SCN: SDXR8

1. a)

JPEG:

A - Convenient and easily accessible file type as it is used extensively.

D - JPEG uses lossy compression which reduces the size of overall files by losing data permanently.

DICOM:

A - DICOM files contain a header which includes more data about the image so it can be processed and presented in a wider variety of ways.

D - Since the header is not fixed, it could be possible that too many optional fields are entered, and this could cause inconsistencies across various DICOM files since there is no clear procedure for filling these fields.

b) i) $50000 \times 4 = 200000$ bytes

$512 \times 512 = 262144$ pixels

$262144 \times 8 = 2097152$ bytes per image

50 iterations = $200000 + (2097152 \times 50) = 105057600$ bytes

ii) $4 \times 100 \times 50000 + 512^2 \times 8 \times 50 \times 100 + \ldots$

$= 10.5$ Gb

c) - the algorithm would not be running parallel on multiple cores, the reduction in clock rate would decrease the time overall though

- Split the algorithm into parts to run it as this removes any bottleneck present.

2. Adopting an electronic health record with a Picture Archive and Communication Systems infrastructure would enable major developments in the quality of healthcare service that can be delivered to the islanders.

Considering that many inhabitants move back to the island to be treated, an EHR that stores pertinent medical data and archives medical images would be enable professionals to gain rapid access to long histories of a patient's medical data. This can improve the diagnoses given and thus the treatment assigned, which would ultimately improve patient prognosis.

However, a concern with the feasibility of implementing a EHR with a PACS system is that the initial cost of the system is significant. This is due to the database server architecture that needs to be implemented to store many terabytes of DICOM medical image files. Since the current imaging infrastructure is already dated, it may not be recommended for the islanders to upgrade to a storage system of these images. This is because the islanders may need to migrate to the mainland for its upgraded imaging systems anyway, where there will likely be a PACS system in place. However, due to the fact that this movement may not be possible, it's likely that an EHR with a PACS system is a necessity so at least a minimum level of care can be delivered. This is especially true since it would be an issue for medical professionals to issue a new scan each time it's needed on dated equipment, thus overall the PACS-EHR system is recommended despite its costs. In terms of minimising the cost, it would be advisable to minimise the hardware requirements by using large database servers, with minimal money spent on heavy computing equipment like GPUs to process the data. Further maximising compression and using DICOM files for selecting specific and relevant 2D slices of images can maximise how this system is utilised.

Another concern about the feasibility of implementing this is the user training that's required. This is because the server architecture requires significant maintenance, and the user will also be required to have expertise with DICOM files to store them correctly. However, once this initial burden is overcome, the system would enable better collaboration between island professionals and island to mainland communications, which will thus improve the treatment offered, benefitting patients. Therefore, overall, the system poses significant initial overhead in training and cost, but given the circumstances upgrading to a EHR-PACS system is advisable to maximise the treatment opportunities given to patients.

3. a) Binary representation: unsigned integer

Unsigned integer is used as the binary number doesn't need to convey sign since the temperature range is positive (30.0 → 43.0). Thus, this reduces the number of bits required to represent the range by 1.

Unsigned Integer Range = $0 \rightarrow 2^n - 1$

00.0

$\therefore n = 9 \Rightarrow 0 \rightarrow 511$

3-digit number using implicit offset:
000 → 511 => 00.0 → 51.1

Optimal number of bits: 9

511 possible combinations, but 131 combinations only needed

b) $t = 38.3\,^{\circ}C$

$2^8\ 2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$ = 3-digit number gives decimal

Binary Number: $101111111 = 2^8 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0 = 383$

$\therefore 101111111 = 383 = 38.3$

C) $0.7^{\circ}C = 007 = 2^2 + 2^1 + 2^0 = 0000000111$

Two's Complement of 007: 111111001
(to convert 007 into negative complement for A+(-B)

$$\therefore \begin{array}{r} 101111111 \\ +\ 111111001 \\ \hline 101111000 \end{array} = 2^8 + 2^6 + 2^5 + 2^4 + 2^3 = 376$$

$\therefore$ 101111000 = $37.6^{\circ}C$, which is correct since $38.3 - 0.7 = 37.6^{\circ}C$
↳ Binary number from Subtraction

4.

$TP = 30$

$FP = 220 - 30 = 190$

$\therefore$

$$\text{Sensitivity} = \frac{TP}{TP+FN} \times 100$$

$$75 = \frac{30}{30+FN} \times 100 \Rightarrow FN = 10$$

1000 Participants	Actual Positive	Actual Negative
Test Positive	30 (TP)	190 (FP)
Test Negative	10 (FN)	770 (TN)

$$\text{Specificity} = \frac{TN}{TN+FP} = \frac{770}{770+190} = 0.8020833\ldots \times 100$$

$$= 80.21\%$$

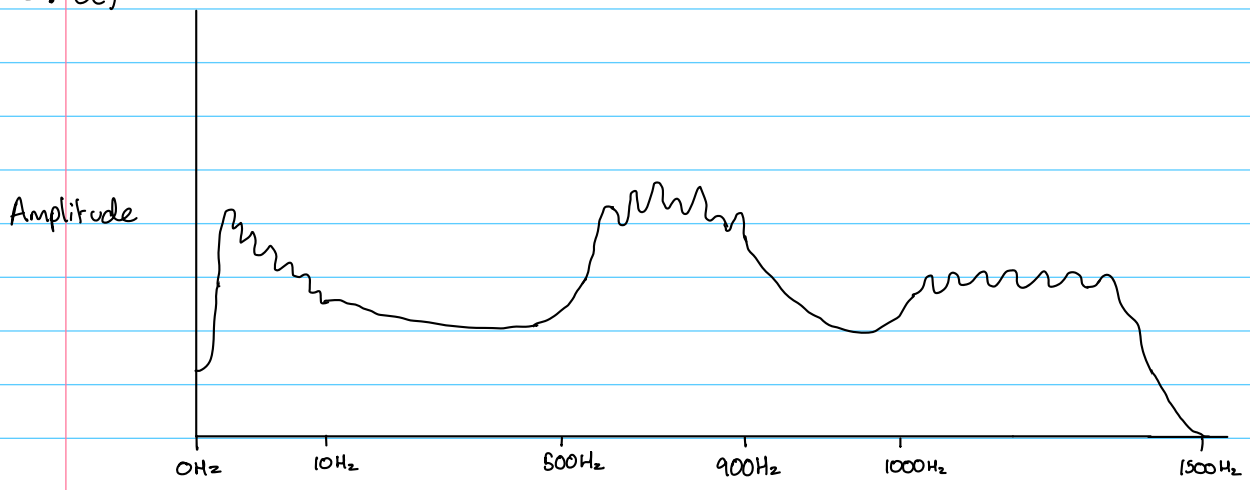
$$\text{Positive Predictive Value (PPV)} = \frac{30}{30+190} \times 100 = 13.6\% \text{ (1dp)}$$

Probability Distribution: This function represents the probabilities that correspond to various outcomes in the possible outcomes domain. The probabilities are on the y-axis, while possible outcomes are on x-axis.

Sampling Distribution: This is the distribution for the statistic that is taken as a random variable

The Sampling Size doesn't represent the population well since it isn't large enough to represent the general population.

5. a)



Maximum Sampling period = $\frac{1}{\text{Most useful frequency}} = \frac{1}{2 \times 900} = 556\mu s$ (3sf)

c)

6. a) i)

$$w(1,4,1,4) = e^{\frac{-(1-0)^2-(4-4)^2}{2\times 16^2} - \frac{116-12^2}{2\times 2.3^2}} = 0$$

$w(1,4,0,4) = 0.5266$

$w(1,5,0,4) = 0.86$

$w(1,5,1,5) = 0.753$

ii)

$$w(1,4,1,4) = e^{\frac{-(1-0)^2-(4-4)^2}{2\times 16^2} - \frac{116-12^2}{2\times 2.3^2}} = 0$$

$w(1,404) = 0.753$

$w(1,5,0,5) = 1.25$

$T_f(1,4) = 299 + 124 + 0.7353$

b) i)

74.9	98.4	98.1	94.6	68.9
94.8	122.8	125.3	126.4	98.6
90.8	118.1	124.8	131.6	98.6
88.3	115.9	123.7	131.8	100.4
63.3	82.9	85.9	92.4	73.8

ii)

135.0	132.7	131.8	126.4	126.4
128.1	122.8	125.3	126.4	124.9
122.7	118.1	124.8	131.7	131.1
119.3	115.9	123.6	131.8	134.2
112.3	109.3	112.0	121.1	132.1

c) If input filter H is linear the bilateral is not linear since the output wouldn't be linear.

Linear filters are seperable, so this can be applied. This means that 2×1D filters are faster than 1×2D. This is also faster than the non linear filter, as a cumulative this would be a significant improvement.

In terms of noise, nonlinear filters are better at denoising.

d) i) bottom line = $I_2 = 0.7 \cdot 138 + (1-0.7)116 = 131.4$

Top line = $I_1 = 0.7 \cdot 119 + (1-0.7)(135)$
$= 123.8$

Vertical line = $0.4\,(131.4) + (1-0.4)123.8 = 126.6$