Quiz 6: Sexual Eigenvectors?

This quiz is open notes, and you may work together. Download the dataset from the class website (Faces.mat).

What is the data?

The data represents 30 photographs of undergraduate students from Whitman. Each photograph is an array of 294×262 pixels each, and they are stored as vectors in $\mathbb{R}^{77028}$. Therefore, when you type `load Faces` you will have a matrix Y that is 77028×30.

You will also see two other vectors, `boys` and `girls`. The vectors contain the indices for the photos of boys and girls, respectively (so that `Y(:,girls)` would contain the data only for the girls, for example).

The Quiz

We want to find the best basis for the space of faces in this database- That is, the best basis in $\mathbb{R}^{77028}$. Write a script file (then publish to HTML and print) that does the following:

1. Find the mean face and visualize it in Figure 1. Use the `reshape` and `imagesc` commands.

   For extra fun, find the mean boy and the mean girl!

2. Mean-subtract your data (your mean is a vector in $\mathbb{R}^{77028}$). Find the best basis vectors via the SVD. Visualize the first four "eigenfaces" using the `subplot`, `reshape`, and `imagesc` commands. Put these in Figure 2.

3. Choose a face at random, and construct the 5, 10 and 15 dimensional reconstructions. Plot the corresponding images in Figure 3 (using `subplot`).

4. Project your faces to the best two dimensional representation (you should get a matrix that is 30×2 or 2×30). In Figure 4, plot the boys as red asterisks and the girls as blue diamonds. For example, if your matrix `Coords` is 30×2, type:

   ```
   plot(Coords(boys,1),Coords(boys,2),'r*');
   hold on;
   plot(Coords(girls,1),Coords(girls,2),'b^');
   hold off
   ```

   You should see that there seems to be a separation of the boys and girls by the second coordinate: If the second coordinate is positive, the photo was very likely a male photo, if the second coordinate is negative, it was likely a female.

5. In Figure 5, plot the images corresponding to the second eigenface and its photographic negative (multiply the vector by -1) side by side (use `subplot(1,2,1)` and `subplot(1,2,2)`). What do you see?