Gebze Technical University
Computer Engineering Department
CSE464/564 Digital Image Processing
October 16, 2019
Homework 1 (v1)

1) The Laplacian operator is defined as the second derivative: $\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$

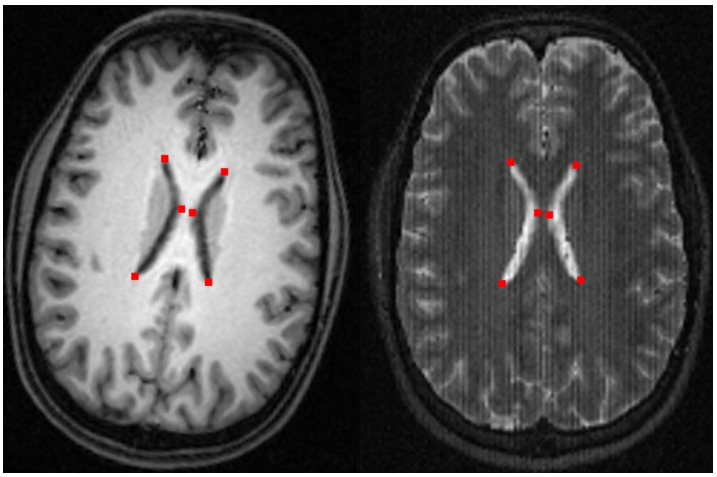
where f represents the input image. Prove that the Laplacian operator is not influenced by rotations.

In other words, say we rotate the location (x,y) using the rotation matrix, and (x',y') represents the rotated version of (x,y).

You are requested to prove that $\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = \frac{\partial^2 f}{\partial x'^2} + \frac{\partial^2 f}{\partial y'^2}$

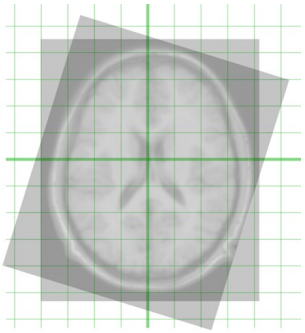
2) One of the conditions that a pixel distance function must verify, in order to qualify as a metric, is triangular inequality (a.k.a. subadditivity). Prove that the L_1 (i.e. cityblock) distance function verifies this property.

3) The following two magnetic resonance (MR) images are of the same patient and they have been acquired at two different moments:



A B

We want to register them; in other words we want to make sure that they are aligned:



More specifically, we want to transform image B so that it is perfectly aligned with image A. All we have to work with are 3 points, for which we know how they register.

Coordinates in image B(x,y)	Coordinates in image A(x,y)
[1,2]	[2,2]
[2,1]	[-1,4]

[3,1]	[-4,4]

Calculate (in any way you want) the transformation matrix C needed to align/register B with A.

4) Let C and D be two sets and B a structuring element. Prove that:

$$(C \cup D) \oplus \check{B} = (C \oplus \check{B}) \cup (D \oplus \check{B})$$

Prepare all answers in electronic format (using latex; not word or libreoffice) (don't take photos of your paper sheets) and upload their pdfs.

Q1: 30 points
Q2: 30 points
Q3: 15 points
Q4: 25 points

Note: the homework deadline is strict, plan your submission carefully. There will be NO EXCEPTIONS.