Mansoura University	Faculty of Engineering	Biomedical Engineering (BME) Program
		Time allowed: 60 min
		Exam is one page
		Assume any missing data
		Include and name all steps

Question # 1: [10 points] List four types of medical image modalities and give an example for their application (e.g., which organ it is used to image)

Question # 2: [5 points] Use the iterative arithmetic reconstruction technique (ART) to reconstruct a 3x3 subject pixels with 4-projections as follows:

Vertical projection: [15 18 12]
Horizontal projection: [15 15 15]
Main Diagonal projection: [9 12 16]
Reverse Diagonal projection: [16 12 9]

Question #3: [5 points] Given the following four manually segmented registered training images, where the object label is "1" and the background label is "0":

Training Image 1

0	0	0	0
0	1	1	0
0	0	1	0
0	0	0	0

Training Image 2

0	0	0	0
0	1	1	0
0	1	1	0
0	0	0	0

Training Image 3

0	0	0	0
0	0	1	0
0	1	1	0
0	0	0	0

Training Image 4

0	0	1	0
0	1	1	0
0	1	1	0
0	0	0	0

(a) Build the probabilistic shape prior map
(b) Use this model to classify the following image, which has Q=10 grey levels

Test Image

8	2	0	9
3	2	1	7
4	1	7	8
5	5	6	8

Question #4: [10 points] For designing a specific classifier, a training data was composed from a grey scale images Y that has 4 grey levels Q={0,1,2,3}. The image Y was classified into one of two lables L={0,1} to produce a labeled image X. If the joint probability P(Y,X) for each class is

P(Y,X=0)= [0.25 0.20 0.10 0.05],and P(Y,X=1)= [0.05 0.05 0.10 0.20]

Answer the following:

(a) Estimate the marginal probability of the grey levels the image Y, p(y)
(b) Determine the prior probability of each class
(c) State the Bayes rule for classification. What are the possible grey level values of class 1?
(d) Classify the test image Test=[3 2 2 1; 0 2 1 3] using the Bayes classifier

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Q.1

1- X-ray medical imaging ⟶ scan bones and air "lungs".

2- Magnetic resonnance imaging "MRI" ⟶ scan soft tissues.
ex. white matter in the brain.

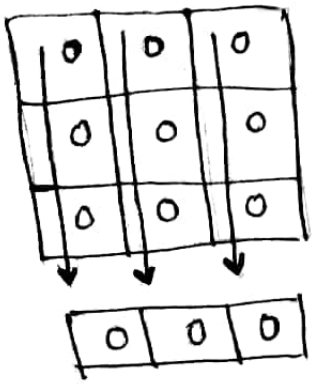
3- ultrasound imaging ⟶ scan infants and pregnant women.

4- computed Tomography imaging CT ⟶ scan nodules in lung.

5- Magnetic resonnance angiography "MRA" ⟶ scan blood vessels.

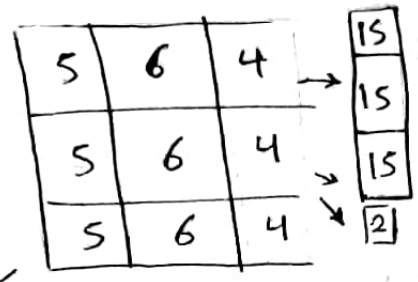
Q.2

-We assume that we have matrix 3x3 of zeros.



[1] vertical projection

∴ Error = [15 18 12]

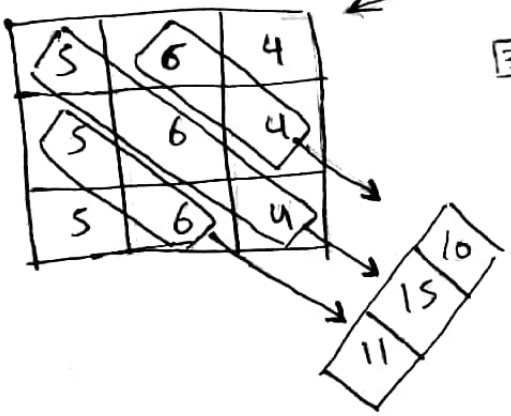


[2] Horizontal projection

∴ Error = [0 0 0]

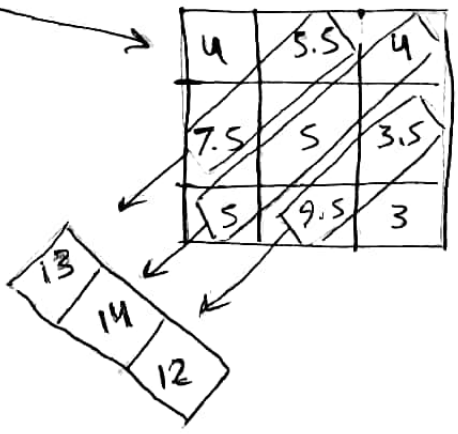
[3] main diagonal projection

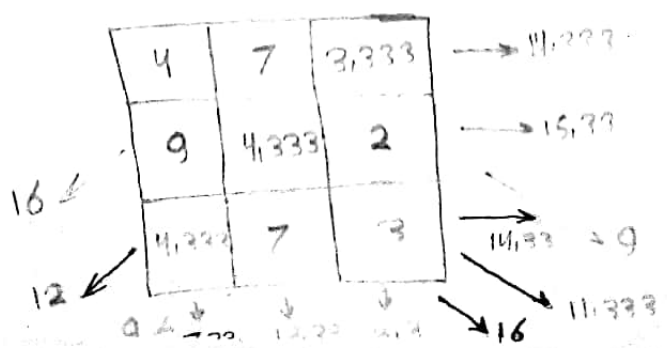
∴ Error = [-1 -3 5]



[4] Reverse diagonal projection

∴ Error = [3 -2 -3





Q.3

object → label 1

Background → label 0

a- probabilistic shap prior map.

$P(S=0)$ → Back ground

1	1	0.75	1
1	0,25	0	1
1	0,25	0	1
1	1	1	1

$P(S=1)$ → object

0	0	0,25	0
0	0,75	1	0
0	0,75	1	0
0	0	0	0

b- if $P(S=1) > P(S=0)$ → then it will be class 1

otherwise → class 2

∴ for any given test image.

0	0	0	0
0	1	1	0
0	1	1	0
0	0	0	0

Q.4

(a-) $P(y) = P(y, X=0) + P(y, X=1)$

$\therefore P(y) = [\,0,3 \quad 0,25 \quad 0,2 \quad 0,25\,]$

X \ y	0	1	2	3
X=1	0,05	0,05	0,1	0,2
X=0	0,25	0,2	0,1	0,05

(b-) $P(X=0) = P(X=0, y=0) + P(X=0, y=1) + P(X=0, y=2) + P(X=0, y=3)$

$\therefore P(X=0) = 0,25 + 0,2 + 0,1 + 0,05 = 0,6$

$P(X=1) = P(X=1, y=0) + P(X=1, y=1) + P(X=1, y=2) + P(X=1, y=3)$

$\therefore P(X=1) = 0,05 + 0,05 + 0,1 + 0,2 = 0,4$

(c-) Decide class 1 $(X=0)$ if $P(X=0|y) \geq P(X=1|y)$

or if $P(X=0, y) \geq P(X=1, y)$

otherwise class 2 $(X=1)$

→ Grey level values of class 1 $(X=0)$ → 0, 1 and 2

(d-) classification = $[\,1 \quad 0 \quad 0 \quad 0 \;;\; 0 \quad 0 \quad 0 \quad 1\,]$.