EECS 16A Designing Information Devices and Systems I
Fall 2015 Anant Sahai, Ali Niknejad

Homework 12

This homework is due November 23, 2015, at Noon.

1. **Homework process and study group**

   Who else did you work with on this homework? List names and student ID's. (In case of hw party, you can also just describe the group.) How did you work on this homework?

2. **Mechanical Gram-Schmidt**

   (a) Use Gram-Schmidt to find a matrix U whose columns form an orthonormal basis for the column space of V.

   $$V = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \tag{1}$$

   and show that you get the same resulting vector when you project $w = [\ 1,\ -1,\ 0,\ -1,\ 0\ ]^T$ onto V and onto U, i.e. show that

   $$V(V^TV)^{-1}V^Tw = U(U^TU)^{-1}U^Tw \tag{2}$$

   (b) Use Gram-Schmidt to find a matrix U whose columns form an orthonormal basis for the column space of V.

   $$V = \begin{bmatrix} 1 & 1 & -1 \\ 0 & 1 & -1 \\ 1 & 0 & 0 \\ 1 & -1 & 1 \\ 0 & -1 & 1 \end{bmatrix} \tag{3}$$

   and show that you get the same resulting vector when you project $w = [\ 1,\ -1,\ 0,\ -1,\ 0\ ]^T$ onto V and onto U.

3. **Redo Midterm Problem 3**

4. **Redo Midterm Problem 4**

   (a)

   (b)

   (c)

5. **Redo Midterm Problem 5**

6. Redo Midterm Problem 6

(a)

(b)

(c)

(d)

(e)

(f)

7. Redo Midterm Problem 7

(a)

(b)

(c)

8. Redo Midterm Problem 8

(a)

(b)

(c)

9. Speeding up OMP - BONUS-in-scope

Consider the OMP Imaging problem from HW11

(a) Modify the code to run faster by using a Gramm-Schmidt orthonormalization to speed it up. (Edit the code given to you in `prob12.ipynb`.)

(b) Do any other modifications you want to further speed up the code. (Hint: when possible, how would you safely extract multiple peaks corresponding to multiple pixels in one go and add them to the recovered list? Would this speed things up?)

10. Your Own Problem Write your own problem related to this week's material and solve it. You may still work in groups to brainstorm problems, but each student should submit a unique problem. What is the problem? How to formulate it? How to solve it? What is the solution?