


%----------------------------> Evaluate Network


dlNet_optimal   = dlNet;

YPred           = predict(dlNet_optimal, XTest);
```

```
loss_test       = crossentropy(YPred, YTest);
f_test          = double(gather(extractdata(loss_test)));
[~,idx_pred]    = max( (extractdata(YPred)), [], 1 );
[~,idx_true]    = max(YTest, [], 1);
acc_test        = mean(idx_pred == idx_true)*100;


%----------------------------> Update: TR Radius

if rho >= 0.75
   delta_new = ( delta + 4*delta )/2;

elseif (0.25 < rho && rho < 0.75)
    delta_new = ( 0.25*delta + 4*delta )/2;
else
    delta_new = ( 0.25*min(llpll, delta) + 0.5*delta )/2;
end
delta  = delta_new;


%----------------------------> Update Bk = gamma*I + psi*M*Psi

% -- s, y:
s                          = p;
y                          = g_t - g;
y                          = y + (1/Nb - 1)*aux;

% -- updating condition:

sty    = s'*y;
if sty > 1e-2*llpll^2

    %-- S, Y:
    S = [S, s];
    Y = [Y, y];

    if ( size(S,2) > lim_m )
        S  = S(:, 2:end);
        Y  = Y(:, 2:end);
    end

    if size(S,2) == 0,  warning('S is empty!'), end
    while ( size(S, 2) > 0 )
        %-- gamma, Minv, Psi:
        SY      = S'*Y;
        SS      = S'*S;

        Lt = tril(SY,-1)';
        LD = tril(SY);
        LDLt    = LD +  Lt;

        eig_val       = eig(LDLt,SS);
        lambdaHat_min = min(eig_val);
```

```
                if lambdaHat_min > 0
                    gamma = max( 0.5*lambdaHat_min, 1);
                else
                    gamma = max( 1, (y'*y)/sty );  %%% add new command
                end


                minv{1,1} = -gamma*SS;
                minv{1,2} = -Lt';
                minv{2,1} = -Lt;
                minv{2,2} = diag(diag(SY));


                Minv      = cell2mat(minv);
                Psi       = [gamma*S, Y];


                if  size(Psi,2) == rank(Psi) && rank(Minv)==size(Minv,2) %if  min(eig(Psi'*Psi)
                    break
                else
                    fprintf('\n Psi is NOT full column rank! or M is Not invertable!\n')
                    S  = S(:, 2:end);
                    Y  = Y(:, 2:end);
                end
            end % while
        end % condition

        fprintf('time5: %d \n', toc(t5))


        Time_(k+1,1)    = toc(start);
        F_(k+1, 1)      = f;
        Acc_(k+1, 1)    = acc;
        F_t(k+1, 1)     = f_test;
        Acc_t(k+1, 1)   = acc_test;
        llGll(k+1, 1)   = llg_sagall;
        Delta(k+1,1)    = delta;
        Rho(k+1, 1)     = rho;


        k = k + 1;
    end

end % epoch
```

```
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 0
batch_iter = 57
time1: 5.488937e+00
time2: 2.157600e-02
time3: 1.136219e+00
time4: 6.557189e+00
time5: 1.736240e+01
 =============> Iteration k : 1
batch_iter = 45
time1: 4.751270e+00
```

```
time2: 1.208800e-01
time3: 8.438230e-01
time4: 6.214947e+00
time5: 1.798882e+01
 =============> Iteration k : 2
batch_iter = 3
time1: 5.175879e+00
time2: 5.238600e-02
time3: 9.340250e-01
time4: 6.433624e+00
time5: 1.799185e+01
 =============> Iteration k : 3
batch_iter = 14
time1: 5.285458e+00
time2: 1.152830e-01
time3: 8.775530e-01
time4: 5.406398e+00
time5: 1.694762e+01
 =============> Iteration k : 4
batch_iter = 17
time1: 5.820234e+00
time2: 1.900560e-01
time3: 7.242560e-01
time4: 6.187086e+00
time5: 1.665713e+01
 =============> Iteration k : 5
batch_iter = 33
time1: 5.798348e+00
time2: 1.794690e-01
time3: 8.115660e-01
time4: 6.006502e+00
time5: 1.658908e+01
 =============> Iteration k : 6
batch_iter = 27
time1: 5.395323e+00
time2: 2.751780e-01
time3: 1.035399e+00
time4: 6.032156e+00
time5: 1.632768e+01
 =============> Iteration k : 7
batch_iter = 44
time1: 5.533976e+00
time2: 1.250550e-01
time3: 7.154470e-01
time4: 6.059253e+00
time5: 1.718382e+01
 =============> Iteration k : 8
batch_iter = 59
time1: 5.812838e+00
time2: 1.725870e-01
time3: 7.487030e-01
time4: 6.382363e+00
time5: 1.700874e+01
 =============> Iteration k : 9
batch_iter = 18
time1: 5.088327e+00
time2: 2.389570e-01
time3: 6.849360e-01
time4: 5.704913e+00
time5: 1.852315e+01
 =============> Iteration k : 10
batch_iter = 41
time1: 5.216746e+00
time2: 2.809470e-01
```

```
time3: 6.730210e-01
time4: 5.484714e+00
time5: 1.752783e+01
 =============> Iteration k : 11
batch_iter = 19
time1: 5.809989e+00
time2: 4.976750e-01
time3: 5.302600e-01
time4: 5.264042e+00
time5: 1.756392e+01
 =============> Iteration k : 12
batch_iter = 22
time1: 6.116234e+00
time2: 5.655480e-01
time3: 5.449710e-01
time4: 5.203202e+00
time5: 1.836661e+01
 =============> Iteration k : 13
batch_iter = 10
time1: 6.211028e+00
time2: 6.066740e-01
time3: 8.449830e-01
time4: 5.448925e+00
time5: 1.733996e+01
 =============> Iteration k : 14
batch_iter = 39
time1: 5.810049e+00
time2: 8.444380e-01
time3: 9.722790e-01
time4: 5.135063e+00
time5: 1.650166e+01
 =============> Iteration k : 15
batch_iter = 46
time1: 6.035706e+00
time2: 1.105806e+00
time3: 1.119444e+00
time4: 5.669436e+00
time5: 1.752840e+01
 =============> Iteration k : 16
batch_iter = 2
time1: 6.188101e+00
time2: 1.072005e+00
time3: 7.012090e-01
time4: 5.643051e+00
time5: 1.725201e+01
 =============> Iteration k : 17
batch_iter = 23
time1: 5.503179e+00
time2: 5.595920e-01
time3: 9.003410e-01
time4: 6.395908e+00
time5: 1.700781e+01
 =============> Iteration k : 18
batch_iter = 48
time1: 5.779840e+00
time2: 4.309280e-01
time3: 5.580370e-01
time4: 6.286418e+00
time5: 1.811861e+01
 =============> Iteration k : 19
batch_iter = 30
time1: 5.286579e+00
time2: 6.028870e-01
time3: 9.638960e-01
```

```
time4: 5.796936e+00
time5: 1.780011e+01
 =============> Iteration k : 20
batch_iter = 6
time1: 5.163234e+00
time2: 8.000210e-01
time3: 8.378200e-01
time4: 6.087520e+00
time5: 1.768012e+01
 =============> Iteration k : 21
batch_iter = 56
time1: 5.178280e+00
time2: 5.385000e-01
time3: 7.516340e-01
time4: 5.850755e+00
time5: 1.842408e+01
 =============> Iteration k : 22
batch_iter = 9
time1: 5.220287e+00
time2: 6.848560e-01
time3: 9.901650e-01
time4: 5.786933e+00
time5: 1.840799e+01
 =============> Iteration k : 23
batch_iter = 36
time1: 5.556644e+00
time2: 8.910820e-01
time3: 8.253820e-01
time4: 5.662998e+00
time5: 1.851946e+01
 =============> Iteration k : 24
batch_iter = 35
time1: 5.371240e+00
time2: 6.341440e-01
time3: 7.622310e-01
time4: 5.837121e+00
time5: 1.825207e+01
 =============> Iteration k : 25
batch_iter = 47
time1: 5.629570e+00
time2: 1.076777e+00
time3: 1.000075e+00
time4: 5.883426e+00
time5: 1.780232e+01
 =============> Iteration k : 26
batch_iter = 49
time1: 5.828993e+00
time2: 6.926310e-01
time3: 8.812850e-01
time4: 5.766477e+00
time5: 1.721459e+01
 =============> Iteration k : 27
batch_iter = 31
time1: 5.862435e+00
time2: 8.253090e-01
time3: 1.077738e+00
time4: 6.395902e+00
time5: 1.712988e+01
 =============> Iteration k : 28
batch_iter = 26
time1: 5.490971e+00
time2: 1.093465e+00
time3: 9.426160e-01
time4: 6.426528e+00
```

```
time5: 1.697272e+01
 =============> Iteration k : 29
batch_iter = 32
time1: 5.122512e+00
time2: 8.496900e-01
time3: 9.142570e-01
time4: 6.208286e+00
time5: 1.686322e+01
 =============> Iteration k : 30
batch_iter = 11
time1: 5.262945e+00
time2: 7.249150e-01
time3: 6.253050e-01
time4: 6.269099e+00
time5: 1.846851e+01
 =============> Iteration k : 31
batch_iter = 50
time1: 4.813369e+00
time2: 6.999230e-01
time3: 9.714200e-01
time4: 6.137208e+00
time5: 1.784548e+01
 =============> Iteration k : 32
batch_iter = 13
time1: 4.677575e+00
time2: 7.115220e-01
time3: 9.909530e-01
time4: 5.910002e+00
time5: 1.856558e+01
 =============> Iteration k : 33
batch_iter = 25
time1: 4.917309e+00
time2: 6.157770e-01
time3: 6.409040e-01
time4: 5.703510e+00
time5: 1.801597e+01
 =============> Iteration k : 34
batch_iter = 58
time1: 5.469937e+00
time2: 6.275020e-01
time3: 7.625150e-01
time4: 5.617436e+00
time5: 1.777783e+01
 =============> Iteration k : 35
batch_iter = 28
time1: 5.491058e+00
time2: 7.174750e-01
time3: 7.390660e-01
time4: 5.632559e+00
time5: 1.856931e+01
 =============> Iteration k : 36
batch_iter = 53
time1: 5.405519e+00
time2: 8.745540e-01
time3: 9.355130e-01
time4: 5.700806e+00
time5: 1.815185e+01
 =============> Iteration k : 37
batch_iter = 24
time1: 5.802667e+00
time2: 8.875260e-01
time3: 9.164760e-01
time4: 6.198622e+00
time5: 1.739651e+01
```

```
 =============> Iteration k : 38
batch_iter = 1
time1: 6.050029e+00
time2: 1.238634e+00
time3: 1.069735e+00
time4: 6.333830e+00
time5: 1.685887e+01
 =============> Iteration k : 39
batch_iter = 42
time1: 5.993867e+00
time2: 8.831990e-01
time3: 1.087854e+00
time4: 6.546411e+00
time5: 1.630280e+01
 =============> Iteration k : 40
batch_iter = 52
time1: 6.211559e+00
time2: 1.013213e+00
time3: 9.593160e-01
time4: 6.333163e+00
time5: 1.596691e+01
 =============> Iteration k : 41
batch_iter = 40
time1: 6.103190e+00
time2: 1.000791e+00
time3: 1.216220e+00
time4: 6.352908e+00
time5: 1.571846e+01
 =============> Iteration k : 42
batch_iter = 43
time1: 5.820689e+00
time2: 7.937640e-01
time3: 1.027666e+00
time4: 6.195006e+00
time5: 1.618286e+01
 =============> Iteration k : 43
batch_iter = 12
time1: 6.072488e+00
time2: 9.817110e-01
time3: 1.018511e+00
time4: 6.274507e+00
time5: 1.721771e+01
 =============> Iteration k : 44
batch_iter = 55
time1: 5.497232e+00
time2: 8.613510e-01
time3: 1.051318e+00
time4: 6.129975e+00
time5: 1.729045e+01
 =============> Iteration k : 45
batch_iter = 16
time1: 5.687202e+00
time2: 9.265040e-01
time3: 9.517750e-01
time4: 6.159282e+00
time5: 1.663258e+01
 =============> Iteration k : 46
batch_iter = 15
time1: 5.790036e+00
time2: 4.409830e-01
time3: 9.616370e-01
time4: 5.875523e+00
time5: 1.811156e+01
 =============> Iteration k : 47
```

```
batch_iter = 4
time1: 6.153454e+00
time2: 7.967830e-01
time3: 8.133040e-01
time4: 5.205954e+00
time5: 1.690515e+01
 ==============> Iteration k : 48
batch_iter = 29
time1: 6.373401e+00
time2: 7.956180e-01
time3: 9.960260e-01
time4: 5.621718e+00
time5: 1.706187e+01
 ==============> Iteration k : 49
batch_iter = 20
time1: 6.700166e+00
time2: 1.275363e+00
time3: 9.892670e-01
time4: 5.804218e+00
time5: 1.638912e+01
 ==============> Iteration k : 50
batch_iter = 54
time1: 6.206573e+00
time2: 8.009470e-01
time3: 1.111806e+00
time4: 5.854912e+00
time5: 1.680860e+01
 ==============> Iteration k : 51
batch_iter = 60
time1: 6.188821e+00
time2: 8.972750e-01
time3: 1.106464e+00
time4: 5.778932e+00
time5: 1.609152e+01
 ==============> Iteration k : 52
batch_iter = 7
time1: 6.579010e+00
time2: 1.198619e+00
time3: 9.945580e-01
time4: 6.489709e+00
time5: 1.601768e+01
 ==============> Iteration k : 53
batch_iter = 34
time1: 6.336952e+00
time2: 1.032760e+00
time3: 1.067721e+00
time4: 6.436741e+00
time5: 1.577023e+01
 ==============> Iteration k : 54
batch_iter = 37
time1: 6.079913e+00
time2: 1.394883e+00
time3: 1.136038e+00
time4: 6.167743e+00
time5: 1.672489e+01
 ==============> Iteration k : 55
batch_iter = 21
time1: 6.248311e+00
time2: 8.816180e-01
time3: 9.199010e-01
time4: 6.293042e+00
time5: 1.660876e+01
 ==============> Iteration k : 56
batch_iter = 5
```

```
time1: 6.068673e+00
time2: 1.080491e+00
time3: 1.003246e+00
time4: 5.995779e+00
time5: 1.748857e+01
 =============> Iteration k : 57
batch_iter = 38
time1: 5.729236e+00
time2: 9.506250e-01
time3: 1.023062e+00
time4: 5.800067e+00
time5: 1.760673e+01
 =============> Iteration k : 58
batch_iter = 51
time1: 5.673574e+00
time2: 9.048820e-01
time3: 1.064054e+00
time4: 5.743541e+00
time5: 1.798204e+01
 =============> Iteration k : 59
batch_iter = 8
time1: 5.590855e+00
time2: 8.803460e-01
time3: 7.224940e-01
time4: 5.689922e+00
time5: 1.758667e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 60
batch_iter = 35
time1: 6.271710e+00
time2: 8.032200e-01
time3: 1.002804e+00
time4: 5.071374e+00
time5: 1.750652e+01
 =============> Iteration k : 61
batch_iter = 47
time1: 6.363880e+00
time2: 1.106204e+00
time3: 9.066850e-01
time4: 5.323242e+00
time5: 1.827683e+01
 =============> Iteration k : 62
batch_iter = 23
time1: 6.082373e+00
time2: 1.081362e+00
time3: 6.281260e-01
time4: 5.524520e+00
time5: 1.685694e+01
 =============> Iteration k : 63
batch_iter = 4
time1: 6.484976e+00
time2: 1.017150e+00
time3: 8.684070e-01
time4: 5.820844e+00
time5: 1.668168e+01
 =============> Iteration k : 64
batch_iter = 37
time1: 6.459433e+00
time2: 7.341830e-01
time3: 1.048239e+00
time4: 5.613227e+00
time5: 1.752504e+01
 =============> Iteration k : 65
batch_iter = 36
```

```
time1: 6.384416e+00
time2: 6.540320e-01
time3: 1.001721e+00
time4: 5.575293e+00
time5: 1.734977e+01
 =============> Iteration k : 66
batch_iter = 50
time1: 6.428117e+00
time2: 9.467570e-01
time3: 9.708690e-01
time4: 5.677719e+00
time5: 1.659296e+01
 =============> Iteration k : 67
batch_iter = 58
time1: 5.575381e+00
time2: 9.973960e-01
time3: 8.973110e-01
time4: 5.854710e+00
time5: 1.752513e+01
 =============> Iteration k : 68
batch_iter = 52
time1: 5.637154e+00
time2: 8.980310e-01
time3: 9.722100e-01
time4: 6.123669e+00
time5: 1.805327e+01
 =============> Iteration k : 69
batch_iter = 39
time1: 5.744228e+00
time2: 6.812810e-01
time3: 9.610120e-01
time4: 5.579437e+00
time5: 1.874092e+01
 =============> Iteration k : 70
batch_iter = 15
time1: 5.628388e+00
time2: 8.883990e-01
time3: 7.751330e-01
time4: 5.312675e+00
time5: 1.730485e+01
 =============> Iteration k : 71
batch_iter = 34
time1: 3.525192e+00
time2: 4.471060e-01
time3: 5.141660e-01
time4: 3.366481e+00
time5: 1.334113e+01
 =============> Iteration k : 72
batch_iter = 55
time1: 2.238355e+00
time2: 2.955540e-01
time3: 4.507380e-01
time4: 2.204729e+00
time5: 7.414070e+00
 =============> Iteration k : 73
batch_iter = 30
time1: 2.206995e+00
time2: 2.986120e-01
time3: 4.455630e-01
time4: 2.139420e+00
time5: 7.490598e+00
 =============> Iteration k : 74
batch_iter = 7
time1: 2.211188e+00
```

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time2: 2.745860e-01
time3: 5.461220e-01
time4: 2.154928e+00
time5: 7.516985e+00
 =============> Iteration k : 75
batch_iter = 53
time1: 2.131253e+00
time2: 2.993930e-01
time3: 4.310100e-01
time4: 2.198717e+00
time5: 7.500000e+00
 =============> Iteration k : 76
batch_iter = 17
time1: 2.185629e+00
time2: 2.668300e-01
time3: 3.909120e-01
time4: 2.158139e+00
time5: 7.649177e+00
 =============> Iteration k : 77
batch_iter = 43
time1: 2.191092e+00
time2: 3.265230e-01
time3: 4.206850e-01
time4: 2.097652e+00
time5: 7.439756e+00
 =============> Iteration k : 78
batch_iter = 46
time1: 2.215554e+00
time2: 2.573540e-01
time3: 4.173310e-01
time4: 2.160434e+00
time5: 7.525680e+00
 =============> Iteration k : 79
batch_iter = 57
time1: 2.193955e+00
time2: 2.882590e-01
time3: 4.483440e-01
time4: 2.168458e+00
time5: 7.365272e+00
 =============> Iteration k : 80
batch_iter = 54
time1: 2.230166e+00
time2: 3.091070e-01
time3: 4.241680e-01
time4: 2.162506e+00
time5: 7.410569e+00
 =============> Iteration k : 81
batch_iter = 9
time1: 2.165319e+00
time2: 2.885180e-01
time3: 4.510710e-01
time4: 2.168098e+00
time5: 7.537576e+00
 =============> Iteration k : 82
batch_iter = 29
time1: 3.308250e+00
time2: 4.794310e-01
time3: 4.464470e-01
time4: 3.369397e+00
time5: 9.750062e+01
 =============> Iteration k : 83
batch_iter = 33
time1: 3.757356e+00
time2: 5.124950e-01
```

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time3: 7.746510e-01
time4: 4.341731e+00
time5: 1.305373e+01
 =============> Iteration k : 84
batch_iter = 40
time1: 3.677056e+00
time2: 3.700320e-01
time3: 5.604930e-01
time4: 4.262443e+00
time5: 1.277577e+01
 =============> Iteration k : 85
batch_iter = 56
time1: 3.597276e+00
time2: 5.368980e-01
time3: 5.381580e-01
time4: 4.108287e+00
time5: 1.306950e+01
 =============> Iteration k : 86
batch_iter = 5
time1: 5.389934e+00
time2: 6.325680e-01
time3: 7.562970e-01
time4: 6.004316e+00
time5: 1.882135e+01
 =============> Iteration k : 87
batch_iter = 18
time1: 5.535385e+00
time2: 4.261830e-01
time3: 9.927480e-01
time4: 6.352603e+00
time5: 1.884847e+01
 =============> Iteration k : 88
batch_iter = 21
time1: 5.340344e+00
time2: 8.152110e-01
time3: 6.173270e-01
time4: 5.982553e+00
time5: 1.788561e+01
 =============> Iteration k : 89
batch_iter = 19
time1: 5.605694e+00
time2: 7.854090e-01
time3: 8.123690e-01
time4: 6.155007e+00
time5: 1.910654e+01
 =============> Iteration k : 90
batch_iter = 59
time1: 6.319110e+00
time2: 1.029172e+00
time3: 9.658240e-01
time4: 6.139911e+00
time5: 1.834963e+01
 =============> Iteration k : 91
batch_iter = 16
time1: 5.802622e+00
time2: 9.110720e-01
time3: 8.147900e-01
time4: 6.210182e+00
time5: 1.874971e+01
 =============> Iteration k : 92
batch_iter = 10
time1: 5.734988e+00
time2: 5.937030e-01
time3: 1.152556e+00
```

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time4: 6.016389e+00
time5: 1.732873e+01
 =============> Iteration k : 93
batch_iter = 2
time1: 6.233897e+00
time2: 9.659520e-01
time3: 1.238575e+00
time4: 6.378472e+00
time5: 1.737258e+01
 =============> Iteration k : 94
batch_iter = 41
time1: 6.497519e+00
time2: 7.834010e-01
time3: 1.106992e+00
time4: 6.324403e+00
time5: 1.648345e+01
 =============> Iteration k : 95
batch_iter = 44
time1: 6.277274e+00
time2: 1.278809e+00
time3: 1.035747e+00
time4: 6.167063e+00
time5: 1.540129e+01
 =============> Iteration k : 96
batch_iter = 3
time1: 6.667114e+00
time2: 1.094894e+00
time3: 1.103246e+00
time4: 6.148370e+00
time5: 1.620886e+01
 =============> Iteration k : 97
batch_iter = 25
time1: 6.178200e+00
time2: 9.454970e-01
time3: 1.056335e+00
time4: 6.582256e+00
time5: 1.652334e+01
 =============> Iteration k : 98
batch_iter = 20
time1: 5.985126e+00
time2: 9.969660e-01
time3: 1.279805e+00
time4: 6.226764e+00
time5: 1.623665e+01
 =============> Iteration k : 99
batch_iter = 24
time1: 6.200575e+00
time2: 1.058785e+00
time3: 1.018938e+00
time4: 6.809412e+00
time5: 1.677291e+01
 =============> Iteration k : 100
batch_iter = 45
time1: 6.468617e+00
time2: 8.084580e-01
time3: 9.118580e-01
time4: 6.592891e+00
time5: 1.662833e+01
 =============> Iteration k : 101
batch_iter = 38
time1: 5.575923e+00
time2: 9.467040e-01
time3: 1.081001e+00
time4: 6.319376e+00
```

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time5: 1.704991e+01
 =============> Iteration k : 102
batch_iter = 49
time1: 5.546083e+00
time2: 9.354540e-01
time3: 8.173080e-01
time4: 5.952010e+00
time5: 1.789083e+01
 =============> Iteration k : 103
batch_iter = 22
time1: 5.627726e+00
time2: 6.302000e-01
time3: 9.971430e-01
time4: 6.200788e+00
time5: 1.764697e+01
 =============> Iteration k : 104
batch_iter = 8
time1: 5.855783e+00
time2: 8.996170e-01
time3: 8.391730e-01
time4: 5.702281e+00
time5: 1.787707e+01
 =============> Iteration k : 105
batch_iter = 60
time1: 6.390650e+00
time2: 1.073611e+00
time3: 1.116982e+00
time4: 5.680599e+00
time5: 1.787437e+01
 =============> Iteration k : 106
batch_iter = 14
time1: 6.298056e+00
time2: 1.126130e+00
time3: 9.746160e-01
time4: 5.591634e+00
time5: 1.750022e+01
 =============> Iteration k : 107
batch_iter = 51
time1: 6.578800e+00
time2: 1.102794e+00
time3: 9.491820e-01
time4: 5.807248e+00
time5: 1.669597e+01
 =============> Iteration k : 108
batch_iter = 31
time1: 6.379325e+00
time2: 8.875110e-01
time3: 9.420070e-01
time4: 6.203734e+00
time5: 1.660363e+01
 =============> Iteration k : 109
batch_iter = 27
time1: 6.321958e+00
time2: 8.402990e-01
time3: 1.078490e+00
time4: 6.306846e+00
time5: 1.625913e+01
 =============> Iteration k : 110
batch_iter = 28
time1: 6.590734e+00
time2: 8.022030e-01
time3: 9.897860e-01
time4: 6.141170e+00
time5: 1.624414e+01
```

```
 =============> Iteration k : 111
batch_iter = 48
time1: 6.241481e+00
time2: 1.048344e+00
time3: 1.350638e+00
time4: 6.208331e+00
time5: 1.631634e+01
 =============> Iteration k : 112
batch_iter = 13
time1: 5.824828e+00
time2: 7.393950e-01
time3: 9.754820e-01
time4: 6.520868e+00
time5: 1.747590e+01
 =============> Iteration k : 113
batch_iter = 1
time1: 6.386408e+00
time2: 1.208386e+00
time3: 9.845110e-01
time4: 6.065107e+00
time5: 1.831484e+01
 =============> Iteration k : 114
batch_iter = 42
time1: 5.912384e+00
time2: 8.661120e-01
time3: 1.011568e+00
time4: 6.095790e+00
time5: 2.127417e+01
 =============> Iteration k : 115
batch_iter = 26
time1: 7.979855e+00
time2: 1.405690e+00
time3: 1.382373e+00
time4: 7.896095e+00
time5: 2.261830e+01
 =============> Iteration k : 116
batch_iter = 32
time1: 8.407547e+00
time2: 1.486255e+00
time3: 1.161724e+00
time4: 7.033313e+00
time5: 2.230234e+01
 =============> Iteration k : 117
batch_iter = 6
time1: 7.915603e+00
time2: 8.979240e-01
time3: 1.225371e+00
time4: 7.444214e+00
time5: 2.399737e+01
 =============> Iteration k : 118
batch_iter = 12
time1: 8.100868e+00
time2: 1.137241e+00
time3: 1.302128e+00
time4: 7.077677e+00
time5: 2.379072e+01
 =============> Iteration k : 119
batch_iter = 11
time1: 8.663441e+00
time2: 9.991200e-01
time3: 1.289242e+00
time4: 7.221752e+00
time5: 2.361150e+01
 =============> Shuffeling of batches for gradient ...
```

```
 =============> Iteration k : 120
batch_iter = 59
time1: 7.810757e+00
time2: 1.157044e+00
time3: 1.197465e+00
time4: 7.290795e+00
time5: 2.233452e+01
 =============> Iteration k : 121
batch_iter = 30
time1: 7.524399e+00
time2: 1.496605e+00
time3: 1.795682e+00
time4: 7.309481e+00
time5: 2.256455e+01
 =============> Iteration k : 122
batch_iter = 4
time1: 7.906157e+00
time2: 1.192984e+00
time3: 1.110491e+00
time4: 7.977823e+00
time5: 2.270370e+01
 =============> Iteration k : 123
batch_iter = 13
time1: 7.881053e+00
time2: 9.773000e-01
time3: 1.319470e+00
time4: 7.797269e+00
time5: 2.407808e+01
 =============> Iteration k : 124
batch_iter = 46
time1: 7.219338e+00
time2: 1.307348e+00
time3: 1.043018e+00
time4: 7.032614e+00
time5: 2.438945e+01
 =============> Iteration k : 125
batch_iter = 28
time1: 6.815119e+00
time2: 1.051416e+00
time3: 1.134058e+00
time4: 7.953698e+00
time5: 2.333725e+01
 =============> Iteration k : 126
batch_iter = 44
time1: 7.908853e+00
time2: 1.234709e+00
time3: 1.058728e+00
time4: 7.407260e+00
time5: 2.269948e+01
 =============> Iteration k : 127
batch_iter = 7
time1: 7.377772e+00
time2: 1.483691e+00
time3: 1.175808e+00
time4: 7.139672e+00
time5: 2.314509e+01
 =============> Iteration k : 128
batch_iter = 43
time1: 8.149090e+00
time2: 1.308040e+00
time3: 1.221364e+00
time4: 7.472596e+00
time5: 2.288211e+01
 =============> Iteration k : 129
```

```
batch_iter = 50
time1: 7.606639e+00
time2: 1.332215e+00
time3: 1.215317e+00
time4: 7.789835e+00
time5: 2.266223e+01
 ==============> Iteration k : 130
batch_iter = 41
time1: 7.701439e+00
time2: 1.198392e+00
time3: 2.006293e+00
time4: 7.331253e+00
time5: 2.228564e+01
 ==============> Iteration k : 131
batch_iter = 23
time1: 8.060874e+00
time2: 1.011111e+00
time3: 1.369595e+00
time4: 7.722974e+00
time5: 2.399515e+01
 ==============> Iteration k : 132
batch_iter = 5
time1: 7.975401e+00
time2: 1.192761e+00
time3: 1.819893e+00
time4: 7.146890e+00
time5: 2.382480e+01
 ==============> Iteration k : 133
batch_iter = 54
time1: 7.177097e+00
time2: 1.309861e+00
time3: 9.968720e-01
time4: 6.997961e+00
time5: 2.469473e+01
 ==============> Iteration k : 134
batch_iter = 22
time1: 7.566008e+00
time2: 8.362640e-01
time3: 1.281033e+00
time4: 7.790283e+00
time5: 2.240089e+01
 ==============> Iteration k : 135
batch_iter = 49
time1: 7.249556e+00
time2: 1.211318e+00
time3: 1.215474e+00
time4: 7.688974e+00
time5: 2.327401e+01
 ==============> Iteration k : 136
batch_iter = 8
time1: 7.880403e+00
time2: 7.995280e-01
time3: 7.912130e-01
time4: 8.147058e+00
time5: 2.344207e+01
 ==============> Iteration k : 137
batch_iter = 15
time1: 7.168298e+00
time2: 6.795200e-01
time3: 1.121391e+00
time4: 7.661537e+00
time5: 2.463119e+01
 ==============> Iteration k : 138
batch_iter = 56
```

```
time1: 7.839039e+00
time2: 1.113778e+00
time3: 1.296209e+00
time4: 7.834767e+00
time5: 2.285067e+01
 =============> Iteration k : 139
batch_iter = 3
time1: 7.984264e+00
time2: 1.429884e+00
time3: 1.390664e+00
time4: 8.263621e+00
time5: 2.319021e+01
 =============> Iteration k : 140
batch_iter = 47
time1: 8.111712e+00
time2: 1.364653e+00
time3: 1.397835e+00
time4: 7.818815e+00
time5: 2.168120e+01
 =============> Iteration k : 141
batch_iter = 37
time1: 7.722314e+00
time2: 1.238257e+00
time3: 1.415177e+00
time4: 8.483176e+00
time5: 2.170278e+01
 =============> Iteration k : 142
batch_iter = 60
time1: 7.915703e+00
time2: 1.556639e+00
time3: 1.619100e+00
time4: 8.887283e+00
time5: 2.182105e+01
 =============> Iteration k : 143
batch_iter = 57
time1: 7.469491e+00
time2: 1.416086e+00
time3: 1.427035e+00
time4: 8.618353e+00
time5: 2.223338e+01
 =============> Iteration k : 144
batch_iter = 17
time1: 7.310140e+00
time2: 1.599605e+00
time3: 1.202034e+00
time4: 8.816787e+00
time5: 2.357699e+01
 =============> Iteration k : 145
batch_iter = 9
time1: 7.800501e+00
time2: 1.165289e+00
time3: 1.094799e+00
time4: 8.134659e+00
time5: 2.376573e+01
 =============> Iteration k : 146
batch_iter = 6
time1: 7.800428e+00
time2: 1.168879e+00
time3: 1.412109e+00
time4: 8.017543e+00
time5: 2.299805e+01
 =============> Iteration k : 147
batch_iter = 40
time1: 7.596825e+00
```

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time2: 1.224263e+00
time3: 1.391046e+00
time4: 7.694591e+00
time5: 2.240341e+01
 =============> Iteration k : 148
batch_iter = 36
time1: 8.205515e+00
time2: 1.236867e+00
time3: 1.122073e+00
time4: 7.093896e+00
time5: 2.200502e+01
 =============> Iteration k : 149
batch_iter = 27
time1: 9.083919e+00
time2: 1.295379e+00
time3: 1.512617e+00
time4: 7.779597e+00
time5: 2.207586e+01
 =============> Iteration k : 150
batch_iter = 16
time1: 8.223558e+00
time2: 1.372757e+00
time3: 1.205626e+00
time4: 7.816395e+00
time5: 2.197267e+01
 =============> Iteration k : 151
batch_iter = 32
time1: 8.594441e+00
time2: 1.490935e+00
time3: 1.588567e+00
time4: 7.867896e+00
time5: 2.212600e+01
 =============> Iteration k : 152
batch_iter = 39
time1: 7.904366e+00
time2: 9.423250e-01
time3: 1.288377e+00
time4: 7.696527e+00
time5: 2.229736e+01
 =============> Iteration k : 153
batch_iter = 18
time1: 7.703990e+00
time2: 1.707281e+00
time3: 1.296070e+00
time4: 8.140291e+00
time5: 2.093222e+01
 =============> Iteration k : 154
batch_iter = 11
time1: 7.968307e+00
time2: 1.207109e+00
time3: 1.478547e+00
time4: 7.535479e+00
time5: 2.086507e+01
 =============> Iteration k : 155
batch_iter = 19
time1: 7.117183e+00
time2: 1.387880e+00
time3: 1.299573e+00
time4: 7.942786e+00
time5: 2.319939e+01
 =============> Iteration k : 156
batch_iter = 45
time1: 7.457207e+00
time2: 1.201532e+00
```

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time3: 1.096316e+00
time4: 7.616070e+00
time5: 2.280618e+01
 =============> Iteration k : 157
batch_iter = 34
time1: 7.280029e+00
time2: 1.099724e+00
time3: 1.174692e+00
time4: 7.507632e+00
time5: 2.319633e+01
 =============> Iteration k : 158
batch_iter = 55
time1: 8.390232e+00
time2: 9.693060e-01
time3: 1.837033e+00
time4: 7.438206e+00
time5: 2.319374e+01
 =============> Iteration k : 159
batch_iter = 25
time1: 8.682045e+00
time2: 1.096248e+00
time3: 1.492688e+00
time4: 7.575660e+00
time5: 2.290229e+01
 =============> Iteration k : 160
batch_iter = 51
time1: 8.012234e+00
time2: 1.605111e+00
time3: 2.089960e+00
time4: 7.886626e+00
time5: 2.266816e+01
 =============> Iteration k : 161
batch_iter = 2
time1: 8.246343e+00
time2: 1.298758e+00
time3: 9.802220e-01
time4: 8.027791e+00
time5: 2.149307e+01
 =============> Iteration k : 162
batch_iter = 38
time1: 8.193755e+00
time2: 1.289317e+00
time3: 1.100678e+00
time4: 8.190016e+00
time5: 2.219741e+01
 =============> Iteration k : 163
batch_iter = 35
time1: 7.791610e+00
time2: 1.203255e+00
time3: 1.103884e+00
time4: 8.577562e+00
time5: 2.173048e+01
 =============> Iteration k : 164
batch_iter = 21
time1: 7.588960e+00
time2: 1.168314e+00
time3: 1.117136e+00
time4: 8.082360e+00
time5: 2.348648e+01
 =============> Iteration k : 165
batch_iter = 53
time1: 7.479409e+00
time2: 1.301620e+00
time3: 1.090649e+00
```

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time4: 7.642584e+00
time5: 2.437497e+01
 =============> Iteration k : 166
batch_iter = 52
time1: 7.414820e+00
time2: 1.256393e+00
time3: 1.177007e+00
time4: 7.997022e+00
time5: 2.331168e+01
 =============> Iteration k : 167
batch_iter = 31
time1: 7.524445e+00
time2: 1.751621e+00
time3: 9.410830e-01
time4: 7.882275e+00
time5: 2.320216e+01
 =============> Iteration k : 168
batch_iter = 20
time1: 7.555958e+00
time2: 1.301443e+00
time3: 1.417868e+00
time4: 8.197222e+00
time5: 2.239805e+01
 =============> Iteration k : 169
batch_iter = 26
time1: 7.276972e+00
time2: 1.408727e+00
time3: 1.309048e+00
time4: 8.247061e+00
time5: 2.312518e+01
 =============> Iteration k : 170
batch_iter = 1
time1: 7.578718e+00
time2: 1.293655e+00
time3: 1.180202e+00
time4: 8.011409e+00
time5: 2.070644e+01
 =============> Iteration k : 171
batch_iter = 14
time1: 8.388151e+00
time2: 1.290750e+00
time3: 1.377347e+00
time4: 8.504623e+00
time5: 2.250311e+01
 =============> Iteration k : 172
batch_iter = 33
time1: 7.890602e+00
time2: 1.279850e+00
time3: 1.102609e+00
time4: 8.586538e+00
time5: 2.079342e+01
 =============> Iteration k : 173
batch_iter = 29
time1: 7.835353e+00
time2: 1.521446e+00
time3: 1.666393e+00
time4: 9.326359e+00
time5: 2.171603e+01
 =============> Iteration k : 174
batch_iter = 42
time1: 8.124954e+00
time2: 1.503027e+00
time3: 1.769551e+00
time4: 8.719239e+00
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time5: 2.120101e+01
 =============> Iteration k : 175
batch_iter = 24
time1: 8.376587e+00
time2: 1.575996e+00
time3: 2.265084e+00
time4: 8.015027e+00
time5: 2.228375e+01
 =============> Iteration k : 176
batch_iter = 58
time1: 7.897685e+00
time2: 1.211401e+00
time3: 1.677613e+00
time4: 8.320057e+00
time5: 2.128623e+01
 =============> Iteration k : 177
batch_iter = 48
time1: 8.168942e+00
time2: 1.432210e+00
time3: 1.460720e+00
time4: 8.154602e+00
time5: 2.353270e+01
 =============> Iteration k : 178
batch_iter = 12
time1: 7.616538e+00
time2: 1.434871e+00
time3: 1.303797e+00
time4: 8.490753e+00
time5: 2.208902e+01
 =============> Iteration k : 179
batch_iter = 10
time1: 7.909353e+00
time2: 1.290868e+00
time3: 1.154177e+00
time4: 7.532307e+00
time5: 2.281066e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 180
batch_iter = 17
time1: 8.277596e+00
time2: 1.365174e+00
time3: 1.186872e+00
time4: 7.734524e+00
time5: 2.187117e+01
 =============> Iteration k : 181
batch_iter = 2
time1: 8.387505e+00
time2: 1.309312e+00
time3: 1.074686e+00
time4: 7.602949e+00
time5: 2.079761e+01
 =============> Iteration k : 182
batch_iter = 16
time1: 8.609994e+00
time2: 1.673251e+00
time3: 1.501426e+00
time4: 8.070854e+00
time5: 2.106266e+01
 =============> Iteration k : 183
batch_iter = 12
time1: 8.600587e+00
time2: 1.904964e+00
time3: 1.203426e+00
time4: 8.325697e+00
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time5: 2.242273e+01
 =============> Iteration k : 184
batch_iter = 39
time1: 8.612845e+00
time2: 1.649070e+00
time3: 1.657549e+00
time4: 8.115792e+00
time5: 2.189406e+01
 =============> Iteration k : 185
batch_iter = 6
time1: 8.877517e+00
time2: 1.298763e+00
time3: 1.112365e+00
time4: 8.228353e+00
time5: 2.199955e+01
 =============> Iteration k : 186
batch_iter = 15
time1: 8.381580e+00
time2: 1.378037e+00
time3: 1.528106e+00
time4: 7.678849e+00
time5: 2.246851e+01
 =============> Iteration k : 187
batch_iter = 33
time1: 7.647243e+00
time2: 1.442160e+00
time3: 1.235906e+00
time4: 8.781557e+00
time5: 2.249288e+01
 =============> Iteration k : 188
batch_iter = 35
time1: 7.884973e+00
time2: 1.182914e+00
time3: 1.226590e+00
time4: 7.490011e+00
time5: 2.311098e+01
 =============> Iteration k : 189
batch_iter = 7
time1: 8.512441e+00
time2: 1.711034e+00
time3: 9.702640e-01
time4: 8.117426e+00
time5: 2.486742e+01
 =============> Iteration k : 190
batch_iter = 51
time1: 7.324519e+00
time2: 1.235456e+00
time3: 1.158941e+00
time4: 7.517724e+00
time5: 2.437914e+01
 =============> Iteration k : 191
batch_iter = 34
time1: 7.823723e+00
time2: 8.942740e-01
time3: 1.312814e+00
time4: 8.060004e+00
time5: 2.418470e+01
 =============> Iteration k : 192
batch_iter = 25
time1: 7.502243e+00
time2: 9.743470e-01
time3: 1.313587e+00
time4: 8.214661e+00
time5: 2.460038e+01
```

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 =============> Iteration k : 193
batch_iter = 44
time1: 7.614204e+00
time2: 8.524540e-01
time3: 1.363419e+00
time4: 7.673923e+00
time5: 2.364311e+01
 =============> Iteration k : 194
batch_iter = 47
time1: 7.167591e+00
time2: 1.197312e+00
time3: 1.078533e+00
time4: 6.722868e+00
time5: 2.397991e+01
 =============> Iteration k : 195
batch_iter = 5
time1: 7.476289e+00
time2: 1.094078e+00
time3: 1.115591e+00
time4: 7.411237e+00
time5: 2.390239e+01
 =============> Iteration k : 196
batch_iter = 10
time1: 7.468655e+00
time2: 8.948340e-01
time3: 1.324188e+00
time4: 7.391240e+00
time5: 2.431540e+01
 =============> Iteration k : 197
batch_iter = 28
time1: 7.512070e+00
time2: 1.099943e+00
time3: 1.116479e+00
time4: 7.590045e+00
time5: 2.396727e+01
 =============> Iteration k : 198
batch_iter = 22
time1: 7.115721e+00
time2: 1.570194e+00
time3: 1.518606e+00
time4: 7.707967e+00
time5: 2.319636e+01
 =============> Iteration k : 199
batch_iter = 48
time1: 7.373595e+00
time2: 1.283758e+00
time3: 1.091094e+00
time4: 8.889452e+00
time5: 2.349718e+01
 =============> Iteration k : 200
batch_iter = 55
time1: 7.395843e+00
time2: 7.985870e-01
time3: 1.510250e+00
time4: 8.440576e+00
time5: 2.334793e+01
 =============> Iteration k : 201
batch_iter = 31
time1: 6.744189e+00
time2: 9.409430e-01
time3: 1.170434e+00
time4: 8.394517e+00
time5: 2.369594e+01
 =============> Iteration k : 202
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batch_iter = 20
time1: 6.816263e+00
time2: 9.776110e-01
time3: 1.590534e+00
time4: 7.907531e+00
time5: 2.299087e+01
 =============> Iteration k : 203
batch_iter = 30
time1: 6.256755e+00
time2: 7.333120e-01
time3: 1.114924e+00
time4: 7.726536e+00
time5: 2.348431e+01
 =============> Iteration k : 204
batch_iter = 52
time1: 6.816330e+00
time2: 9.046220e-01
time3: 1.137884e+00
time4: 7.792432e+00
time5: 2.307706e+01
 =============> Iteration k : 205
batch_iter = 37
time1: 6.810594e+00
time2: 1.285913e+00
time3: 1.305025e+00
time4: 7.970449e+00
time5: 2.283041e+01
 =============> Iteration k : 206
batch_iter = 54
time1: 7.219877e+00
time2: 8.854270e-01
time3: 1.093988e+00
time4: 8.484039e+00
time5: 2.472516e+01
 =============> Iteration k : 207
batch_iter = 38
time1: 6.988504e+00
time2: 1.075806e+00
time3: 1.009642e+00
time4: 7.869637e+00
time5: 2.250258e+01
 =============> Iteration k : 208
batch_iter = 4
time1: 7.718187e+00
time2: 1.211178e+00
time3: 1.216962e+00
time4: 7.683709e+00
time5: 2.310540e+01
 =============> Iteration k : 209
batch_iter = 56
time1: 6.973671e+00
time2: 1.185401e+00
time3: 1.435664e+00
time4: 8.773039e+00
time5: 2.312592e+01
 =============> Iteration k : 210
batch_iter = 50
time1: 6.841882e+00
time2: 1.103216e+00
time3: 1.202731e+00
time4: 9.112363e+00
time5: 2.300258e+01
 =============> Iteration k : 211
batch_iter = 57
```

```
time1: 7.813705e+00
time2: 1.207572e+00
time3: 1.497564e+00
time4: 8.530093e+00
time5: 2.124874e+01
 =============> Iteration k : 212
batch_iter = 19
time1: 7.811211e+00
time2: 1.071791e+00
time3: 1.199082e+00
time4: 9.335972e+00
time5: 2.193370e+01
 =============> Iteration k : 213
batch_iter = 21
time1: 7.485128e+00
time2: 1.592795e+00
time3: 1.215141e+00
time4: 8.967208e+00
time5: 2.169720e+01
 =============> Iteration k : 214
batch_iter = 11
time1: 7.904082e+00
time2: 1.411894e+00
time3: 1.099492e+00
time4: 9.249293e+00
time5: 2.241382e+01
 =============> Iteration k : 215
batch_iter = 18
time1: 8.070079e+00
time2: 1.240069e+00
time3: 2.060323e+00
time4: 8.633905e+00
time5: 2.153650e+01
 =============> Iteration k : 216
batch_iter = 40
time1: 7.534965e+00
time2: 1.185514e+00
time3: 1.311611e+00
time4: 7.900973e+00
time5: 2.225863e+01
 =============> Iteration k : 217
batch_iter = 27
time1: 8.332570e+00
time2: 1.495519e+00
time3: 1.282791e+00
time4: 7.322058e+00
time5: 2.201036e+01
 =============> Iteration k : 218
batch_iter = 46
time1: 8.608314e+00
time2: 1.420577e+00
time3: 1.273790e+00
time4: 8.335724e+00
time5: 2.211065e+01
 =============> Iteration k : 219
batch_iter = 42
time1: 8.698050e+00
time2: 2.376159e+00
time3: 1.216347e+00
time4: 8.590626e+00
time5: 2.262354e+01
 =============> Iteration k : 220
batch_iter = 53
time1: 8.310166e+00
```

```
time2: 1.131948e+00
time3: 1.119203e+00
time4: 7.567520e+00
time5: 2.161717e+01
 =============> Iteration k : 221
batch_iter = 13
time1: 7.885655e+00
time2: 1.489913e+00
time3: 9.992090e-01
time4: 8.099950e+00
time5: 2.100040e+01
 =============> Iteration k : 222
batch_iter = 3
time1: 7.654513e+00
time2: 1.534043e+00
time3: 1.733786e+00
time4: 7.982429e+00
time5: 2.192387e+01
 =============> Iteration k : 223
batch_iter = 29
time1: 8.062602e+00
time2: 1.504326e+00
time3: 1.487636e+00
time4: 8.738485e+00
time5: 2.193181e+01
 =============> Iteration k : 224
batch_iter = 23
time1: 8.883532e+00
time2: 1.689233e+00
time3: 1.193798e+00
time4: 7.973625e+00
time5: 2.251288e+01
 =============> Iteration k : 225
batch_iter = 58
time1: 8.115421e+00
time2: 1.258029e+00
time3: 1.224051e+00
time4: 7.781298e+00
time5: 2.300630e+01
 =============> Iteration k : 226
batch_iter = 1
time1: 7.171751e+00
time2: 1.420261e+00
time3: 1.187250e+00
time4: 8.064183e+00
time5: 2.302913e+01
 =============> Iteration k : 227
batch_iter = 60
time1: 8.205449e+00
time2: 1.018806e+00
time3: 1.420793e+00
time4: 8.162051e+00
time5: 2.292259e+01
 =============> Iteration k : 228
batch_iter = 36
time1: 9.194134e+00
time2: 1.406365e+00
time3: 1.089082e+00
time4: 7.258743e+00
time5: 2.322450e+01
 =============> Iteration k : 229
batch_iter = 49
time1: 8.992253e+00
time2: 1.382575e+00
```

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time3: 1.794022e+00
time4: 7.718475e+00
time5: 2.367197e+01
 =============> Iteration k : 230
batch_iter = 14
time1: 8.821096e+00
time2: 1.395857e+00
time3: 9.512090e-01
time4: 7.004396e+00
time5: 2.350790e+01
 =============> Iteration k : 231
batch_iter = 45
time1: 8.506204e+00
time2: 1.003869e+00
time3: 1.062840e+00
time4: 6.915583e+00
time5: 2.430169e+01
 =============> Iteration k : 232
batch_iter = 8
time1: 8.017213e+00
time2: 1.078971e+00
time3: 1.002864e+00
time4: 7.577167e+00
time5: 2.263978e+01
 =============> Iteration k : 233
batch_iter = 59
time1: 8.144180e+00
time2: 1.437085e+00
time3: 1.666972e+00
time4: 8.000092e+00
time5: 2.370518e+01
 =============> Iteration k : 234
batch_iter = 41
time1: 7.687470e+00
time2: 1.108498e+00
time3: 9.832380e-01
time4: 7.682438e+00
time5: 2.288819e+01
 =============> Iteration k : 235
batch_iter = 9
time1: 7.387739e+00
time2: 1.320225e+00
time3: 1.016093e+00
time4: 7.555975e+00
time5: 2.349441e+01
 =============> Iteration k : 236
batch_iter = 32
time1: 7.566367e+00
time2: 1.397118e+00
time3: 1.201170e+00
time4: 7.696884e+00
time5: 2.357067e+01
 =============> Iteration k : 237
batch_iter = 26
time1: 7.800626e+00
time2: 1.002984e+00
time3: 1.014458e+00
time4: 7.842596e+00
time5: 2.373743e+01
 =============> Iteration k : 238
batch_iter = 24
time1: 7.601283e+00
time2: 8.179980e-01
time3: 1.080407e+00
```

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time4: 7.213421e+00
time5: 2.462321e+01
 =============> Iteration k : 239
batch_iter = 43
time1: 6.869823e+00
time2: 8.076270e-01
time3: 1.104747e+00
time4: 7.805048e+00
time5: 2.421367e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 240
batch_iter = 56
time1: 6.525667e+00
time2: 1.025709e+00
time3: 1.177938e+00
time4: 8.693671e+00
time5: 2.503751e+01
 =============> Iteration k : 241
batch_iter = 60
time1: 6.818681e+00
time2: 1.012389e+00
time3: 1.276700e+00
time4: 7.699180e+00
time5: 2.401193e+01
 =============> Iteration k : 242
batch_iter = 18
time1: 6.590832e+00
time2: 8.350120e-01
time3: 1.000722e+00
time4: 7.986919e+00
time5: 2.349466e+01
 =============> Iteration k : 243
batch_iter = 43
time1: 7.165884e+00
time2: 1.299640e+00
time3: 1.076550e+00
time4: 8.220366e+00
time5: 2.267889e+01
 =============> Iteration k : 244
batch_iter = 11
time1: 6.912707e+00
time2: 1.200090e+00
time3: 1.285462e+00
time4: 7.777938e+00
time5: 2.391011e+01
 =============> Iteration k : 245
batch_iter = 9
time1: 7.663855e+00
time2: 1.794395e+00
time3: 1.113405e+00
time4: 8.779527e+00
time5: 2.303390e+01
 =============> Iteration k : 246
batch_iter = 37
time1: 8.102675e+00
time2: 1.604554e+00
time3: 1.608599e+00
time4: 7.778569e+00
time5: 2.198336e+01
 =============> Iteration k : 247
batch_iter = 49
time1: 7.717760e+00
time2: 1.586905e+00
time3: 1.294628e+00
```

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time4: 7.729204e+00
time5: 2.096270e+01
 =============> Iteration k : 248
batch_iter = 12
time1: 8.006448e+00
time2: 1.403694e+00
time3: 1.072703e+00
time4: 8.933631e+00
time5: 2.253792e+01
 =============> Iteration k : 249
batch_iter = 53
time1: 8.393740e+00
time2: 1.253659e+00
time3: 1.373216e+00
time4: 8.114491e+00
time5: 2.201066e+01
 =============> Iteration k : 250
batch_iter = 27
time1: 8.111804e+00
time2: 1.464637e+00
time3: 1.394518e+00
time4: 7.927997e+00
time5: 2.079917e+01
 =============> Iteration k : 251
batch_iter = 51
time1: 8.787048e+00
time2: 1.458685e+00
time3: 1.132061e+00
time4: 7.978283e+00
time5: 2.340992e+01
 =============> Iteration k : 252
batch_iter = 58
time1: 8.186244e+00
time2: 1.682500e+00
time3: 1.923290e+00
time4: 8.057330e+00
time5: 2.359136e+01
 =============> Iteration k : 253
batch_iter = 15
time1: 8.517758e+00
time2: 1.190483e+00
time3: 1.890731e+00
time4: 8.663150e+00
time5: 2.283982e+01
 =============> Iteration k : 254
batch_iter = 4
time1: 8.374237e+00
time2: 1.290693e+00
time3: 1.311593e+00
time4: 8.351165e+00
time5: 2.223838e+01
 =============> Iteration k : 255
batch_iter = 19
time1: 8.529438e+00
time2: 1.578667e+00
time3: 1.189159e+00
time4: 7.572864e+00
time5: 2.320099e+01
 =============> Iteration k : 256
batch_iter = 5
time1: 8.338992e+00
time2: 1.535380e+00
time3: 1.461555e+00
time4: 6.791132e+00
```

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time5: 2.402783e+01
 =============> Iteration k : 257
batch_iter = 8
time1: 8.095466e+00
time2: 1.194719e+00
time3: 1.258292e+00
time4: 7.413271e+00
time5: 2.179051e+01
 =============> Iteration k : 258
batch_iter = 32
time1: 8.918702e+00
time2: 1.345730e+00
time3: 1.080030e+00
time4: 7.112396e+00
time5: 2.291509e+01
 =============> Iteration k : 259
batch_iter = 45
time1: 8.117405e+00
time2: 1.250869e+00
time3: 1.051621e+00
time4: 7.114927e+00
time5: 2.281630e+01
 =============> Iteration k : 260
batch_iter = 25
time1: 8.089722e+00
time2: 1.611630e+00
time3: 1.439722e+00
time4: 7.454747e+00
time5: 2.333702e+01
 =============> Iteration k : 261
batch_iter = 6
time1: 8.036190e+00
time2: 1.363910e+00
time3: 1.205028e+00
time4: 6.999852e+00
time5: 2.478945e+01
 =============> Iteration k : 262
batch_iter = 33
time1: 8.199339e+00
time2: 1.358810e+00
time3: 1.216317e+00
time4: 8.025087e+00
time5: 2.506787e+01
 =============> Iteration k : 263
batch_iter = 40
time1: 6.995556e+00
time2: 8.932270e-01
time3: 1.295157e+00
time4: 7.797546e+00
time5: 2.180188e+01
 =============> Iteration k : 264
batch_iter = 44
time1: 7.293937e+00
time2: 9.991200e-01
time3: 1.011008e+00
time4: 7.446406e+00
time5: 2.322295e+01
 =============> Iteration k : 265
batch_iter = 46
time1: 7.402528e+00
time2: 1.261562e+00
time3: 9.259570e-01
time4: 7.907427e+00
time5: 2.435607e+01
```

```
 =============> Iteration k : 266
batch_iter = 2
time1: 7.431694e+00
time2: 7.024260e-01
time3: 9.303910e-01
time4: 6.633420e+00
time5: 2.419467e+01
 =============> Iteration k : 267
batch_iter = 30
time1: 7.657939e+00
time2: 6.908290e-01
time3: 1.340085e+00
time4: 7.046563e+00
time5: 2.523216e+01
 =============> Iteration k : 268
batch_iter = 39
time1: 7.739111e+00
time2: 1.181410e+00
time3: 1.210262e+00
time4: 7.577451e+00
time5: 2.339467e+01
 =============> Iteration k : 269
batch_iter = 23
time1: 7.663685e+00
time2: 9.012340e-01
time3: 1.112369e+00
time4: 8.288687e+00
time5: 2.271266e+01
 =============> Iteration k : 270
batch_iter = 34
time1: 7.542429e+00
time2: 9.491220e-01
time3: 1.072155e+00
time4: 8.201255e+00
time5: 2.310121e+01
 =============> Iteration k : 271
batch_iter = 13
time1: 7.405373e+00
time2: 7.457150e-01
time3: 1.271225e+00
time4: 8.373764e+00
time5: 2.452502e+01
 =============> Iteration k : 272
batch_iter = 17
time1: 6.892377e+00
time2: 1.303469e+00
time3: 1.293562e+00
time4: 8.510586e+00
time5: 2.392465e+01
 =============> Iteration k : 273
batch_iter = 24
time1: 6.595960e+00
time2: 1.057722e+00
time3: 1.021745e+00
time4: 8.009564e+00
time5: 2.379007e+01
 =============> Iteration k : 274
batch_iter = 47
time1: 7.887261e+00
time2: 1.364245e+00
time3: 1.529951e+00
time4: 8.870362e+00
time5: 2.331928e+01
 =============> Iteration k : 275
```

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batch_iter = 36
time1: 6.984023e+00
time2: 1.359978e+00
time3: 1.117900e+00
time4: 8.293519e+00
time5: 2.239698e+01
 ==============> Iteration k : 276
batch_iter = 26
time1: 6.772719e+00
time2: 1.202098e+00
time3: 1.384417e+00
time4: 7.834229e+00
time5: 2.293826e+01
 ==============> Iteration k : 277
batch_iter = 22
time1: 7.095178e+00
time2: 1.039982e+00
time3: 1.053641e+00
time4: 8.345457e+00
time5: 2.323901e+01
 ==============> Iteration k : 278
batch_iter = 14
time1: 7.590359e+00
time2: 1.265407e+00
time3: 1.177920e+00
time4: 7.534994e+00
time5: 2.336825e+01
 ==============> Iteration k : 279
batch_iter = 21
time1: 8.095475e+00
time2: 1.404321e+00
time3: 1.681263e+00
time4: 7.708070e+00
time5: 2.231208e+01
 ==============> Iteration k : 280
batch_iter = 55
time1: 8.050599e+00
time2: 1.698302e+00
time3: 1.731899e+00
time4: 8.553970e+00
time5: 2.273400e+01
 ==============> Iteration k : 281
batch_iter = 31
time1: 1.017289e+01
time2: 1.588348e+00
time3: 1.404801e+00
time4: 8.501420e+00
time5: 2.219225e+01
 ==============> Iteration k : 282
batch_iter = 16
time1: 8.702698e+00
time2: 1.953301e+00
time3: 1.315833e+00
time4: 7.979250e+00
time5: 2.283792e+01
 ==============> Iteration k : 283
batch_iter = 52
time1: 8.417211e+00
time2: 1.270955e+00
time3: 1.680518e+00
time4: 7.646598e+00
time5: 2.257618e+01
 ==============> Iteration k : 284
batch_iter = 20
```

```
time1: 7.883316e+00
time2: 1.127376e+00
time3: 1.337654e+00
time4: 7.593853e+00
time5: 2.263064e+01
 =============> Iteration k : 285
batch_iter = 54
time1: 8.596113e+00
time2: 1.483204e+00
time3: 2.041547e+00
time4: 7.876437e+00
time5: 2.238121e+01
 =============> Iteration k : 286
batch_iter = 1
time1: 8.507578e+00
time2: 1.573551e+00
time3: 1.303399e+00
time4: 7.817544e+00
time5: 2.286825e+01
 =============> Iteration k : 287
batch_iter = 38
time1: 7.918779e+00
time2: 1.657587e+00
time3: 1.301808e+00
time4: 7.024021e+00
time5: 2.364844e+01
 =============> Iteration k : 288
batch_iter = 48
time1: 8.000095e+00
time2: 1.194078e+00
time3: 1.338857e+00
time4: 7.267053e+00
time5: 2.472003e+01
 =============> Iteration k : 289
batch_iter = 7
time1: 7.469364e+00
time2: 9.824380e-01
time3: 1.103432e+00
time4: 7.608350e+00
time5: 2.390537e+01
 =============> Iteration k : 290
batch_iter = 41
time1: 7.391997e+00
time2: 1.206617e+00
time3: 9.561080e-01
time4: 7.204177e+00
time5: 2.370357e+01
 =============> Iteration k : 291
batch_iter = 50
time1: 7.872297e+00
time2: 9.858230e-01
time3: 7.939980e-01
time4: 7.085404e+00
time5: 2.438652e+01
 =============> Iteration k : 292
batch_iter = 3
time1: 7.412693e+00
time2: 7.966920e-01
time3: 9.974010e-01
time4: 7.478873e+00
time5: 2.420442e+01
 =============> Iteration k : 293
batch_iter = 10
time1: 7.820838e+00
```

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time2: 1.163060e+00
time3: 9.191290e-01
time4: 7.490622e+00
time5: 2.371838e+01
 =============> Iteration k : 294
batch_iter = 28
time1: 7.636156e+00
time2: 1.107222e+00
time3: 1.004710e+00
time4: 7.640682e+00
time5: 2.373776e+01
 =============> Iteration k : 295
batch_iter = 35
time1: 7.622805e+00
time2: 9.765200e-01
time3: 1.067679e+00
time4: 8.086835e+00
time5: 2.352755e+01
 =============> Iteration k : 296
batch_iter = 59
time1: 6.873145e+00
time2: 1.086029e+00
time3: 1.307186e+00
time4: 7.896913e+00
time5: 2.248517e+01
 =============> Iteration k : 297
batch_iter = 42
time1: 7.305747e+00
time2: 1.090116e+00
time3: 1.099141e+00
time4: 8.479976e+00
time5: 2.239320e+01
 =============> Iteration k : 298
batch_iter = 29
time1: 7.792173e+00
time2: 9.781170e-01
time3: 1.134977e+00
time4: 9.287388e+00
time5: 2.289382e+01
 =============> Iteration k : 299
batch_iter = 57
time1: 7.170367e+00
time2: 1.318708e+00
time3: 1.482248e+00
time4: 7.917434e+00
time5: 2.335929e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 300
batch_iter = 19
time1: 6.875055e+00
time2: 1.033047e+00
time3: 1.173572e+00
time4: 1.019694e+01
time5: 2.311339e+01
 =============> Iteration k : 301
batch_iter = 3
time1: 7.166339e+00
time2: 1.281001e+00
time3: 1.198476e+00
time4: 9.321871e+00
time5: 2.129676e+01
 =============> Iteration k : 302
batch_iter = 28
time1: 7.286425e+00
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time2: 1.382244e+00
time3: 1.469059e+00
time4: 8.120400e+00
time5: 2.208228e+01
 =============> Iteration k : 303
batch_iter = 45
time1: 7.507679e+00
time2: 1.670399e+00
time3: 1.093908e+00
time4: 8.082524e+00
time5: 2.303231e+01
 =============> Iteration k : 304
batch_iter = 59
time1: 7.055358e+00
time2: 1.132343e+00
time3: 1.467361e+00
time4: 7.521438e+00
time5: 2.385983e+01
 =============> Iteration k : 305
batch_iter = 15
time1: 7.634299e+00
time2: 1.120299e+00
time3: 1.239222e+00
time4: 7.805820e+00
time5: 2.429990e+01
 =============> Iteration k : 306
batch_iter = 38
time1: 7.824301e+00
time2: 1.491355e+00
time3: 1.505929e+00
time4: 7.943615e+00
time5: 2.243148e+01
 =============> Iteration k : 307
batch_iter = 51
time1: 8.464662e+00
time2: 1.137653e+00
time3: 1.514449e+00
time4: 8.106309e+00
time5: 2.177379e+01
 =============> Iteration k : 308
batch_iter = 22
time1: 7.871368e+00
time2: 1.311283e+00
time3: 1.026926e+00
time4: 8.937455e+00
time5: 2.197307e+01
 =============> Iteration k : 309
batch_iter = 14
time1: 7.880942e+00
time2: 1.616038e+00
time3: 1.499461e+00
time4: 9.197399e+00
time5: 2.298650e+01
 =============> Iteration k : 310
batch_iter = 29
time1: 8.390712e+00
time2: 1.577680e+00
time3: 1.423897e+00
time4: 8.075203e+00
time5: 2.140216e+01
 =============> Iteration k : 311
batch_iter = 44
time1: 8.891801e+00
time2: 1.396453e+00
```

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time3: 1.405886e+00
time4: 8.392243e+00
time5: 2.120419e+01
 =============> Iteration k : 312
batch_iter = 4
time1: 7.599702e+00
time2: 1.636007e+00
time3: 1.202495e+00
time4: 8.419161e+00
time5: 2.179584e+01
 =============> Iteration k : 313
batch_iter = 20
time1: 7.777653e+00
time2: 1.015259e+00
time3: 1.446133e+00
time4: 8.000132e+00
time5: 2.279344e+01
 =============> Iteration k : 314
batch_iter = 46
time1: 7.619220e+00
time2: 2.100866e+00
time3: 1.122403e+00
time4: 7.678520e+00
time5: 2.241609e+01
 =============> Iteration k : 315
batch_iter = 36
time1: 8.176184e+00
time2: 1.674091e+00
time3: 1.319902e+00
time4: 8.167674e+00
time5: 2.382310e+01
 =============> Iteration k : 316
batch_iter = 42
time1: 8.280931e+00
time2: 1.484814e+00
time3: 1.210975e+00
time4: 7.414113e+00
time5: 2.363648e+01
 =============> Iteration k : 317
batch_iter = 48
time1: 8.650199e+00
time2: 1.134460e+00
time3: 8.853810e-01
time4: 7.519890e+00
time5: 2.342532e+01
 =============> Iteration k : 318
batch_iter = 47
time1: 8.191751e+00
time2: 1.506647e+00
time3: 1.203476e+00
time4: 7.620989e+00
time5: 2.336619e+01
 =============> Iteration k : 319
batch_iter = 43
time1: 8.478903e+00
time2: 1.106048e+00
time3: 1.121456e+00
time4: 7.678180e+00
time5: 2.268439e+01
 =============> Iteration k : 320
batch_iter = 40
time1: 8.124833e+00
time2: 1.554512e+00
time3: 1.112005e+00
```

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time4: 8.399890e+00
time5: 2.341190e+01
 =============> Iteration k : 321
batch_iter = 7
time1: 7.734879e+00
time2: 1.334587e+00
time3: 1.127432e+00
time4: 7.839101e+00
time5: 2.263057e+01
 =============> Iteration k : 322
batch_iter = 35
time1: 8.195594e+00
time2: 1.455824e+00
time3: 2.026279e+00
time4: 8.301245e+00
time5: 2.248533e+01
 =============> Iteration k : 323
batch_iter = 16
time1: 8.167177e+00
time2: 1.683254e+00
time3: 1.317042e+00
time4: 8.395124e+00
time5: 2.117629e+01
 =============> Iteration k : 324
batch_iter = 31
time1: 7.478817e+00
time2: 1.998718e+00
time3: 1.495837e+00
time4: 7.713754e+00
time5: 2.039327e+01
 =============> Iteration k : 325
batch_iter = 32
time1: 7.175050e+00
time2: 1.300300e+00
time3: 1.132947e+00
time4: 9.275987e+00
time5: 2.236658e+01
 =============> Iteration k : 326
batch_iter = 17
time1: 7.185440e+00
time2: 1.117272e+00
time3: 1.473870e+00
time4: 8.612826e+00
time5: 2.281750e+01
 =============> Iteration k : 327
batch_iter = 21
time1: 8.007698e+00
time2: 1.318914e+00
time3: 1.005816e+00
time4: 8.451106e+00
time5: 2.322606e+01
 =============> Iteration k : 328
batch_iter = 55
time1: 7.161064e+00
time2: 1.607470e+00
time3: 1.700362e+00
time4: 8.087809e+00
time5: 2.269575e+01
 =============> Iteration k : 329
batch_iter = 12
time1: 8.423136e+00
time2: 1.132227e+00
time3: 1.897895e+00
time4: 8.464918e+00
```

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time5: 2.329344e+01
 =============> Iteration k : 330
batch_iter = 5
time1: 7.809877e+00
time2: 1.076793e+00
time3: 1.714609e+00
time4: 7.971963e+00
time5: 2.212138e+01
 =============> Iteration k : 331
batch_iter = 11
time1: 8.805875e+00
time2: 1.435642e+00
time3: 1.096851e+00
time4: 7.497516e+00
time5: 2.318435e+01
 =============> Iteration k : 332
batch_iter = 34
time1: 8.199396e+00
time2: 1.565261e+00
time3: 1.095070e+00
time4: 7.214335e+00
time5: 2.339511e+01
 =============> Iteration k : 333
batch_iter = 49
time1: 8.682520e+00
time2: 1.172420e+00
time3: 1.319532e+00
time4: 8.066163e+00
time5: 2.472244e+01
 =============> Iteration k : 334
batch_iter = 27
time1: 8.792596e+00
time2: 1.475882e+00
time3: 1.310798e+00
time4: 7.624364e+00
time5: 2.364692e+01
 =============> Iteration k : 335
batch_iter = 18
time1: 8.844582e+00
time2: 1.468486e+00
time3: 1.396790e+00
time4: 8.170402e+00
time5: 2.300937e+01
 =============> Iteration k : 336
batch_iter = 54
time1: 7.304869e+00
time2: 1.580630e+00
time3: 1.327247e+00
time4: 7.532854e+00
time5: 2.309092e+01
 =============> Iteration k : 337
batch_iter = 23
time1: 7.890582e+00
time2: 1.111003e+00
time3: 1.628649e+00
time4: 8.802549e+00
time5: 2.278280e+01
 =============> Iteration k : 338
batch_iter = 41
time1: 7.766203e+00
time2: 1.598522e+00
time3: 1.635577e+00
time4: 7.761968e+00
time5: 2.351437e+01
```

```
 =============> Iteration k : 339
batch_iter = 39
time1: 7.942925e+00
time2: 1.491518e+00
time3: 1.021566e+00
time4: 8.005940e+00
time5: 2.327385e+01
 =============> Iteration k : 340
batch_iter = 10
time1: 7.502014e+00
time2: 1.010174e+00
time3: 1.201502e+00
time4: 8.508067e+00
time5: 2.321435e+01
 =============> Iteration k : 341
batch_iter = 26
time1: 7.692782e+00
time2: 1.368756e+00
time3: 1.303936e+00
time4: 8.607272e+00
time5: 2.356616e+01
 =============> Iteration k : 342
batch_iter = 33
time1: 7.923406e+00
time2: 1.230191e+00
time3: 1.122856e+00
time4: 7.975887e+00
time5: 2.329533e+01
 =============> Iteration k : 343
batch_iter = 37
time1: 7.270521e+00
time2: 9.117540e-01
time3: 1.095729e+00
time4: 7.970010e+00
time5: 2.200756e+01
 =============> Iteration k : 344
batch_iter = 58
time1: 7.392213e+00
time2: 1.085422e+00
time3: 1.327568e+00
time4: 8.428068e+00
time5: 2.250443e+01
 =============> Iteration k : 345
batch_iter = 25
time1: 7.901367e+00
time2: 1.113629e+00
time3: 1.116696e+00
time4: 8.594315e+00
time5: 2.406253e+01
 =============> Iteration k : 346
batch_iter = 57
time1: 8.331862e+00
time2: 1.193407e+00
time3: 1.173955e+00
time4: 8.112716e+00
time5: 2.196201e+01
 =============> Iteration k : 347
batch_iter = 6
time1: 8.710458e+00
time2: 1.420423e+00
time3: 2.054876e+00
time4: 7.634691e+00
time5: 2.175124e+01
 =============> Iteration k : 348
```

```
batch_iter = 24
time1: 8.481647e+00
time2: 1.917310e+00
time3: 1.115722e+00
time4: 8.096182e+00
time5: 2.171907e+01
 ==============> Iteration k : 349
batch_iter = 30
time1: 8.268316e+00
time2: 1.802719e+00
time3: 1.986050e+00
time4: 8.500499e+00
time5: 2.211756e+01
 ==============> Iteration k : 350
batch_iter = 50
time1: 8.996429e+00
time2: 2.046805e+00
time3: 1.359706e+00
time4: 7.524163e+00
time5: 2.088121e+01
 ==============> Iteration k : 351
batch_iter = 2
time1: 7.814424e+00
time2: 1.420626e+00
time3: 1.631259e+00
time4: 8.470006e+00
time5: 2.181174e+01
 ==============> Iteration k : 352
batch_iter = 56
time1: 8.398951e+00
time2: 1.509884e+00
time3: 1.368084e+00
time4: 8.393603e+00
time5: 2.213890e+01
 ==============> Iteration k : 353
batch_iter = 53
time1: 7.954905e+00
time2: 1.289435e+00
time3: 1.127353e+00
time4: 8.476398e+00
time5: 2.178944e+01
 ==============> Iteration k : 354
batch_iter = 8
time1: 7.796814e+00
time2: 1.523145e+00
time3: 1.703847e+00
time4: 7.797685e+00
time5: 2.217473e+01
 ==============> Iteration k : 355
batch_iter = 60
time1: 8.076108e+00
time2: 1.178391e+00
time3: 1.128676e+00
time4: 7.272650e+00
time5: 2.351553e+01
 ==============> Iteration k : 356
batch_iter = 9
time1: 7.754056e+00
time2: 5.464620e-01
time3: 1.100693e+00
time4: 6.259451e+00
time5: 1.801679e+01
 ==============> Iteration k : 357
batch_iter = 1
```

```
time1: 5.960763e+00
time2: 6.972310e-01
time3: 7.840230e-01
time4: 5.756105e+00
time5: 1.773785e+01
 =============> Iteration k : 358
batch_iter = 13
time1: 6.352187e+00
time2: 8.350450e-01
time3: 1.101341e+00
time4: 5.076029e+00
time5: 1.848887e+01
 =============> Iteration k : 359
batch_iter = 52
time1: 6.001215e+00
time2: 9.769870e-01
time3: 9.190790e-01
time4: 5.105270e+00
time5: 1.866764e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 360
batch_iter = 27
time1: 6.205957e+00
time2: 6.640630e-01
time3: 7.149370e-01
time4: 5.209449e+00
time5: 1.821260e+01
 =============> Iteration k : 361
batch_iter = 12
time1: 6.380255e+00
time2: 1.106202e+00
time3: 1.097828e+00
time4: 4.829572e+00
time5: 1.778347e+01
 =============> Iteration k : 362
batch_iter = 24
time1: 5.981797e+00
time2: 9.049180e-01
time3: 9.982180e-01
time4: 5.311222e+00
time5: 1.657689e+01
 =============> Iteration k : 363
batch_iter = 21
time1: 6.093968e+00
time2: 8.182550e-01
time3: 9.660450e-01
time4: 5.528582e+00
time5: 1.780504e+01
 =============> Iteration k : 364
batch_iter = 33
time1: 5.932984e+00
time2: 8.638700e-01
time3: 1.073771e+00
time4: 5.558709e+00
time5: 1.775160e+01
 =============> Iteration k : 365
batch_iter = 45
time1: 6.046184e+00
time2: 6.173230e-01
time3: 7.898200e-01
time4: 6.274244e+00
time5: 1.732793e+01
 =============> Iteration k : 366
batch_iter = 37
```

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time1: 6.290142e+00
time2: 8.661450e-01
time3: 8.222640e-01
time4: 6.584908e+00
time5: 1.648033e+01
 =============> Iteration k : 367
batch_iter = 17
time1: 5.316340e+00
time2: 6.061990e-01
time3: 9.902640e-01
time4: 5.985858e+00
time5: 1.719265e+01
 =============> Iteration k : 368
batch_iter = 52
time1: 4.938917e+00
time2: 7.175020e-01
time3: 1.077924e+00
time4: 6.043642e+00
time5: 1.828537e+01
 =============> Iteration k : 369
batch_iter = 16
time1: 4.578033e+00
time2: 7.840100e-01
time3: 9.241430e-01
time4: 5.892987e+00
time5: 1.830393e+01
 =============> Iteration k : 370
batch_iter = 41
time1: 4.831000e+00
time2: 6.665100e-01
time3: 1.001482e+00
time4: 5.768774e+00
time5: 1.835003e+01
 =============> Iteration k : 371
batch_iter = 19
time1: 4.939443e+00
time2: 6.221070e-01
time3: 6.688360e-01
time4: 5.943063e+00
time5: 1.866259e+01
 =============> Iteration k : 372
batch_iter = 4
time1: 5.425533e+00
time2: 9.313160e-01
time3: 1.027020e+00
time4: 5.768273e+00
time5: 1.776497e+01
 =============> Iteration k : 373
batch_iter = 13
time1: 6.297011e+00
time2: 7.472820e-01
time3: 1.004427e+00
time4: 5.715009e+00
time5: 1.750531e+01
 =============> Iteration k : 374
batch_iter = 60
time1: 6.572999e+00
time2: 8.859500e-01
time3: 9.610110e-01
time4: 5.453638e+00
time5: 1.658830e+01
 =============> Iteration k : 375
batch_iter = 32
time1: 6.305882e+00
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time2: 1.167253e+00
time3: 1.173585e+00
time4: 5.809150e+00
time5: 1.731351e+01
 =============> Iteration k : 376
batch_iter = 57
time1: 6.598578e+00
time2: 8.855120e-01
time3: 9.710750e-01
time4: 5.631863e+00
time5: 1.658536e+01
 =============> Iteration k : 377
batch_iter = 9
time1: 6.995754e+00
time2: 1.050315e+00
time3: 1.408455e+00
time4: 5.996933e+00
time5: 1.696593e+01
 =============> Iteration k : 378
batch_iter = 30
time1: 6.423899e+00
time2: 1.095854e+00
time3: 9.575730e-01
time4: 5.652928e+00
time5: 1.646884e+01
 =============> Iteration k : 379
batch_iter = 15
time1: 6.786702e+00
time2: 8.832860e-01
time3: 9.970930e-01
time4: 5.999027e+00
time5: 1.742855e+01
 =============> Iteration k : 380
batch_iter = 29
time1: 6.741710e+00
time2: 8.036750e-01
time3: 1.008307e+00
time4: 5.592187e+00
time5: 1.640558e+01
 =============> Iteration k : 381
batch_iter = 43
time1: 6.468650e+00
time2: 1.092111e+00
time3: 1.049110e+00
time4: 6.106092e+00
time5: 1.701180e+01
 =============> Iteration k : 382
batch_iter = 36
time1: 5.963599e+00
time2: 9.935820e-01
time3: 1.243386e+00
time4: 5.565981e+00
time5: 1.749030e+01
 =============> Iteration k : 383
batch_iter = 53
time1: 5.627068e+00
time2: 6.532430e-01
time3: 1.079486e+00
time4: 5.700818e+00
time5: 1.789567e+01
 =============> Iteration k : 384
batch_iter = 50
time1: 5.905784e+00
time2: 6.472510e-01
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time3: 8.671160e-01
time4: 5.635755e+00
time5: 1.771304e+01
 =============> Iteration k : 385
batch_iter = 34
time1: 5.632566e+00
time2: 7.527890e-01
time3: 1.064040e+00
time4: 5.093212e+00
time5: 1.851259e+01
 =============> Iteration k : 386
batch_iter = 14
time1: 5.386063e+00
time2: 8.057500e-01
time3: 8.151490e-01
time4: 5.441265e+00
time5: 1.793388e+01
 =============> Iteration k : 387
batch_iter = 31
time1: 5.178228e+00
time2: 5.870200e-01
time3: 9.067380e-01
time4: 5.907578e+00
time5: 1.898915e+01
 =============> Iteration k : 388
batch_iter = 7
time1: 5.027979e+00
time2: 4.698320e-01
time3: 6.057830e-01
time4: 5.866779e+00
time5: 1.838051e+01
 =============> Iteration k : 389
batch_iter = 23
time1: 5.224572e+00
time2: 6.653220e-01
time3: 8.232790e-01
time4: 5.450054e+00
time5: 1.801825e+01
 =============> Iteration k : 390
batch_iter = 59
time1: 5.796236e+00
time2: 4.937850e-01
time3: 9.221610e-01
time4: 5.457444e+00
time5: 1.787224e+01
 =============> Iteration k : 391
batch_iter = 28
time1: 5.774640e+00
time2: 7.304210e-01
time3: 1.014258e+00
time4: 5.656657e+00
time5: 1.737807e+01
 =============> Iteration k : 392
batch_iter = 26
time1: 5.550090e+00
time2: 7.316440e-01
time3: 1.010591e+00
time4: 5.976855e+00
time5: 1.759429e+01
 =============> Iteration k : 393
batch_iter = 25
time1: 5.655514e+00
time2: 1.018945e+00
time3: 1.092796e+00
```

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time4: 5.936285e+00
time5: 1.714698e+01
 =============> Iteration k : 394
batch_iter = 1
time1: 5.943674e+00
time2: 9.284920e-01
time3: 1.030678e+00
time4: 6.414310e+00
time5: 1.587730e+01
 =============> Iteration k : 395
batch_iter = 44
time1: 6.527299e+00
time2: 1.173394e+00
time3: 9.995260e-01
time4: 6.628871e+00
time5: 1.630044e+01
 =============> Iteration k : 396
batch_iter = 47
time1: 5.816716e+00
time2: 9.792750e-01
time3: 9.931860e-01
time4: 6.222250e+00
time5: 2.037148e+01
 =============> Iteration k : 397
batch_iter = 11
time1: 6.892379e+00
time2: 9.149540e-01
time3: 1.083600e+00
time4: 6.088701e+00
time5: 1.647366e+01
 =============> Iteration k : 398
batch_iter = 48
time1: 6.054163e+00
time2: 8.353130e-01
time3: 1.109710e+00
time4: 6.467029e+00
time5: 1.661677e+01
 =============> Iteration k : 399
batch_iter = 3
time1: 6.369236e+00
time2: 1.405933e+00
time3: 9.964120e-01
time4: 6.369434e+00
time5: 1.635003e+01
 =============> Iteration k : 400
batch_iter = 58
time1: 6.181487e+00
time2: 8.752810e-01
time3: 1.114464e+00
time4: 6.274820e+00
time5: 1.701264e+01
 =============> Iteration k : 401
batch_iter = 2
time1: 6.368562e+00
time2: 8.128550e-01
time3: 6.971480e-01
time4: 5.854254e+00
time5: 1.721897e+01
 =============> Iteration k : 402
batch_iter = 49
time1: 5.368431e+00
time2: 7.306220e-01
time3: 9.848530e-01
time4: 5.981420e+00
```

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time5: 1.789030e+01
 =============> Iteration k : 403
batch_iter = 20
time1: 5.493084e+00
time2: 6.320460e-01
time3: 1.010564e+00
time4: 5.216766e+00
time5: 1.871448e+01
 =============> Iteration k : 404
batch_iter = 42
time1: 5.683823e+00
time2: 8.048280e-01
time3: 1.012334e+00
time4: 5.137554e+00
time5: 1.888901e+01
 =============> Iteration k : 405
batch_iter = 51
time1: 5.292817e+00
time2: 6.047560e-01
time3: 5.345960e-01
time4: 5.025541e+00
time5: 1.871154e+01
 =============> Iteration k : 406
batch_iter = 46
time1: 5.916078e+00
time2: 7.441140e-01
time3: 5.354180e-01
time4: 5.291660e+00
time5: 1.830848e+01
 =============> Iteration k : 407
batch_iter = 6
time1: 5.484007e+00
time2: 5.713680e-01
time3: 8.881060e-01
time4: 5.202888e+00
time5: 1.810871e+01
 =============> Iteration k : 408
batch_iter = 40
time1: 5.701433e+00
time2: 8.055770e-01
time3: 9.732920e-01
time4: 5.580978e+00
time5: 1.751848e+01
 =============> Iteration k : 409
batch_iter = 55
time1: 5.765316e+00
time2: 1.085836e+00
time3: 8.726940e-01
time4: 5.869222e+00
time5: 1.756201e+01
 =============> Iteration k : 410
batch_iter = 54
time1: 5.606232e+00
time2: 9.742950e-01
time3: 9.114160e-01
time4: 5.628287e+00
time5: 1.731634e+01
 =============> Iteration k : 411
batch_iter = 5
time1: 5.923524e+00
time2: 1.160404e+00
time3: 1.016493e+00
time4: 6.273576e+00
time5: 1.713317e+01
```

```
 =============> Iteration k : 412
batch_iter = 38
time1: 5.399723e+00
time2: 1.213837e+00
time3: 9.238170e-01
time4: 6.383656e+00
time5: 1.622039e+01
 =============> Iteration k : 413
batch_iter = 35
time1: 5.596176e+00
time2: 9.189430e-01
time3: 1.303306e+00
time4: 6.616948e+00
time5: 1.589246e+01
 =============> Iteration k : 414
batch_iter = 22
time1: 5.796962e+00
time2: 9.094250e-01
time3: 1.093974e+00
time4: 6.576645e+00
time5: 1.611456e+01
 =============> Iteration k : 415
batch_iter = 39
time1: 5.798938e+00
time2: 8.218110e-01
time3: 1.199833e+00
time4: 6.886762e+00
time5: 1.576756e+01
 =============> Iteration k : 416
batch_iter = 18
time1: 5.284576e+00
time2: 9.245140e-01
time3: 1.071092e+00
time4: 6.485991e+00
time5: 1.774287e+01
 =============> Iteration k : 417
batch_iter = 56
time1: 5.384669e+00
time2: 1.055682e+00
time3: 1.128828e+00
time4: 6.197538e+00
time5: 1.718259e+01
 =============> Iteration k : 418
batch_iter = 10
time1: 5.562630e+00
time2: 8.255500e-01
time3: 1.068602e+00
time4: 6.091181e+00
time5: 1.732303e+01
 =============> Iteration k : 419
batch_iter = 8
time1: 5.394911e+00
time2: 9.969260e-01
time3: 1.070902e+00
time4: 6.010215e+00
time5: 1.738709e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 420
batch_iter = 17
time1: 5.597957e+00
time2: 7.737210e-01
time3: 7.668540e-01
time4: 5.540866e+00
time5: 1.691481e+01
```

```
 =============> Iteration k : 421
batch_iter = 16
time1: 6.505196e+00
time2: 6.485840e-01
time3: 1.037763e+00
time4: 5.560378e+00
time5: 1.699122e+01
 =============> Iteration k : 422
batch_iter = 22
time1: 6.303085e+00
time2: 1.218986e+00
time3: 1.048833e+00
time4: 5.720034e+00
time5: 1.578908e+01
 =============> Iteration k : 423
batch_iter = 60
time1: 6.827193e+00
time2: 9.357340e-01
time3: 1.006054e+00
time4: 5.692921e+00
time5: 1.646676e+01
 =============> Iteration k : 424
batch_iter = 14
time1: 6.625121e+00
time2: 1.021605e+00
time3: 1.082352e+00
time4: 6.224628e+00
time5: 1.658586e+01
 =============> Iteration k : 425
batch_iter = 41
time1: 5.956946e+00
time2: 1.101428e+00
time3: 8.923520e-01
time4: 6.085150e+00
time5: 1.634446e+01
 =============> Iteration k : 426
batch_iter = 26
time1: 6.765787e+00
time2: 9.957860e-01
time3: 1.009916e+00
time4: 5.999290e+00
time5: 1.628659e+01
 =============> Iteration k : 427
batch_iter = 48
time1: 6.745214e+00
time2: 1.322537e+00
time3: 9.969930e-01
time4: 6.328012e+00
time5: 1.713130e+01
 =============> Iteration k : 428
batch_iter = 5
time1: 6.280620e+00
time2: 1.014046e+00
time3: 1.011975e+00
time4: 5.953110e+00
time5: 1.632627e+01
 =============> Iteration k : 429
batch_iter = 8
time1: 6.895088e+00
time2: 1.527533e+00
time3: 1.086256e+00
time4: 6.311321e+00
time5: 1.620947e+01
 =============> Iteration k : 430
```

```
batch_iter = 42
time1: 5.986066e+00
time2: 8.899810e-01
time3: 1.178295e+00
time4: 6.006059e+00
time5: 1.701227e+01
 ==============> Iteration k : 431
batch_iter = 9
time1: 6.060572e+00
time2: 8.846680e-01
time3: 1.039411e+00
time4: 5.778021e+00
time5: 1.769823e+01
 ==============> Iteration k : 432
batch_iter = 11
time1: 5.917343e+00
time2: 7.474960e-01
time3: 1.043176e+00
time4: 5.956299e+00
time5: 1.823066e+01
 ==============> Iteration k : 433
batch_iter = 29
time1: 5.283715e+00
time2: 6.996570e-01
time3: 9.885210e-01
time4: 5.284665e+00
time5: 1.858842e+01
 ==============> Iteration k : 434
batch_iter = 20
time1: 5.489412e+00
time2: 7.108510e-01
time3: 9.035800e-01
time4: 5.274927e+00
time5: 1.780700e+01
 ==============> Iteration k : 435
batch_iter = 34
time1: 5.107527e+00
time2: 8.343570e-01
time3: 8.710160e-01
time4: 5.171768e+00
time5: 1.829327e+01
 ==============> Iteration k : 436
batch_iter = 13
time1: 5.409698e+00
time2: 5.768960e-01
time3: 6.325200e-01
time4: 5.054514e+00
time5: 1.902390e+01
 ==============> Iteration k : 437
batch_iter = 44
time1: 5.507447e+00
time2: 7.521910e-01
time3: 5.904050e-01
time4: 5.140238e+00
time5: 1.858532e+01
 ==============> Iteration k : 438
batch_iter = 57
time1: 5.570149e+00
time2: 3.902600e-01
time3: 9.570830e-01
time4: 5.446556e+00
time5: 1.822110e+01
 ==============> Iteration k : 439
batch_iter = 50
```

```
time1: 5.384210e+00
time2: 7.553740e-01
time3: 6.484900e-01
time4: 5.673849e+00
time5: 1.847983e+01
 ==============> Iteration k : 440
batch_iter = 15
time1: 5.577960e+00
time2: 7.977540e-01
time3: 1.036484e+00
time4: 5.699298e+00
time5: 1.825164e+01
 ==============> Iteration k : 441
batch_iter = 45
time1: 5.513025e+00
time2: 8.686520e-01
time3: 9.935600e-01
time4: 5.824174e+00
time5: 1.830599e+01
 ==============> Iteration k : 442
batch_iter = 47
time1: 5.864175e+00
time2: 7.943260e-01
time3: 9.964440e-01
time4: 5.995818e+00
time5: 1.709627e+01
 ==============> Iteration k : 443
batch_iter = 24
time1: 6.110256e+00
time2: 1.083227e+00
time3: 1.081880e+00
time4: 6.178782e+00
time5: 1.694262e+01
 ==============> Iteration k : 444
batch_iter = 19
time1: 6.094319e+00
time2: 7.854730e-01
time3: 1.110751e+00
time4: 6.778022e+00
time5: 1.604563e+01
 ==============> Iteration k : 445
batch_iter = 1
time1: 6.525851e+00
time2: 1.180985e+00
time3: 1.012772e+00
time4: 6.509269e+00
time5: 1.569501e+01
 ==============> Iteration k : 446
batch_iter = 39
time1: 6.266748e+00
time2: 1.069029e+00
time3: 9.123270e-01
time4: 6.275286e+00
time5: 1.621639e+01
 ==============> Iteration k : 447
batch_iter = 43
time1: 6.381734e+00
time2: 1.077874e+00
time3: 1.385990e+00
time4: 6.507036e+00
time5: 1.552009e+01
 ==============> Iteration k : 448
batch_iter = 4
time1: 6.254034e+00
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time2: 8.996470e-01
time3: 1.112140e+00
time4: 6.408200e+00
time5: 1.648659e+01
 =============> Iteration k : 449
batch_iter = 58
time1: 5.812908e+00
time2: 7.184190e-01
time3: 9.879290e-01
time4: 6.110237e+00
time5: 1.650391e+01
 =============> Iteration k : 450
batch_iter = 51
time1: 6.193265e+00
time2: 8.914010e-01
time3: 9.074580e-01
time4: 6.096512e+00
time5: 1.698859e+01
 =============> Iteration k : 451
batch_iter = 55
time1: 5.982993e+00
time2: 9.819350e-01
time3: 9.948100e-01
time4: 6.118945e+00
time5: 1.737755e+01
 =============> Iteration k : 452
batch_iter = 52
time1: 5.810383e+00
time2: 8.554280e-01
time3: 1.024009e+00
time4: 6.160395e+00
time5: 1.749735e+01
 =============> Iteration k : 453
batch_iter = 54
time1: 5.744109e+00
time2: 9.166780e-01
time3: 9.997380e-01
time4: 5.636331e+00
time5: 1.684801e+01
 =============> Iteration k : 454
batch_iter = 2
time1: 6.069821e+00
time2: 1.003324e+00
time3: 9.688260e-01
time4: 5.741100e+00
time5: 1.713474e+01
 =============> Iteration k : 455
batch_iter = 35
time1: 6.089479e+00
time2: 8.622390e-01
time3: 9.406990e-01
time4: 5.192240e+00
time5: 1.816832e+01
 =============> Iteration k : 456
batch_iter = 3
time1: 6.325343e+00
time2: 9.038910e-01
time3: 9.421790e-01
time4: 5.228673e+00
time5: 1.687827e+01
 =============> Iteration k : 457
batch_iter = 38
time1: 6.492057e+00
time2: 9.383830e-01
```

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time3: 1.045721e+00
time4: 4.911306e+00
time5: 1.641387e+01
 =============> Iteration k : 458
batch_iter = 25
time1: 6.586448e+00
time2: 9.080060e-01
time3: 1.021779e+00
time4: 5.584384e+00
time5: 1.650614e+01
 =============> Iteration k : 459
batch_iter = 7
time1: 6.550826e+00
time2: 1.044192e+00
time3: 1.034177e+00
time4: 5.671067e+00
time5: 1.729707e+01
 =============> Iteration k : 460
batch_iter = 36
time1: 6.101720e+00
time2: 1.103732e+00
time3: 1.161372e+00
time4: 5.739951e+00
time5: 1.701141e+01
 =============> Iteration k : 461
batch_iter = 10
time1: 6.418849e+00
time2: 1.001297e+00
time3: 9.548900e-01
time4: 6.046308e+00
time5: 1.711021e+01
 =============> Iteration k : 462
batch_iter = 31
time1: 6.099790e+00
time2: 9.780800e-01
time3: 1.007669e+00
time4: 5.614396e+00
time5: 1.651517e+01
 =============> Iteration k : 463
batch_iter = 46
time1: 5.925694e+00
time2: 8.166730e-01
time3: 9.620990e-01
time4: 5.335355e+00
time5: 1.824632e+01
 =============> Iteration k : 464
batch_iter = 33
time1: 5.745168e+00
time2: 7.512900e-01
time3: 9.714370e-01
time4: 5.474906e+00
time5: 1.784090e+01
 =============> Iteration k : 465
batch_iter = 21
time1: 5.568220e+00
time2: 5.833780e-01
time3: 9.820860e-01
time4: 5.213264e+00
time5: 1.860068e+01
 =============> Iteration k : 466
batch_iter = 59
time1: 5.190113e+00
time2: 6.087510e-01
time3: 9.853450e-01
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time4: 5.390353e+00
time5: 1.770615e+01
 =============> Iteration k : 467
batch_iter = 40
time1: 5.087915e+00
time2: 7.878560e-01
time3: 7.853900e-01
time4: 5.617499e+00
time5: 1.816614e+01
 =============> Iteration k : 468
batch_iter = 18
time1: 5.200031e+00
time2: 6.443500e-01
time3: 7.886710e-01
time4: 5.766699e+00
time5: 1.859115e+01
 =============> Iteration k : 469
batch_iter = 49
time1: 5.110280e+00
time2: 6.508190e-01
time3: 8.681270e-01
time4: 5.964337e+00
time5: 1.828245e+01
 =============> Iteration k : 470
batch_iter = 32
time1: 5.386339e+00
time2: 5.796340e-01
time3: 7.308570e-01
time4: 6.099775e+00
time5: 1.779602e+01
 =============> Iteration k : 471
batch_iter = 37
time1: 5.452064e+00
time2: 6.958610e-01
time3: 7.348880e-01
time4: 5.410742e+00
time5: 1.844815e+01
 =============> Iteration k : 472
batch_iter = 23
time1: 5.592464e+00
time2: 1.056266e+00
time3: 9.211840e-01
time4: 5.976387e+00
time5: 1.740419e+01
 =============> Iteration k : 473
batch_iter = 30
time1: 5.889887e+00
time2: 6.871400e-01
time3: 1.086839e+00
time4: 5.616769e+00
time5: 1.728739e+01
 =============> Iteration k : 474
batch_iter = 6
time1: 6.279853e+00
time2: 9.304440e-01
time3: 1.026514e+00
time4: 5.814347e+00
time5: 1.717189e+01
 =============> Iteration k : 475
batch_iter = 56
time1: 6.398914e+00
time2: 1.186600e+00
time3: 1.093137e+00
time4: 5.983114e+00
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time5: 1.590504e+01
 =============> Iteration k : 476
batch_iter = 27
time1: 6.192421e+00
time2: 1.284410e+00
time3: 1.022103e+00
time4: 6.160141e+00
time5: 1.571667e+01
 =============> Iteration k : 477
batch_iter = 12
time1: 6.515629e+00
time2: 1.016971e+00
time3: 1.210822e+00
time4: 6.249612e+00
time5: 1.643571e+01
 =============> Iteration k : 478
batch_iter = 53
time1: 6.248283e+00
time2: 9.343920e-01
time3: 1.204511e+00
time4: 6.186042e+00
time5: 1.607940e+01
 =============> Iteration k : 479
batch_iter = 28
time1: 6.110811e+00
time2: 1.153457e+00
time3: 1.096807e+00
time4: 6.218487e+00
time5: 1.609970e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 480
batch_iter = 7
time1: 6.514041e+00
time2: 7.929650e-01
time3: 1.030942e+00
time4: 6.768178e+00
time5: 1.741858e+01
 =============> Iteration k : 481
batch_iter = 56
time1: 6.086636e+00
time2: 8.632740e-01
time3: 1.113872e+00
time4: 6.077099e+00
time5: 1.672077e+01
 =============> Iteration k : 482
batch_iter = 54
time1: 5.696560e+00
time2: 1.063112e+00
time3: 9.507210e-01
time4: 6.102426e+00
time5: 1.743500e+01
 =============> Iteration k : 483
batch_iter = 42
time1: 5.614313e+00
time2: 8.215240e-01
time3: 1.110062e+00
time4: 5.866970e+00
time5: 1.739943e+01
 =============> Iteration k : 484
batch_iter = 9
time1: 5.622531e+00
time2: 7.333700e-01
time3: 1.222681e+00
time4: 5.921961e+00
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time5: 1.819684e+01
 =============> Iteration k : 485
batch_iter = 17
time1: 6.122920e+00
time2: 5.455570e-01
time3: 9.928400e-01
time4: 5.821385e+00
time5: 1.831150e+01
 =============> Iteration k : 486
batch_iter = 35
time1: 5.787992e+00
time2: 7.065130e-01
time3: 5.762200e-01
time4: 5.250869e+00
time5: 1.899126e+01
 =============> Iteration k : 487
batch_iter = 4
time1: 5.717543e+00
time2: 8.802040e-01
time3: 7.428780e-01
time4: 4.758106e+00
time5: 1.858114e+01
 =============> Iteration k : 488
batch_iter = 40
time1: 5.510929e+00
time2: 7.826540e-01
time3: 7.406600e-01
time4: 4.750897e+00
time5: 1.862690e+01
 =============> Iteration k : 489
batch_iter = 51
time1: 6.463771e+00
time2: 5.378500e-01
time3: 7.138330e-01
time4: 5.324753e+00
time5: 1.818183e+01
 =============> Iteration k : 490
batch_iter = 2
time1: 5.982071e+00
time2: 6.172690e-01
time3: 7.107990e-01
time4: 5.887389e+00
time5: 1.756605e+01
 =============> Iteration k : 491
batch_iter = 19
time1: 5.813433e+00
time2: 7.565020e-01
time3: 9.432410e-01
time4: 5.780335e+00
time5: 1.727349e+01
 =============> Iteration k : 492
batch_iter = 31
time1: 5.979673e+00
time2: 9.402030e-01
time3: 9.618130e-01
time4: 6.329347e+00
time5: 1.728303e+01
 =============> Iteration k : 493
batch_iter = 43
time1: 5.775255e+00
time2: 8.827540e-01
time3: 9.409210e-01
time4: 6.086445e+00
time5: 1.728529e+01
```

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 =============> Iteration k : 494
batch_iter = 23
time1: 5.915304e+00
time2: 8.069490e-01
time3: 1.030013e+00
time4: 6.180726e+00
time5: 1.708035e+01
 =============> Iteration k : 495
batch_iter = 33
time1: 5.132659e+00
time2: 8.195040e-01
time3: 9.408640e-01
time4: 6.345803e+00
time5: 1.715297e+01
 =============> Iteration k : 496
batch_iter = 46
time1: 5.249316e+00
time2: 9.868380e-01
time3: 9.335620e-01
time4: 6.251361e+00
time5: 1.733751e+01
 =============> Iteration k : 497
batch_iter = 48
time1: 5.459259e+00
time2: 8.236480e-01
time3: 1.099750e+00
time4: 6.348666e+00
time5: 1.643120e+01
 =============> Iteration k : 498
batch_iter = 25
time1: 5.396054e+00
time2: 7.981170e-01
time3: 9.914230e-01
time4: 6.695528e+00
time5: 1.669422e+01
 =============> Iteration k : 499
batch_iter = 34
time1: 4.810566e+00
time2: 6.444980e-01
time3: 1.305199e+00
time4: 6.096995e+00
time5: 1.722824e+01
 =============> Iteration k : 500
batch_iter = 44
time1: 5.096343e+00
time2: 1.032073e+00
time3: 9.004010e-01
time4: 6.089281e+00
time5: 1.819707e+01
 =============> Iteration k : 501
batch_iter = 41
time1: 5.094747e+00
time2: 1.095660e+00
time3: 1.106829e+00
time4: 6.077450e+00
time5: 1.751531e+01
 =============> Iteration k : 502
batch_iter = 45
time1: 5.493903e+00
time2: 9.386890e-01
time3: 1.108744e+00
time4: 6.042454e+00
time5: 1.720212e+01
 =============> Iteration k : 503
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batch_iter = 15
time1: 5.564330e+00
time2: 6.921150e-01
time3: 7.883660e-01
time4: 5.886016e+00
time5: 1.752583e+01
 ==============> Iteration k : 504
batch_iter = 52
time1: 5.983037e+00
time2: 9.101130e-01
time3: 9.892240e-01
time4: 5.369399e+00
time5: 1.699176e+01
 ==============> Iteration k : 505
batch_iter = 53
time1: 6.837590e+00
time2: 8.218940e-01
time3: 1.115831e+00
time4: 5.736163e+00
time5: 1.670321e+01
 ==============> Iteration k : 506
batch_iter = 36
time1: 6.405987e+00
time2: 9.349160e-01
time3: 1.069607e+00
time4: 5.710987e+00
time5: 1.569223e+01
 ==============> Iteration k : 507
batch_iter = 32
time1: 6.111690e+00
time2: 1.150152e+00
time3: 9.189150e-01
time4: 5.988253e+00
time5: 1.540103e+01
 ==============> Iteration k : 508
batch_iter = 13
time1: 6.303091e+00
time2: 9.660580e-01
time3: 9.930270e-01
time4: 6.236720e+00
time5: 1.506792e+01
 ==============> Iteration k : 509
batch_iter = 30
time1: 5.906614e+00
time2: 8.948850e-01
time3: 1.119595e+00
time4: 6.621831e+00
time5: 1.531245e+01
 ==============> Iteration k : 510
batch_iter = 24
time1: 6.184538e+00
time2: 1.019802e+00
time3: 9.479500e-01
time4: 6.697554e+00
time5: 1.610964e+01
 ==============> Iteration k : 511
batch_iter = 49
time1: 6.181418e+00
time2: 8.920510e-01
time3: 1.373527e+00
time4: 6.212565e+00
time5: 1.661435e+01
 ==============> Iteration k : 512
batch_iter = 22
```

```
time1: 5.693443e+00
time2: 1.031742e+00
time3: 1.205362e+00
time4: 5.909310e+00
time5: 1.704158e+01
 =============> Iteration k : 513
batch_iter = 11
time1: 5.388010e+00
time2: 1.143727e+00
time3: 1.059764e+00
time4: 5.640949e+00
time5: 1.738658e+01
 =============> Iteration k : 514
batch_iter = 37
time1: 6.152599e+00
time2: 8.438860e-01
time3: 9.360670e-01
time4: 5.650727e+00
time5: 1.783108e+01
 =============> Iteration k : 515
batch_iter = 47
time1: 6.021055e+00
time2: 7.487940e-01
time3: 9.578030e-01
time4: 5.208844e+00
time5: 1.730253e+01
 =============> Iteration k : 516
batch_iter = 26
time1: 6.091199e+00
time2: 7.015770e-01
time3: 1.110121e+00
time4: 4.819738e+00
time5: 1.621682e+01
 =============> Iteration k : 517
batch_iter = 29
time1: 5.855897e+00
time2: 9.985870e-01
time3: 1.098421e+00
time4: 5.515067e+00
time5: 1.647468e+01
 =============> Iteration k : 518
batch_iter = 59
time1: 6.302008e+00
time2: 9.009140e-01
time3: 1.009031e+00
time4: 5.457392e+00
time5: 1.663148e+01
 =============> Iteration k : 519
batch_iter = 28
time1: 6.291910e+00
time2: 9.414460e-01
time3: 1.014006e+00
time4: 6.144536e+00
time5: 1.682995e+01
 =============> Iteration k : 520
batch_iter = 3
time1: 6.492280e+00
time2: 1.186962e+00
time3: 7.969810e-01
time4: 5.606923e+00
time5: 1.749305e+01
 =============> Iteration k : 521
batch_iter = 6
time1: 5.814430e+00
```

```
time2: 8.173640e-01
time3: 9.313930e-01
time4: 5.561152e+00
time5: 1.772053e+01
 =============> Iteration k : 522
batch_iter = 27
time1: 5.699159e+00
time2: 9.147660e-01
time3: 1.155384e+00
time4: 5.406826e+00
time5: 1.711188e+01
 =============> Iteration k : 523
batch_iter = 60
time1: 5.817525e+00
time2: 7.494980e-01
time3: 7.899730e-01
time4: 5.457009e+00
time5: 1.760096e+01
 =============> Iteration k : 524
batch_iter = 10
time1: 5.378207e+00
time2: 7.378510e-01
time3: 8.965770e-01
time4: 5.482225e+00
time5: 1.767411e+01
 =============> Iteration k : 525
batch_iter = 58
time1: 5.150802e+00
time2: 9.612170e-01
time3: 5.147140e-01
time4: 5.585672e+00
time5: 1.847981e+01
 =============> Iteration k : 526
batch_iter = 18
time1: 4.807642e+00
time2: 7.098280e-01
time3: 9.941120e-01
time4: 5.947151e+00
time5: 1.823826e+01
 =============> Iteration k : 527
batch_iter = 12
time1: 4.952145e+00
time2: 5.371940e-01
time3: 8.840610e-01
time4: 5.887629e+00
time5: 1.819476e+01
 =============> Iteration k : 528
batch_iter = 39
time1: 5.359986e+00
time2: 6.273850e-01
time3: 6.012980e-01
time4: 5.913912e+00
time5: 1.825837e+01
 =============> Iteration k : 529
batch_iter = 55
time1: 5.612248e+00
time2: 7.899210e-01
time3: 1.080916e+00
time4: 5.420084e+00
time5: 1.718098e+01
 =============> Iteration k : 530
batch_iter = 5
time1: 5.597448e+00
time2: 5.627210e-01
```

```
time3: 1.308200e+00
time4: 5.886089e+00
time5: 1.709174e+01
 =============> Iteration k : 531
batch_iter = 50
time1: 5.911029e+00
time2: 1.018087e+00
time3: 1.093849e+00
time4: 5.612022e+00
time5: 1.627462e+01
 =============> Iteration k : 532
batch_iter = 21
time1: 6.147265e+00
time2: 1.041902e+00
time3: 1.194533e+00
time4: 5.867903e+00
time5: 1.530011e+01
 =============> Iteration k : 533
batch_iter = 57
time1: 6.274561e+00
time2: 1.187710e+00
time3: 1.016649e+00
time4: 6.095601e+00
time5: 1.558679e+01
 =============> Iteration k : 534
batch_iter = 14
time1: 6.188420e+00
time2: 1.097158e+00
time3: 1.132990e+00
time4: 6.232197e+00
time5: 1.589116e+01
 =============> Iteration k : 535
batch_iter = 8
time1: 6.395497e+00
time2: 8.846640e-01
time3: 1.174726e+00
time4: 6.218565e+00
time5: 1.601933e+01
 =============> Iteration k : 536
batch_iter = 1
time1: 5.971110e+00
time2: 9.024130e-01
time3: 1.071370e+00
time4: 6.279588e+00
time5: 1.611483e+01
 =============> Iteration k : 537
batch_iter = 38
time1: 6.597285e+00
time2: 6.340890e-01
time3: 9.515080e-01
time4: 6.431103e+00
time5: 1.745024e+01
 =============> Iteration k : 538
batch_iter = 16
time1: 5.385959e+00
time2: 9.234010e-01
time3: 1.183691e+00
time4: 5.879475e+00
time5: 1.712021e+01
 =============> Iteration k : 539
batch_iter = 20
time1: 5.966907e+00
time2: 9.752620e-01
time3: 9.316030e-01
```

```
time4: 5.887066e+00
time5: 1.758911e+01
 =============> Shuffeling of batches for gradient ...
 =============> Iteration k : 540
batch_iter = 12
time1: 5.828197e+00
time2: 6.398900e-01
time3: 1.174400e+00
time4: 5.636812e+00
time5: 1.794022e+01
 =============> Iteration k : 541
batch_iter = 6
time1: 5.791656e+00
time2: 8.743230e-01
time3: 9.115010e-01
time4: 5.281666e+00
time5: 1.831865e+01
 =============> Iteration k : 542
batch_iter = 45
time1: 6.007097e+00
time2: 8.309950e-01
time3: 1.027652e+00
time4: 4.772188e+00
time5: 1.738642e+01
 =============> Iteration k : 543
batch_iter = 48
time1: 5.915953e+00
time2: 8.437430e-01
time3: 9.009330e-01
time4: 5.189512e+00
time5: 1.689707e+01
 =============> Iteration k : 544
batch_iter = 53
time1: 6.192688e+00
time2: 1.038020e+00
time3: 8.261330e-01
time4: 5.293621e+00
time5: 1.627426e+01
 =============> Iteration k : 545
batch_iter = 16
time1: 6.438339e+00
time2: 7.992360e-01
time3: 1.006398e+00
time4: 5.962758e+00
time5: 1.719961e+01
 =============> Iteration k : 546
batch_iter = 57
time1: 6.103741e+00
time2: 8.848070e-01
time3: 9.067550e-01
time4: 5.478996e+00
time5: 1.772342e+01
 =============> Iteration k : 547
batch_iter = 2
time1: 6.188527e+00
time2: 8.912220e-01
time3: 9.378320e-01
time4: 5.596784e+00
time5: 1.747421e+01
 =============> Iteration k : 548
batch_iter = 27
time1: 6.093041e+00
time2: 8.845210e-01
time3: 9.948900e-01
```

```
time4: 5.330590e+00
time5: 1.742499e+01
 =============> Iteration k : 549
batch_iter = 44
time1: 5.708681e+00
time2: 7.229890e-01
time3: 1.073046e+00
time4: 5.802618e+00
time5: 1.769665e+01
 =============> Iteration k : 550
batch_iter = 38
time1: 5.415174e+00
time2: 7.052170e-01
time3: 8.774110e-01
time4: 5.575091e+00
time5: 1.702114e+01
 =============> Iteration k : 551
batch_iter = 11
time1: 5.356952e+00
time2: 7.495850e-01
time3: 8.575850e-01
time4: 5.575847e+00
time5: 1.804191e+01
 =============> Iteration k : 552
batch_iter = 52
time1: 5.156761e+00
time2: 8.364640e-01
time3: 6.516230e-01
time4: 5.307529e+00
time5: 1.789248e+01
 =============> Iteration k : 553
batch_iter = 32
time1: 5.338938e+00
time2: 5.567580e-01
time3: 4.808380e-01
time4: 5.408714e+00
time5: 1.863463e+01
 =============> Iteration k : 554
batch_iter = 59
time1: 5.979862e+00
time2: 4.237060e-01
time3: 6.004090e-01
time4: 5.780431e+00
time5: 1.808363e+01
 =============> Iteration k : 555
batch_iter = 43
time1: 5.227506e+00
time2: 7.555250e-01
time3: 8.835770e-01
time4: 5.758088e+00
time5: 1.813211e+01
 =============> Iteration k : 556
batch_iter = 54
time1: 5.384485e+00
time2: 6.745830e-01
time3: 9.289660e-01
time4: 5.671261e+00
time5: 1.788993e+01
 =============> Iteration k : 557
batch_iter = 50
time1: 5.501929e+00
time2: 6.898140e-01
time3: 9.961470e-01
time4: 5.611660e+00
```

```
time5: 1.712559e+01
 =============> Iteration k : 558
batch_iter = 40
time1: 5.920241e+00
time2: 9.642300e-01
time3: 1.002333e+00
time4: 6.133336e+00
time5: 1.676847e+01
 =============> Iteration k : 559
batch_iter = 55
time1: 5.708265e+00
time2: 9.010740e-01
time3: 1.069938e+00
time4: 6.310962e+00
time5: 1.753073e+01
 =============> Iteration k : 560
batch_iter = 24
time1: 5.745812e+00
time2: 9.825810e-01
time3: 1.403766e+00
time4: 5.899289e+00
time5: 1.611846e+01
 =============> Iteration k : 561
batch_iter = 51
time1: 5.983815e+00
time2: 1.076882e+00
time3: 8.926500e-01
time4: 6.407592e+00
time5: 1.591612e+01
 =============> Iteration k : 562
batch_iter = 26
time1: 6.169927e+00
time2: 8.681280e-01
time3: 1.091426e+00
time4: 6.491895e+00
time5: 1.611072e+01
 =============> Iteration k : 563
batch_iter = 14
time1: 5.876874e+00
time2: 9.032430e-01
time3: 1.058682e+00
time4: 6.159287e+00
time5: 1.538270e+01
 =============> Iteration k : 564
batch_iter = 29
time1: 5.718951e+00
time2: 8.840260e-01
time3: 1.010844e+00
time4: 6.586224e+00
time5: 1.659418e+01
 =============> Iteration k : 565
batch_iter = 7
time1: 6.368340e+00
time2: 1.105695e+00
time3: 1.121848e+00
time4: 6.476428e+00
time5: 1.639694e+01
 =============> Iteration k : 566
batch_iter = 8
time1: 5.698426e+00
time2: 8.757500e-01
time3: 1.044170e+00
time4: 6.030754e+00
time5: 1.709445e+01
```

```
 =============> Iteration k : 567
batch_iter = 37
time1: 5.708332e+00
time2: 9.630140e-01
time3: 1.045545e+00
time4: 5.987876e+00
time5: 1.692512e+01
 =============> Iteration k : 568
batch_iter = 10
time1: 5.881426e+00
time2: 5.007770e-01
time3: 1.185113e+00
time4: 5.908298e+00
time5: 1.669343e+01
 =============> Iteration k : 569
batch_iter = 39
time1: 6.406308e+00
time2: 1.067402e+00
time3: 8.330820e-01
time4: 6.073300e+00
 Psi is NOT full column rank! or M is Not invertable!

 Psi is NOT full column rank! or M is Not invertable!

 Psi is NOT full column rank! or M is Not invertable!

 Psi is NOT full column rank! or M is Not invertable!

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 Psi is NOT full column rank! or M is Not invertable!

 Psi is NOT full column rank! or M is Not invertable!

 Psi is NOT full column rank! or M is Not invertable!
time5: 2.269400e+01
 =============> Iteration k : 570
batch_iter = 49
time1: 5.597334e+00
time2: 2.120430e-01
time3: 1.046418e+00
time4: 5.617884e+00
time5: 1.714889e+01
 =============> Iteration k : 571
batch_iter = 41
time1: 5.642930e+00
time2: 2.841970e-01
time3: 7.361560e-01
time4: 5.671400e+00
time5: 1.660583e+01
 =============> Iteration k : 572
batch_iter = 36
```

```
time1: 5.451382e+00
time2: 4.424870e-01
time3: 9.781310e-01
time4: 4.882106e+00
time5: 1.670723e+01
 =============> Iteration k : 573
batch_iter = 19
time1: 6.602002e+00
time2: 4.901760e-01
time3: 9.791530e-01
time4: 5.378218e+00
time5: 1.529374e+01
 =============> Iteration k : 574
batch_iter = 60
time1: 6.307559e+00
time2: 4.125620e-01
time3: 1.101922e+00
time4: 5.982965e+00
time5: 1.585890e+01
 =============> Iteration k : 575
batch_iter = 4
time1: 6.020477e+00
time2: 7.091060e-01
time3: 1.063406e+00
time4: 6.075371e+00
time5: 1.714548e+01
 =============> Iteration k : 576
batch_iter = 56
time1: 6.302311e+00
time2: 7.042950e-01
time3: 9.907950e-01
time4: 5.901418e+00
time5: 1.600229e+01
 =============> Iteration k : 577
batch_iter = 23
time1: 6.106750e+00
time2: 8.665410e-01
time3: 1.094564e+00
time4: 6.331920e+00
time5: 1.785279e+01
 =============> Iteration k : 578
batch_iter = 22
time1: 6.250079e+00
time2: 8.980650e-01
time3: 9.184390e-01
time4: 5.679613e+00
time5: 1.730141e+01
 =============> Iteration k : 579
batch_iter = 25
time1: 5.880204e+00
time2: 1.022549e+00
time3: 8.941290e-01
time4: 5.625638e+00
time5: 1.784912e+01
 =============> Iteration k : 580
batch_iter = 33
time1: 4.976045e+00
time2: 8.978540e-01
time3: 9.452240e-01
time4: 5.580720e+00
time5: 1.827993e+01
 =============> Iteration k : 581
batch_iter = 47
time1: 5.315001e+00
```

```
time2: 5.820640e-01
time3: 8.744380e-01
time4: 5.499609e+00
time5: 1.770753e+01
 =============> Iteration k : 582
batch_iter = 31
time1: 5.788316e+00
time2: 6.227560e-01
time3: 8.870190e-01
time4: 5.470401e+00
time5: 1.810044e+01
 =============> Iteration k : 583
batch_iter = 46
time1: 5.525919e+00
time2: 5.171730e-01
time3: 8.174620e-01
time4: 5.206907e+00
time5: 1.909883e+01
 =============> Iteration k : 584
batch_iter = 5
time1: 5.552919e+00
time2: 7.510360e-01
time3: 6.129980e-01
time4: 4.409868e+00
time5: 1.847617e+01
 =============> Iteration k : 585
batch_iter = 28
time1: 5.282035e+00
time2: 8.360420e-01
time3: 7.721640e-01
time4: 4.598751e+00
time5: 1.790196e+01
 =============> Iteration k : 586
batch_iter = 13
time1: 6.083150e+00
time2: 9.060510e-01
time3: 9.960430e-01
time4: 4.716406e+00
time5: 1.776696e+01
 =============> Iteration k : 587
batch_iter = 21
time1: 5.782260e+00
time2: 7.049960e-01
time3: 9.066500e-01
time4: 5.191060e+00
time5: 1.638850e+01
 =============> Iteration k : 588
batch_iter = 35
time1: 5.863491e+00
time2: 1.048110e+00
time3: 9.748810e-01
time4: 5.469018e+00
time5: 1.711241e+01
 =============> Iteration k : 589
batch_iter = 9
time1: 5.834581e+00
time2: 8.120240e-01
time3: 7.327060e-01
time4: 6.067617e+00
time5: 1.701135e+01
 =============> Iteration k : 590
batch_iter = 1
time1: 5.783042e+00
time2: 7.713800e-01
```

```
time3: 9.535840e-01
time4: 5.843480e+00
time5: 2.009642e+01
 =============> Iteration k : 591
batch_iter = 30
time1: 6.019980e+00
time2: 8.664960e-01
time3: 1.027494e+00
time4: 6.578005e+00
time5: 1.618548e+01
 =============> Iteration k : 592
batch_iter = 15
time1: 5.691163e+00
time2: 1.006670e+00
time3: 1.110531e+00
time4: 6.366399e+00
time5: 1.529820e+01
 =============> Iteration k : 593
batch_iter = 17
time1: 5.380245e+00
time2: 9.151270e-01
time3: 1.379519e+00
time4: 6.195162e+00
time5: 1.673358e+01
 =============> Iteration k : 594
batch_iter = 18
time1: 5.749570e+00
time2: 8.244070e-01
time3: 1.221962e+00
time4: 6.245086e+00
time5: 1.639927e+01
 =============> Iteration k : 595
batch_iter = 42
time1: 5.927485e+00
time2: 1.070702e+00
time3: 1.020639e+00
time4: 6.044845e+00
time5: 1.682512e+01
 =============> Iteration k : 596
batch_iter = 58
time1: 5.288474e+00
time2: 7.123840e-01
time3: 1.171538e+00
time4: 6.100461e+00
time5: 1.671543e+01
 =============> Iteration k : 597
batch_iter = 20
time1: 5.735810e+00
time2: 8.878520e-01
time3: 1.008575e+00
time4: 6.154930e+00
time5: 1.670009e+01
 =============> Iteration k : 598
batch_iter = 34
time1: 5.979524e+00
time2: 8.275910e-01
time3: 1.163370e+00
time4: 6.318637e+00
time5: 1.670304e+01
 =============> Iteration k : 599
batch_iter = 3
time1: 6.105492e+00
time2: 6.249560e-01
time3: 1.088325e+00
```

```
time4: 6.069931e+00
time5: 1.731712e+01
```

```
fprintf("\n=========================================================================\n")
```

```
=========================================================================
```

```
fprintf("\n The end of Training.")
```

```
 The end of Training.
```

```
fprintf("\n=========================================================================\n")
```

```
=========================================================================
```

Model Gradient (Backward)

```
function [loss, gradients, acc, state] = model_Forward_Backward(dlNet, dlX, Y)

if nargout == 1

    Yhat         = forward(dlNet, dlX);
    loss         = crossentropy(Yhat, Y);

elseif nargout == 2
    Yhat         = forward(dlNet, dlX);
    loss         = crossentropy(Yhat, Y);
    gradients    = dlgradient(loss, dlNet.Learnables);

elseif nargout == 3
    Yhat         = forward(dlNet, dlX);
    loss         = crossentropy(Yhat, Y);
    gradients    = dlgradient(loss, dlNet.Learnables);
    acc          = accuracy_fun(Yhat, Y);

elseif nargout == 4
    [Yhat, state]     = forward(dlNet, dlX);
    loss              = crossentropy(Yhat, Y);
    gradients         = dlgradient(loss, dlNet.Learnables);
    acc               = accuracy_fun(Yhat, Y);
end

end


function acc = accuracy_fun(Y_pre, Y)

Y_predict    = extractdata(Y_pre);
[~,idx_pre]  = max(Y_predict,[],1);
```

```
[~,idx_true] = max(Y,[],1);
acc          = mean(idx_pre==idx_true)*100;

end
```