# BÁO CÁO THỰC HÀNH

# MÔN NHẬN DANG THỊ GIÁC VÀ ỨNG DỤNG

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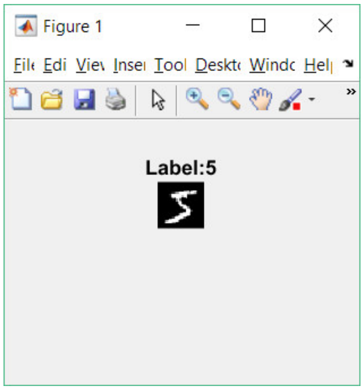
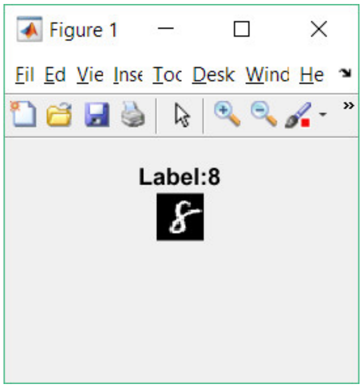
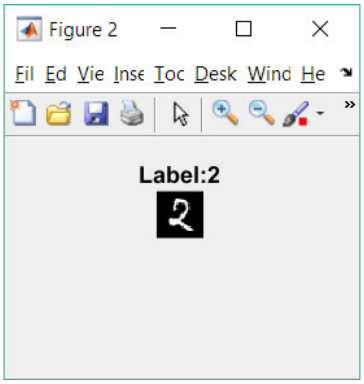
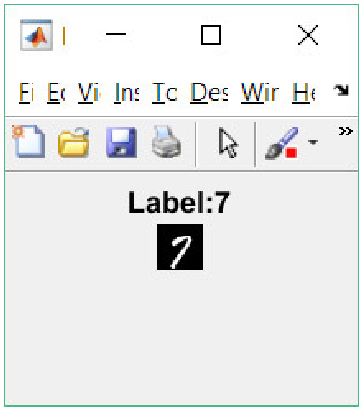
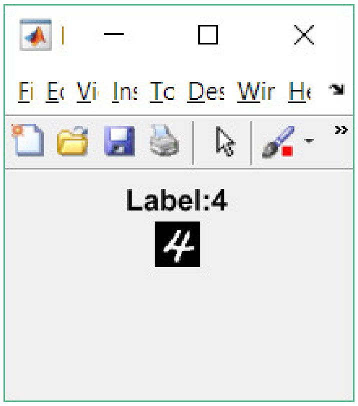
# BÀI TẬP THỰC HÀNH 3

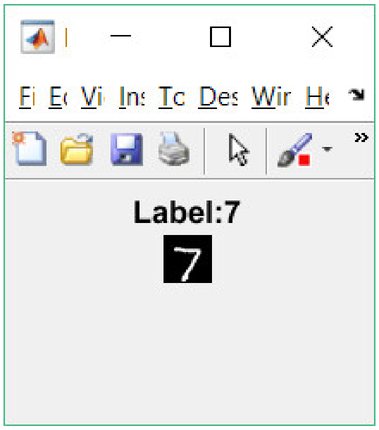
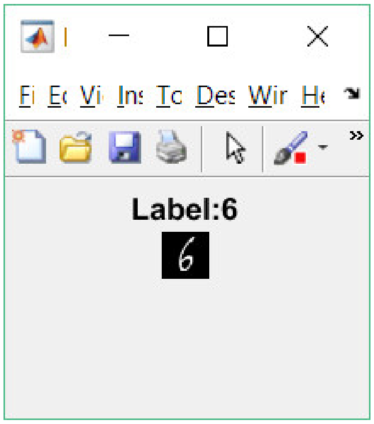
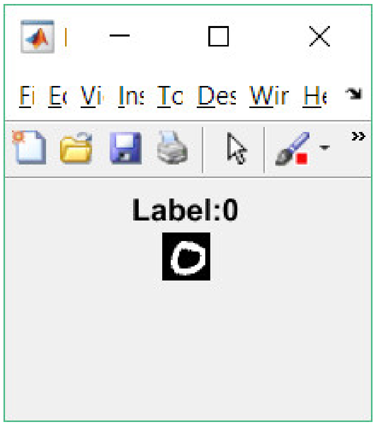
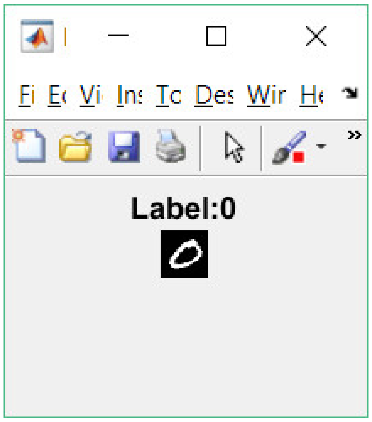
## Q1.

```
function showTrainImageAtN(n)
    if ~exist('n','var')
        disp('Wrong parameters...');
        return
    end

    fprintf('\n Load du lieu train);
    imgAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblAll = loadMNISTLabels('./train-labels.idx1-ubyte');

    figure,
    img = imgAll(:, n);
    img2D = reshape(img, 28, 28); % reshape
    strLabelImage = ['Label:', num2str(lblAll(n))];
    imshow(img2D); % show image
    title(strLabelImage);
end
```

| | | |
|---|---|---|
| N = 1 | N = 500 | N = 5000 |
| <br> <br>Label:5 | <br> <br>Label:8 | <br> <br>Label:2 |
| N = 10000 | N = 59000 | |
| <br>Label:7 | <br>Label:4 | |

## Q2.

```
function showTestImageAtN(n)
    if ~exist('n','var')
        disp('Wrong parameters...');
        return
    end

    fprintf('\n Load du lieu test');
    imgAll = loadMNISTImages('./t10k-images.idx3-ubyte');
    lblAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');

    figure,
    img = imgAll(:, n);
    img2D = reshape(img, 28, 28); % reshape
    strLabelImage = ['Label:', num2str(lblAll(n))];
    imshow(img2D); % show image
    title(strLabelImage);
end
```

| | | |
|---|---|---|
| N = 1<br><br> <br>Label:7 | N = 500<br><br> <br>Label:6 | N = 5000<br><br> <br>Label:0 |
| N = 9000<br><br> <br>Label:0 | | |

## Q3.

```
function thongKeImageTrain()
    fprintf('\n Load du lieu');
    lblAll = loadMNISTLabels('./train-labels.idx1-ubyte');

    nCol = 10;
    A = zeros([2 nCol]);

    for i=1:nCol
        label = i - 1;
        A(1, i) = label;
        A(2, i) = sum(lblAll == label);
    end

    % print A
    A
    % write csv file
    strFileName = ['D:\Q3', '.csv'];
    csvwrite(strFileName, A);

end
```

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|
| 5923 | 6742 | 5958 | 6131 | 5842 | 5421 | 5918 | 6265 | 5851 | 5949 |

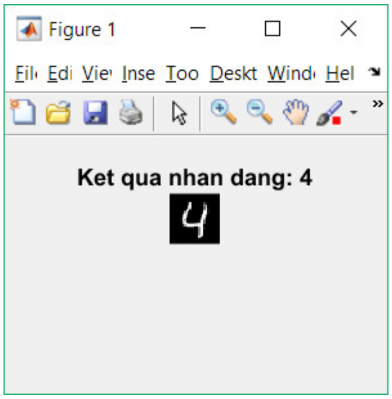
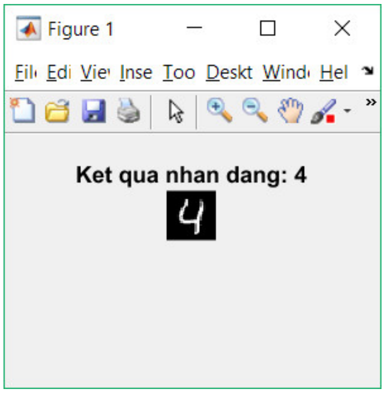
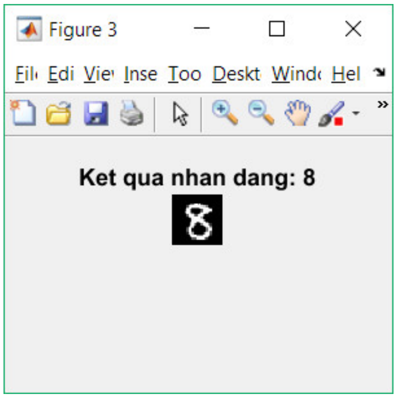
## Q4.

```
function thongKeImageTest()
    fprintf('\n Load du lieu');
    lblAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');

    nCol = 10;
    A = zeros([2 nCol]);

    for i=1:nCol
        label = i - 1;
        A(1, i) = label;
        A(2, i) = sum(lblAll == label);
    end

    % print A
    A
    % write csv file
    strFileName = ['D:\Q4', '.csv'];
    csvwrite(strFileName, A);
end
```

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|
| 980 | 1135 | 1032 | 1010 | 982 | 892 | 958 | 1028 | 974 | 1009 |

## Q5.

```
function lblPredictTest = recognizeImageAtN(n)
    if ~exist('n','var')
        disp('Wrong parameters...');
        return
    end

    imgTrainAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblTrainAll = loadMNISTLabels('./train-labels.idx1-ubyte');
    Mdl = fitcknn(imgTrainAll', lblTrainAll);

    imgTestAll = loadMNISTImages('./t10k-images.idx3-ubyte');

    imgTest = imgTestAll(:, n);
    lblPredictTest = predict(Mdl, imgTest');

    figure;
    img2D = reshape(imgTest, 28, 28);
    imshow(img2D);

    strLabelImage = ['Ket qua nhan dang: ', num2str(lblPredictTest)];
    title(strLabelImage);
end
```

| N = 5 | N = 500 | N = 900 |
|---|---|---|
| <br> <br>Ket qua nhan dang: 4 | <br> <br>Ket qua nhan dang: 4 | <br> <br>Ket qua nhan dang: 8 |

## Q6.

```
function checkRecognitionImage(n)
    if ~exist('n','var')
        disp('Wrong parameters...');
        return
    end

    imgTrainAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblTrainAll = loadMNISTLabels('./train-labels.idx1-ubyte');
    Mdl = fitcknn(imgTrainAll', lblTrainAll);

    imgTestAll = loadMNISTImages('./t10k-images.idx3-ubyte');
    lblTestAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');

    imgTest = imgTestAll(:, n);
    lblPredictTest = predict(Mdl, imgTest');
    lblImageTest = lblTestAll(n);

    figure;
    img2D = reshape(imgTest, 28, 28);
    imshow(img2D);

    strLabelImage = 'Ban dau ';
    strLabelImage = [strLabelImage, num2str(lblTestAll(n)), '.'];
    strLabelImage = [strLabelImage, ' Du doan: '];
    strLabelImage = [strLabelImage, num2str(lblPredictTest), '.'];

    if (lblPredictTest == lblImageTest)
        strLabelImage = [strLabelImage, ' Ket qua dung.'];
    else
        strLabelImage = [strLabelImage, ' Ket qua sai.'];
    end
    title(strLabelImage);
end
```

## Q7.

```
function countNumOfLabelWrongKnn(n)
    if ~exist('n','var')
        disp('Wrong parameters...');
        return
    end

    imgTrainAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblTrainAll = loadMNISTLabels('./train-labels.idx1-ubyte');
    Mdl = fitcknn(imgTrainAll', lblTrainAll);

    imgTestAll = loadMNISTImages('./t10k-images.idx3-ubyte');
    lblTestAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');
    nNumbers = size(imgTestAll, 2);
    counter = 0;

    for i=1:nNumbers
        lblTest = lblTestAll(i);
        if num2str(lblTest) == num2str(n)
            imgTest = imgTestAll(:, i);
            lblPredictTest = predict(Mdl, imgTest');
            if lblPredictTest ~= lblTest
                counter = counter + 1;
            end
        end
    end

    fprintf('So luong anh co label nhan dang sai: %d\n', counter);
end
```

| **N** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
|---|---|---|---|---|---|---|---|---|---|---|
|  | 7 | 6 | 40 | 40 | 38 | 32 | 14 | 36 | 54 | 42 |

## Q7*.

```
function createConfusionMatrixKnn()
    imgTrainAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblTrainAll = loadMNISTLabels('./train-labels.idx1-ubyte');
    Mdl = fitcknn(imgTrainAll', lblTrainAll);

    imgTestAll = loadMNISTImages('./t10k-images.idx3-ubyte');
    lblTestAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');
    nNumbers = size(imgTestAll, 2);

    nCol = 10;
    confusionMatrix = zeros(nCol, nCol);

    for i=1:nNumbers
        lblTest = lblTestAll(i);
        imgTest = imgTestAll(:, i);
        lblPredictTest = predict(Mdl, imgTest');
        confusionMatrix(lblTest + 1, lblPredictTest + 1) =
confusionMatrix(lblTest + 1, lblPredictTest + 1) + 1;
    end

    disp('Confusion matrix');
    confusionMatrix

    % write csv file
    strFileName = ['D:\Q71', '.csv'];
    csvwrite(strFileName, confusionMatrix);
end
```

| | | Predicted Label | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Actual Label Test | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | **973** | 1 | 1 | 0 | 0 | 1 | 3 | 1 | 0 | 0 |
| | 1 | 0 | **1129** | 3 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| | 2 | 7 | 6 | **992** | 5 | 1 | 0 | 2 | 16 | 3 | 0 |
| | 3 | 0 | 1 | 2 | **970** | 1 | 19 | 0 | 7 | 7 | 3 |
| | 4 | 0 | 7 | 0 | 0 | **944** | 0 | 3 | 5 | 1 | 22 |
| | 5 | 1 | 1 | 0 | 12 | 2 | **860** | 5 | 1 | 6 | 4 |
| | 6 | 4 | 2 | 0 | 0 | 3 | 5 | **944** | 0 | 0 | 0 |
| | 7 | 0 | 14 | 6 | 2 | 4 | 0 | 0 | **992** | 0 | 10 |
| | 8 | 6 | 1 | 3 | 14 | 5 | 13 | 3 | 4 | **920** | 5 |
| | 9 | 2 | 5 | 1 | 6 | 10 | 5 | 1 | 11 | 1 | **967** |

## Q8**.

```
function calculatePrecisionOfKnn(NumNeighbors, Distance)
% NumNeighbors    Number of neighbors to predict
% Distance        'euclidean'/ 'seuclidean'/ 'cityblock'/ 'chebychev'/
'minkowski'
%                 / 'mahalanobis'/  'cosine'/ 'correlation'/ 'spearman'/
'hamming'/ 'jaccard'
    if ~exist('NumNeighbors','var')
        NumNeighbors = 1;
    end
    if ~exist('Distance','var')
        Distance = 'euclidean';
    end

    imgTrainAll = loadMNISTImages('./train-images.idx3-ubyte');
    lblTrainAll = loadMNISTLabels('./train-labels.idx1-ubyte');
    Mdl = fitcknn(imgTrainAll', lblTrainAll, 'NumNeighbors', NumNeighbors,
'Distance', Distance);

    imgTestAll = loadMNISTImages('./t10k-images.idx3-ubyte');
    lblTestAll = loadMNISTLabels('./t10k-labels.idx1-ubyte');
    nNumbers = size(imgTestAll, 2);

    nCol = 10;
    confusionMatrix = zeros(nCol, nCol);

    for i=1:nNumbers
        lblTest = lblTestAll(i);
        imgTest = imgTestAll(:, i);
        lblPredictTest = predict(Mdl, imgTest');
        confusionMatrix(lblTest + 1, lblPredictTest + 1) =
confusionMatrix(lblTest + 1, lblPredictTest + 1) + 1;
    end

    precision = 0;
    recall = 0;
    accuracy = 0;

    for i=1:nCol
        accuracy = accuracy + confusionMatrix(i, i);
        precision = precision + confusionMatrix(i, i) /
sum(confusionMatrix(i, :));
        recall = recall + confusionMatrix(i, i) / sum(confusionMatrix(:,
i));
    end

    accuracy = 100 * accuracy / nNumbers;
    precision = 100 * precision / nCol;
    recall = 100 * recall / nCol;

    fprintf('\nAccuracy= %s', num2str(accuracy));
    fprintf('\nPrecision= %s', num2str(precision));
    fprintf('\nRecall= %s\n', num2str(recall));
end
```

```
>> calculatePrecisionOfKnn(1, 'euclidean')

        Accuracy= 96.91

        Precision= 96.8794

        Recall= 96.9148


>> calculatePrecisionOfKnn(1, 'cosine')

        Accuracy= 97.23

        Precision= 97.1898

        Recall= 97.238


>> calculatePrecisionOfKnn(3, 'euclidean')

        Accuracy= 97.06

        Precision= 97.0273

        Recall= 97.0921


>> calculatePrecisionOfKnn(3, 'cosine')

        Accuracy= 97.37

        Precision= 97.3384

        Recall= 97.377
```