# MACM 316 HW #10: Image Recognition

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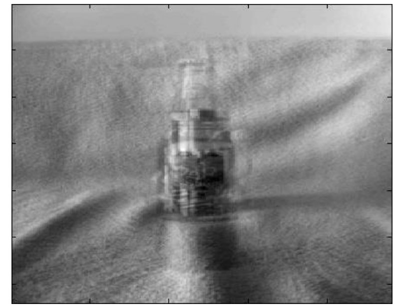
## Method and Observations:



To complete the first part, I represented each image (all 7 of them in the assignment PDF) as a vector. I used least squares approximation (LSA) to determine 6 coefficients such that the corresponding linear combination of the first 6 images was an LSA of the 7th. This procedure produces the figure on the right, which is not a very good representation of the actual object.
Then, using the faces of four brave volunteers I met in the Math student's common room, my dad, and my girlfriend (first row, and first 2 in the second row), I produced an approximation of my face (3rd picture in 2nd row). These are shown by the colour photos on the right.

Below those is the least squares approximation of my face using their faces. It seems like the highest coefficient was given to the photo with the gentleman in the orange hoodie, and not the photo of my dad.
Note: when working with the images in MATLAB, all of the generated images (i.e. the grayscale ones) were generated sideways. Only when I was writing this document did I turn the faces right side up.
Then, for each of the 7 photos, I used the corresponding image matrix generated by the provided *photoInput.m* script to compress the image using SVD. I did this by taking the SVD of each matrix, and examining the picture for different approximations. I used approximations with 1, 2, 3, 4, 8, 16, 32, and 64 of the highest singular values, which meant computing $[\mathrm{U}]\ [\mathrm{S_M}]\ [\mathrm{V^T}]$ for each of the M values listed above, where $[\mathrm{S_M}]$ is the S matrix containing only the M largest singular values. I found the results across each picture extremely consistent; indeed, to tell one face apart from the others, I only needed the top 8 singular values, which corresponded to 3.33% of the original image! It is worth noting that these "compressed" images is the bare minimum for recognizing the face in the photo. Using 3.33% of the original photo in this way does not make the faces look the most flattering, but at least distinguishable from the rest.

## Conclusion:

A linear combination of other faces to approximate my own does not result in anything that looked like me, but at least it looks like a face. "Regular" images (i.e. ones that contain more than noise) have an underlying structure. This structure is captured by the SVD of the corresponding matrix. When we use a small number of singular values to reconstruct the picture, what we are really doing is using creating the picture with the essential pieces of the images structure.