**Medical Imaging, ECE 491** **Final Exam** **Total Grade=50 Points** **December 30th, 2018**

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|---|---|---|
| Mansoura University | Faculty of Engineering | Biomedical Engineering (BME) Program |
| | | Time allowed: 120 min |
| | | Exam is 4 pages |
| | | Assume any missing data |
| | | **Include and name all steps** |

**Question #1 [5 points, equally distributed]** Fill in the table below:

**1.1.** A data of size 100 sample is used for train and test using 5-fold cross validation. One should do a number of .....experiments with the number of training samples per experiment equals to .....

**1.2.** In Expectation-Maximization algorithm, the maximization step maximizes.....with respect to.....

**1.3.** High frequency ultrasonic images (5-15MHz) has .... spatial resolution and..... penetration capabilities (select either low or high in each space)

**1.4.** To provide an average velocity measurement over large area, one should use ..... ultrasonic

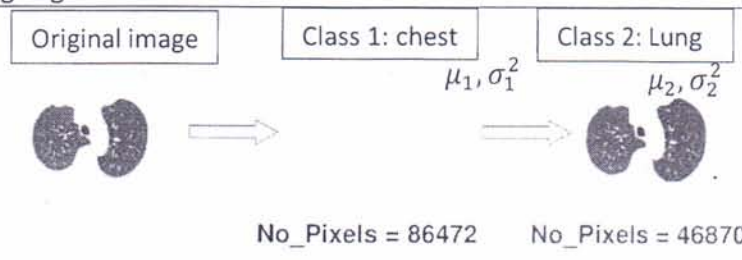
**1.5.** The time constant of the decay of the relaxation process of hydrogen protons in the direction of the main magnet is described using .....-weighted MRI

| | |
|---|---|
| 1.1 | |
| 1.2 | |
| 1.3 | |
| 1.4 | |
| 1.5 | |

| **Question # 2:** **[5 points]** Draw an illustration of CT image formation. List one advantage and one disadvantage and one application | **Question # 3:** **[5 points]** Describe how nuclear imaging is produced. Why beta particle are used in tumor therapy and not used in nuclear imaging. |
|---|---|
| | |

**Question # 4:** **[5 points]** If the vertical projection of 3 pixel in a column is 0.8 $cm^{-1}$. One of the pixels is a water tissue with an attenuation coefficient of 0.2 $cm^{-1}$. The other two pixels are of same tissue. Determine their attenuation coefficient and their Hounsfield units

**Question # 5:** **[5 points]** A chest CT training image, composed of two classes, with number of pixels of each class shown in Figure. If the means $\mu$ and variances $\sigma^2$ of two image classes are estimated from training image. Describe how to build a parametric supervised model for each class intensity distribution. How to use this model in lung segmentation?



**Question # 6:** **[5 points]** A given image Y with two classes $x = 0$ and $x = 1$. Compute only the prior probabilities and the mean of class $x = 0$ in the M-step of EM algorithm, for the following estimated 4x3 E-step responsibility $\pi(x = 0|\mathbf{Y})$ for class $x = 0$:

Image; Y

| | | |
|---|---|---|
| 7 | 5 | 6 |
| 8 | 4 | 1 |
| 4 | 1 | 0 |
| 2 | 2 | 4 |

$\pi(x = 0|\mathbf{Y})$

| | | |
|---|---|---|
| 1 | 1 | 0.9 |
| 1 | 0.1 | 0 |
| 0 | 0 | 0 |
| 0 | 0 | 0 |

**Question # 7:** **[5 points]** Sketch an M-mode ultrasonic scan example. List one application

**Question # 8:** **[5 points]** Sketch an MRI scanner. What is the condition that an atom is MRI active?

**Question # 9:** **[5 points]** Given a probabilistic shape model **for the object** Pshape(object) estimated from 5 training images.

- What is the condition needed for the training images to estimate the shape model from them?
- How many training images are labeled as background for the shaded pixel?
- Classify the test image based on this model.

Pshape(object)

| | | |
|---|---|---|
| 1 | 1 | **0.8** |
| 0.6 | 0.4 | 1 |
| 0 | 0.2 | 0 |

Test image

| | | |
|---|---|---|
| 9 | 8 | 7 |
| 4 | 5 | 2 |
| 0 | 1 | 0 |

**Question # 10:** **[5 points]** A Doppler shift ultrasound scanner transmits an ultrasound wave with a frequency of **2MHz**. A blood cell moving with a velocity of 2000 m/sec away from the transducer. Compute the frequency of the received echo from the moving blood cell. Recalculate the frequency if the blood cell is stationary and no longer moving [due to a clot (تجلط)].

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