





(a)&(b)

```

loadings = zeros(10, ncols-1, ncols-1); % eigenvectors
means = zeros(10, ncols-1); % mean image
errors = zeros(10, 1); % MSE error
npcs = 20; % the number of principal components

for num_label = 1:10
    X = data((num_label-1)*5000+1:num_label*5000, 1:ncols-1);
    % refer to Matlab Documentation: https://www.mathworks.com/help/releases/R2017b/stats/pca.html
    % "coeff": p*p loadings
    % "score": Principal component scores are the representations of X in the principal component space. Rows of score
    % "explained": the percentage of the total variance explained by each pc
    % "mu": the estimated mean of each variable in X
    [coeff,score,~,~,explained,mu] = pca(X, 'NumComponents', npcs);
    loadings(num_label, :, 1:npcs) = coeff;
    means(num_label, :) = mu;
    % the second argument of immse is the result of reconstruction
    errors(num_label) = immse(X, score*coeff' + repmat(mu,5000,1)) * (ncols-1);
end

```

(c)

```

% get Euclidean distance
distances = pdist(means);

% multidimensional scaling gets positions from distances
[positions, ~] = mdscale(distances, 2);

% plot the 2d map
scatter(positions(:, 1), positions(:, 2));
text(positions(:, 1), positions(:, 2), labelNames);
saveas(gcf, '2dmap.png');

```