CSE252 – Object Recognition – Take Home Exam

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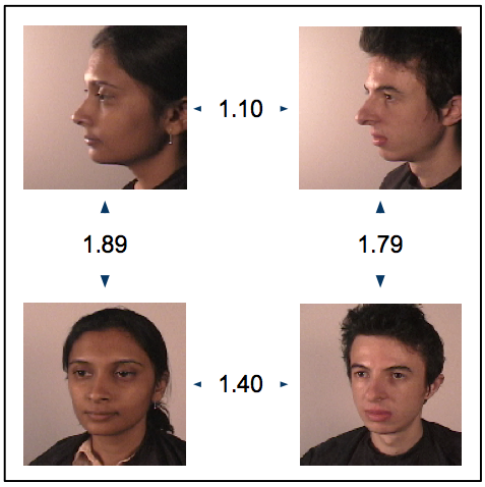
`http://www-cse.ucsd.edu/classes/sp11/cse252c`

Due date: Wednesday June 8th at 11:59pm.

You are free to use your notes, books and online resources on this exam, but you must work alone. In order to get full credit you must show all your work and cite your sources. Your answers should be typeset in LaTeX and submitted electronically as a pdf file before the due date. Good luck!

1. (50 pts) **Cross-Condition Matching.** The following diagram illustrates a problem that arises in a variety of visual recognition problems, which is that the computed distance between images of the same face in different conditions (e.g., lighting and pose) is often greater than the distance between images of different faces in the same condition.



   Suppose you are given a fully annotated dataset of face images for N students from UCSD, each captured under M different poses and illuminations. Call this dataset the "library" $\mathcal{L}$. Now suppose you are given a pair of face images I_a and I_b obtained from two different surveillance cameras installed at UCLA. Call the images I_a and I_b the "probes."

   Your task is to design a function $f(I_a, I_b|\mathcal{L})$ that returns a positive value if the probes depict the same individual and a negative value otherwise. Explain your proposed approach with a clearly written description, including pseudocode and complexity analysis.

2. (50 pts.) **Clustering by Melting and Kernel PCA Denoising.** For this problem, start by reading the following two papers:

   - B. Schölkopf et al., "Input Space Versus Feature Space in Kernel-Based Methods," *IEEE Trans. Neural Networks*, 1999.
   - Y.-F. Wong, "Clustering Data by Melting," *Neural Computation*, 1993

   The first paper explains how to use Kernel PCA for denoising via *preimage* estimation. The second paper introduces a clustering method called "melting." Once you have read the papers, summarize the problem motivations and proposed algorithms in each paper. How are the two approaches connected mathematically? Is one a generalization of the other, and if so, in what way? What are the advantages and disadvantages of each approach? For 10 bonus points, explain how these methods relate to the approach of Y. Cheng, "Mean Shift, Mode Seeking, and Clustering," *IEEE Trans. PAMI*, 1995.