Midterm for Multimedia Analysis and Indexing (MMAI) – Fall 2007

Name: _____ **School ID:** _____

Midterm (2:20 pm, Tuesday, Nov. 6, 2007)

Note:

(1) Write down your NAME and School ID in the booklet and the test problem set (this paper). You have to submit them **BOTH** to TA after the midterm.

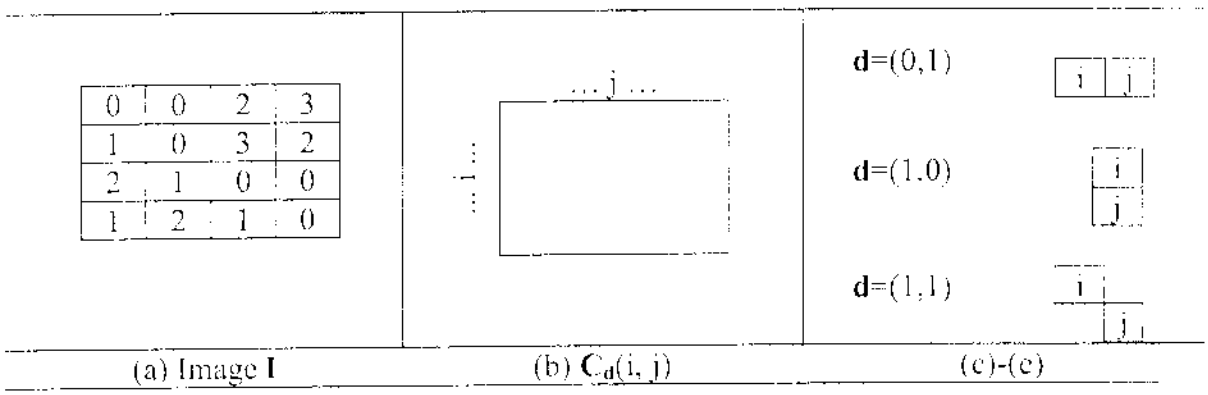
(2) Best luck to you!

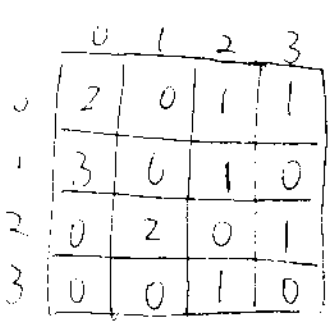
1. Co-occurrence texture: (20%)

Please show the three co-occurrence matrices $\mathbf{C_d}(i, j)$, specified by different displacement vectors $\boldsymbol{d}$ ((c)-(e)), for a gray image $\boldsymbol{I}$, which has the gray value in each pixel.

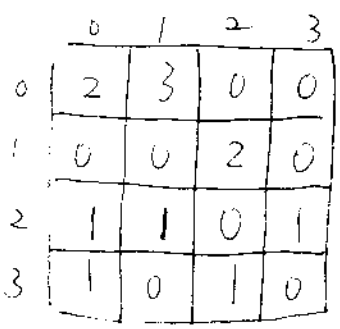
5 (1) What are the dimensions of the co-occurrence matrices? 4×4

(5 (2) Please show the three co-occurrence matrices with **d**=(0,1), **d**=(1,0), and **d**=(1,1).

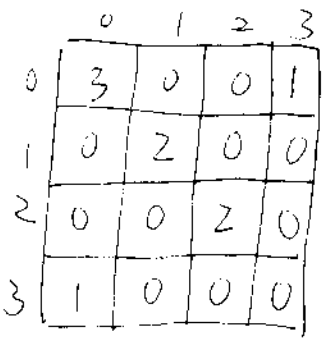




d(0,1)



d(1,0)



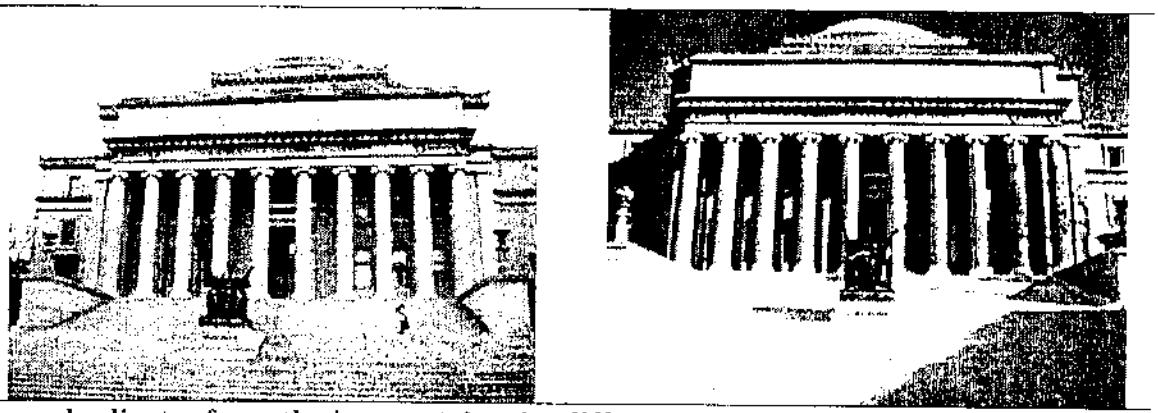
II. Image Similarity and Near-Duplicate Detection (20%)

We are to design a system to *efficiently* and *effectively* discover the near-duplicates (picture pairs taken at the same site or with a very similar scene. See the following two example images.) from a very **LARGE** databases (i.e., Flickr) with around N user-contributed images (N ~= 250 millions). Given an image in the database, the system needs to show the top K near-duplicate images in the database and their corresponding near-duplicate scores. You are allowed to compute the near-duplicate similarities offline.

(1) What might be good candidates for feature representations of images and their corresponding distance (or similarity) measures? Why?

(2) What is the time complexity to compute all the pair-wise similarities in the image database? Any algorithms to speed up the near-duplicate detection (e.g., filtering out irrelevant images first with low-cost image similarity measures)? What might be the impact of your proposed approach in reducing the time complexity? Any tradeoff for accuracy?

(3) With your proposed algorithm, what might be the estimated time complexity if a new image is inserted into the database (N images)?



Near-duplicates from the images taken by different persons in front of the Low Library of Columbia University, New York.

III. Precision and Recall (25%)

In the retrieved image list of depth 15, we had inspected the retrieved images and marked the hit (+) at different depths. There are totally **10** ground-truth images. Please

(1) Complete the "recall" at different depths. Note that at depth ***i***, we are to evaluate the retrieved results of the first ***i*** images (ranked 1 to *i*).

(2) Complete the "precision" at different depths

(3) Please draw the precision and recall curve of the retrieved results (at depth 15). Please use **ONLY** the recall and precision values where a "hit" occurs.

#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hit	-	+	+	-	+	+	-	-	+	+	+	+	-	+	+
Recall	0	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1
Precision	0	0.5	0.67	0.5	0.6	0.67	0.57	0.5	0.56	0.6	0.64	0.67	0.62	0.64	0.67

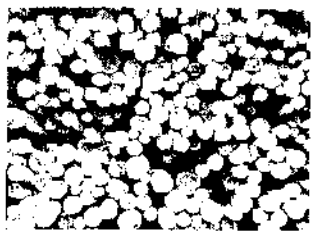
IV. Please briefly explain (10%)

(1) What's the *semantic gap*?

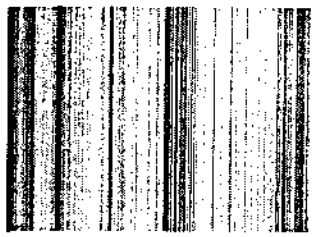
(2) What's the *curse of dimensionality*?

V. Gabor Textures (25%)

The following are the images and their corresponding plots of Gabor features in terms of the **mean** over the whole response map after being convoluted by a Gabor filter, specified by a scale and an orientation factor. In the texture plot, the Y-axis (↑) represents (4) *scales* and the X-axis (→) represents (6) *orientations*. The light color represents high intensity. **Please find the best match between the images and features**. Please shortly justify your answer.



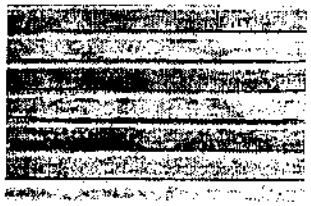
(1) d



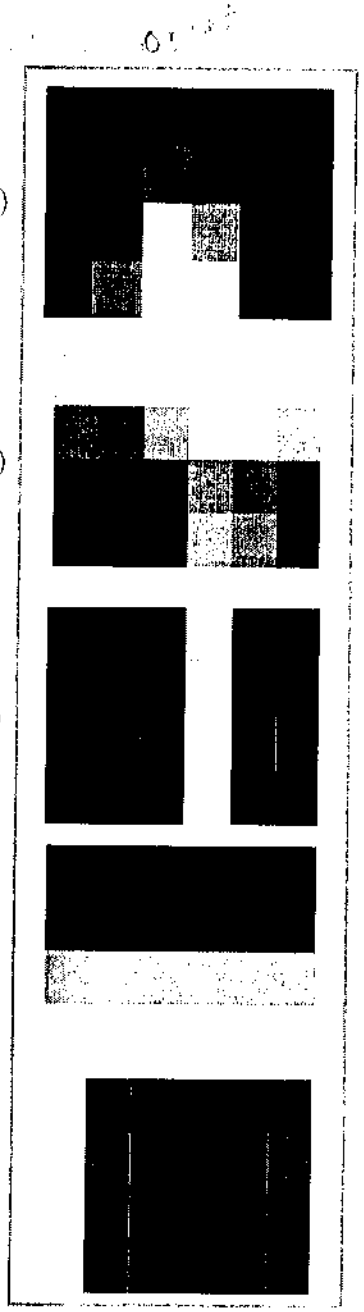
(2) e

(3) a

(4) b



(5) c



Multimedia Analysis and Indexing – Spring 2007

Name: _____ **School ID**:_____

Midterm (2:30 pm, Wednesday, May 16, 2007)

Note:

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I. Co-occurrence texture: (20%)

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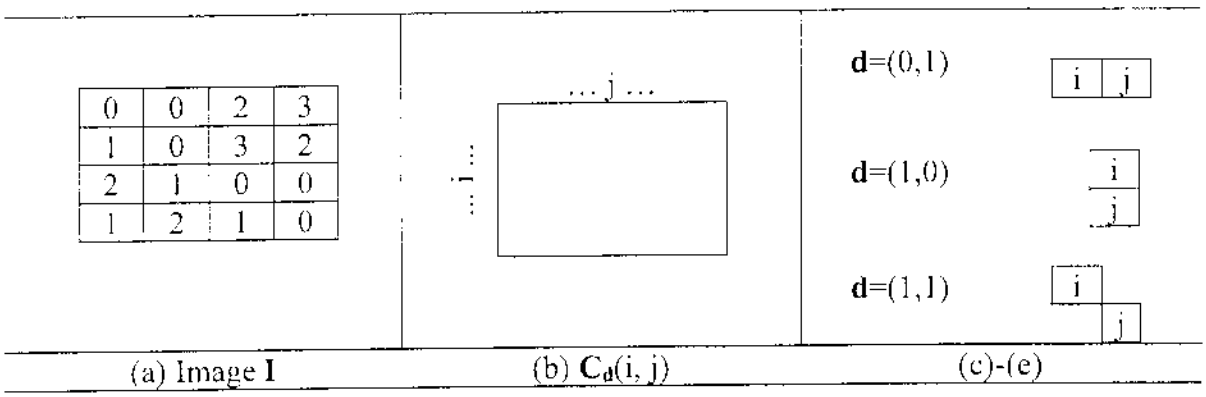

(a) Image **I** (b) $\mathbf{C_d}(i, j)$ (c)-(e)

II. Image Similarity and Near-Duplicate Detection (30%)

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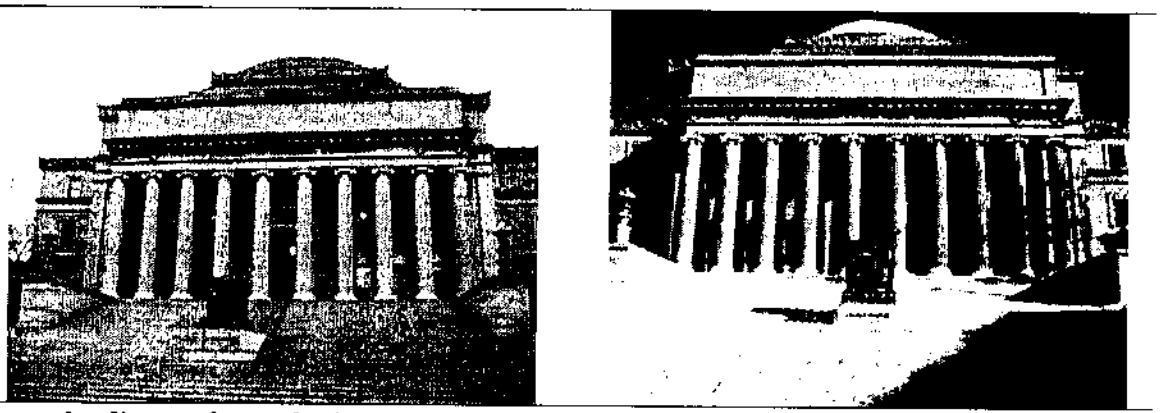

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Hit	-	+	+	-	+	+	-	-	+	+	+	+	-	+	+
Recall															
Precision															

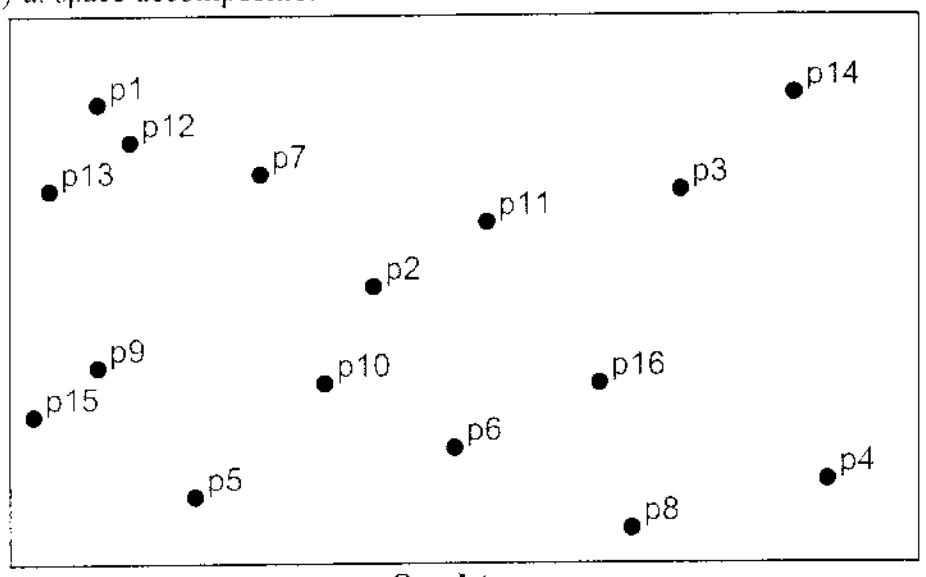
IV. Quad-tree and KD-tree (25%)

We have 16 points in a 2-dimensional space. Please organize these points by **space decomposition** and their corresponding **tree structures** in the following two methods:

(1) *Quad-tree*, which splits the space into 4 equal subspaces and continues until each leaf node has a single point.

(2) *KD-tree*, which recursively subdivides points into two halves (median values are used) using vertical and horizontal lines till one point left in each leaf.

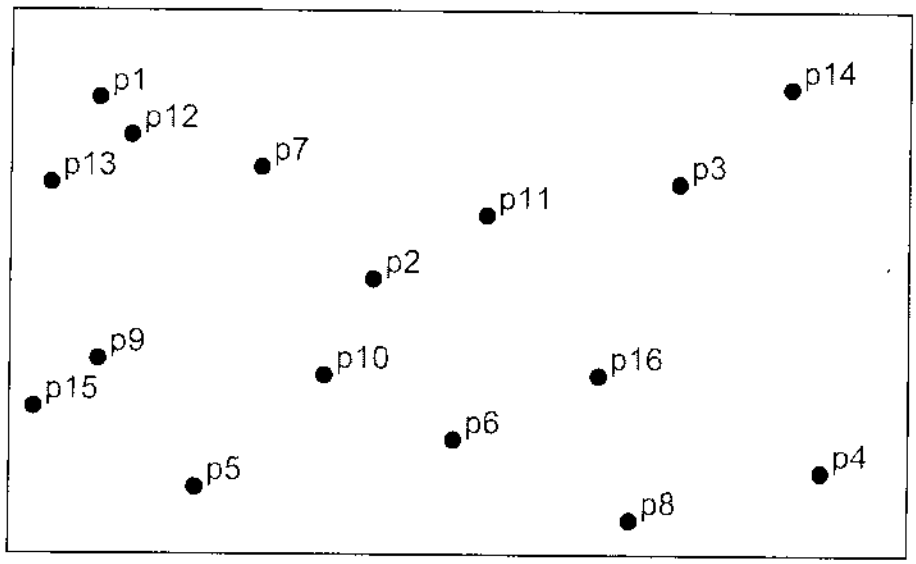
(1)-a: space decomposition



Quad-tree

(1)-b: tree representation in Quad-tree

(2)-a: space decomposition



KD-tree

(2)-b: tree representation in KD-tree