Question 17.1

The points $(x, y) = (10, 35)$ and $(x, y) = (29, 57)$ are first transformed with the transformation matrix:

$$\begin{bmatrix} 1 & 3 \\ 2 & 2 \end{bmatrix} \tag{1}$$

and then with the transformation matrix:

$$\begin{bmatrix} 7 & 3 \\ 3 & 4 \end{bmatrix} \tag{2}$$

Afterwards, the Euclidean distance between the two points is computed. This distance is:

1. 1023
2. 577
3. 987
4. 854
5. 340
6. Do not know

Question 17.2

You have made an algorithm that can classify objects to be either *cell* or *noise-object*. In the left image of Figure 1 an expert has colored actual cells green and noise-objects red. Your algorithm only finds cells, and the result of the algorithm can be seen in the right image. How many *true positives* are there?

1. 2
2. 1
3. 4
4. 0
5. 3
6. Do not know

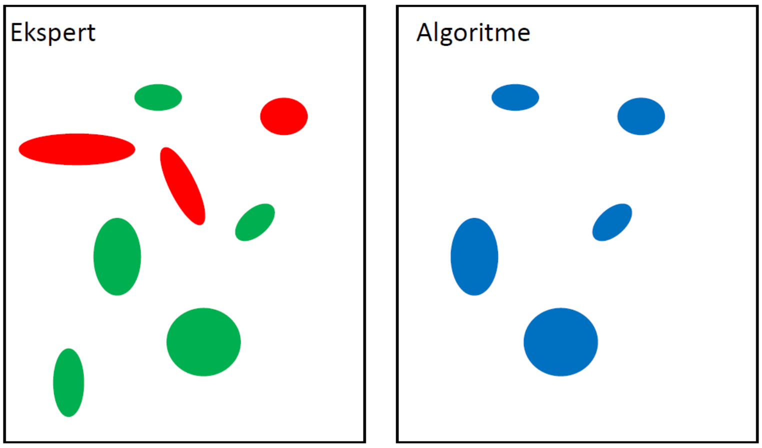

Figure 1: Cell classificaion. Left: An experts annotation. Right: The result of the algorithm.

Question 17.4

A 5 x 5 image is filled with values given by the *gray level run length* code: 3, 17, 5, 200, 3, 8, 1, 100, 1, 13, 5, 110, 1, 10, 4, 35, 2, 9. The image has an (x,y) zero based coordinate system with origo in the top left corner. Using *dynamic programming* an *optimal path* from the top to the bottom of the image is computed. What is the total cost of the resulting path?

1. 87
2. 38
3. 67
4. 120
5. 57
6. Do not know

Question 17.5

What set of BLOB features seperates the 6 BLOBs in figure 2 best?

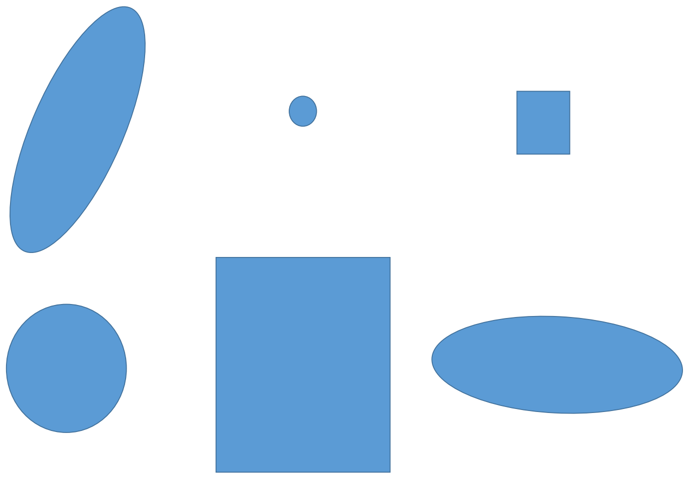

Figure 2: 6 BLOBs

1. *compactness* and *circularity*
2. *bounding box ratio* and *circularity*
3. Area and *compactness*
4. *compactness* and *bounding box ratio*
5. Area and *bounding box ratio*
6. Do not know

Question 17.6

A *gamma mapping* with $\gamma = 1.28$ is performed on the image shown in Figure 3. All pixels are now rounded to integers and the image is filtered with a *Vertical Prewitt* filter. What is the result in the marked pixel?

1. 129
2. 116
3. 144
4. 123
5. 131
6. Do not know

208	71	244	202	173	180
231	139	124	245	193	8
32	244	204	167	189	71
233	246	36	9	100	12
161	40	108	217	167	25
25	248	234	238	44	210

Figure 3: Grayscale image

Question 17.7

A *template matching* is performed on the image of Figure 4 (left) using the template shown in Figure 4 (right). What is the difference between the *correlation* in the pixel marked with red circle and the *correlation* in the pixel marked with a green circle?

1. 5643
2. 10624
3. 14302
4. 9342
5. 7452
6. Do not know

177	195	181	30	192	140
81	203	192	127	65	35
242	48	70	245	129	38
9	125	173	87	178	66
112	114	167	149	227	214
97	165	41	57	245	65

212	234	192
149	73	97
140	193	145

Figure 4: Left: Gray scale image. Right: Template.

Question 17.8

In order to make a *pixel classification* an expert has annotated areas of an image containing air, soft tissue, kidney, liver and bone. The pixel values of the original image are given in Hounsfield units. The mean and standard deviation of the selected pixel values are listed in Table 1. A *minimum distance classification* is performed on the image. What is the *class range* for soft tissue?

1. $[-120.2, -15.2[$
2. $[-54.2, 12.3[$
3. $[-341, 3.4[$
4. $[-240, 21.3[$
5. $[-499, -8.5[$
6. Do not know

Tissue	mean	standard deviation
air	-944	97
soft tissue	-54	7.9
kidney	37	5
liver	53	2.6
bone	220	5

Table 1: Mean and standard deviation of the pixel values in the areas annotated by the expert.

Question 17.10

A *template matching* is performed on the image of Figure 5 (left) using the template shown in Figure 5 (right). What is the *normalized cross correlation* in the pixel marked with a green circle?

1. 0.56
2. 0.92
3. 0.83
4. 0.67
5. 0.81
6. Do not know

177	195	181	30	192	140
81	203	192	127	65	35
242	48	70	245	129	38
9	125	173	87	178	66
112	114	167	149	227	214
97	165	41	57	245	65

212	234	192
149	73	97
140	193	145

Figure 5: Left: Gray scale image. Right: Template

Question 17.11

A BLOB analysis is performed on the image shown in Figure 6. The largest BLOB is found using *8-connectivity*. What is the *bounding box ratio* of this BLOB?

1. 1.31
2. 0.86
3. 1.44
4. 1.09
5. 0.57
6. Do not know

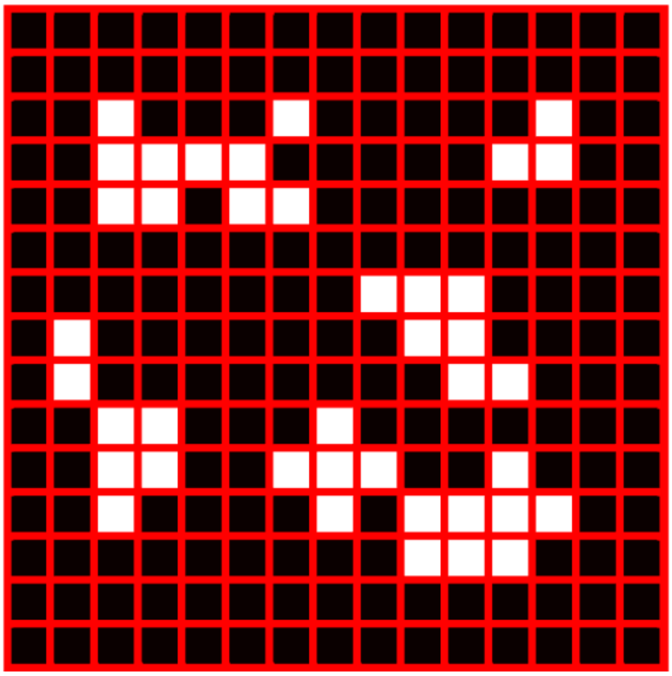

Figure 6: Binary image. White pixels are foreground (1) and black pixels are background (0).

Question 17.12

A BLOB analysis is performed on the image shown in Figure 7. All BLOBS are found using *4-connectivity* and their *compactness* are computed. How many BLOBs have a *compactness* greater than 0.90?

1. 2
2. 1
3. 3
4. 4
5. 5
6. Do not know

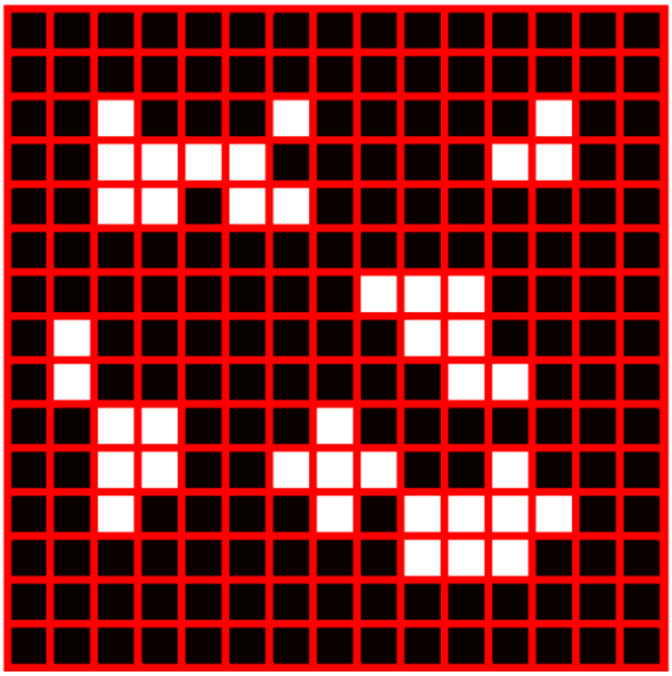

Figure 7: Binary image. White pixels are foreground (1) and black pixels are background (0).

Question 17.13

A binary image is coded with a *binary chain coding*, using a zero based (x,y) coordinate system with origo in the top left corner:

(4,3)(0045606655221222)

A *morphological opening* is performed on the image using the SE1 of Figure 8. How many foreground pixels does the resulting image contain?

1. 4
2. 2
3. 7
4. 5
5. 3
6. Do not know

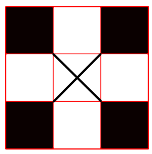

Figure 8: SE1. White pixels are foreground (1) and black pixels are background (0). The center is marked with a black cross.

Question 17.14

You have a camera with a *focal length* of 52 mm and a CCD chip of 8 mm x 6 mm. The image dimensions are 3200 x 2400 pixels. It can be assumed that $b = f$. From a distance of 10 cm you have taken a sharp picture of an eye with a completely round pupil. The image is thresholded such that only the pupil is visible. You find the area of the pupil to be 416248 pixels. What is the real diameter of the pupil given in millimeters?

1. 4.2 millimeter
2. 3.5 millimeter
3. 2.9 millimeter
4. 3.8 millimeter
5. 4.4 millimeter
6. Do not know

Question 17.15

You have made an algorithm that can classify objects to be either *cell* or *noise-object*. In the left image of Figure 9 an expert has colored actual cells green and noise-objects red. Your algorithm only finds cells, and the result of the algorithm can be seen in the right image. What is the *accuracy* of your algorithm?

1. 0.75
2. 0.67
3. 0.87
4. 0.92
5. 0.70
6. Do not know

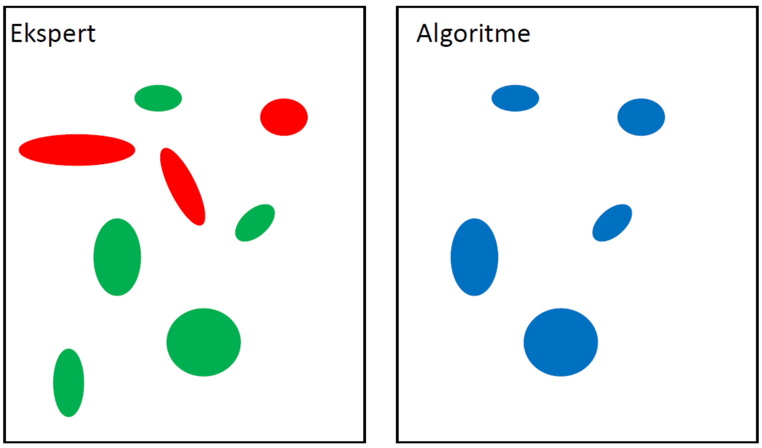

Figure 9: Cell classificaion. Left: An experts annotation. Right: The result of the algorithm.

Question 17.16

In a gray scale image the pixel value in the position (37.4, 23.5) is computed using bilinear interpolation. The four nearest pixels and their pixel values are:

x	y	value
37	23	105
38	23	204
37	24	232
38	24	111

What is the resulting interpolated value?

1. 198
2. 155
3. 201
4. 164
5. 177
6. Do not know

Question 17.17

A *linear gray level mapping* is performed on the image of Figure 10 such that the new maximum value of the image is 210 and the new minimum value of the image is 45. Next, the image is filtered with a *3x3 median filter*. What is the resulting value of the marked pixel?

1. 210
2. 179
3. 98
4. 110
5. 123
6. Do not know

88	66	46	178	167	83
149	152	108	163	104	27
27	6	24	9	209	156
231	108	153	18	183	199
224	80	120	81	247	108
209	41	177	135	135	23

Figure 10: Grayscale image.

Question 17.18

Using *dynamic programming* an *optimal path* is found from the top to the bottom of the image in Figure 11. A Matlab matrix coordinate system is used. What is the value in the *accumulator image* at the position $(4, 4)$?

199	240	209	18	175	237
99	244	4	115	47	198
62	147	11	139	94	124
103	15	43	76	160	111
25	60	166	190	199	114
34	90	187	48	21	78

Figure 11: Grayscale image.

1. 65
2. 131
3. 109
4. 123
5. 98
6. Do not know

Question 17.19

In order to make a *pixel classification* an expert has annotated areas of an image containing air, soft tissue, kidney, liver and bone. The pixel values of the original image are given in Hounsfield units. The values of the annotated pixels are listed in Table 2. A *minimum distance classification* is performed on the image. How many pixels of the image shown in Figure 12 will be classified as liver?

1. 3
2. 12
3. 9
4. 7
5. 13
6. Do not know

Tissue	pixel values
air	-854, -987, -1023
soft tissue	-58, -55, -47
kidney	33, 38, 35
liver	52, 48, 45
bone	221, 218, 219

Table 2: Pixel values in the areas annotated by the expert.

5	6	182	183	184	187
8	9	52	54	97	165
32	33	65	68	195	181
35	37	8	71	75	140
29	30	33	34	145	152
23	34	40	38	189	167

Figure 12: Grayscale billede

Question 17.20

In order to make a *pixel classification* an expert has annotated areas of an image containing air, soft tissue, kidney, liver and bone. The pixel values of the original image are given in Hounsfield units. The mean and standard deviation of the selected pixel values are listed in Table 3. A *parametric classification* is performed on the image. A pixel with the value 46 will be classified as?

1. air
2. soft tissue
3. kidney
4. liver
5. bone
6. Do not know

Tissue	mean	standard deviation
air	-944	97
soft tissue	-54	7.9
kidney	37	5
leier	53	2.6
bone	220	5

Table 3: Mean and standard deviation of the pixel values in the areas annotated by the expert.

Question 17.21

The image in Figure 13 is thresholded at 170. Values above the threshold are set to 1. This results in a binary image (I). The following morphological operations are carried out:

$$(\mathrm{I} \ominus \mathrm{SE1}) \oplus \mathrm{SE2},$$

where SE1 and SE2 are shown in Figure 14. How many foreground pixels does the resulting image contain?

65	159	28	45	39	13
97	234	189	198	155	75
13	97	210	201	203	18
9	198	201	196	199	164
90	2	28	199	92	1
132	57	102	14	169	132

Figure 13: Grayscale image

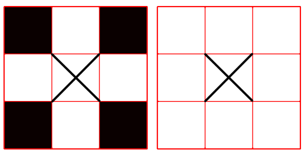

Figure 14: Left: SE1, Right: SE2. White pixels are foreground (1) and black pixels are background (0). The center pixel is marked with a black cross.

1. 5
2. 12
3. 14
4. 4
5. 9
6. Do not know

Question 17.23

The image shown in Figure 15 is filtered with a *Horizontal Sobel filter*. In order to avoid *the border problem*, the image is extended with the value 0 (zero padding). What are the resulting values in the two marked pixels?

1. 104 and -23
2. -310 and -104
3. 56 and -167
4. 234 and 254
5. -405 and 215
6. Do not know

208	110	222	89	47	125
222	232	148	131	61	125
22	46	140	102	106	86
102	67	37	19	13	230
66	37	218	61	230	94
204	35	159	31	241	28

Figure 15: Grayscale image

Question 17.24

A binary image is coded with a *binary run-length coding*, using a zero based (x,y) coordinate system with origo in the top left corner:

[1; (4,4)],[2, (3,4)],[3,(2,2)],[4,(2,2)],[5,(3,3)]

A BLOB analysis is carried out on the image using *4-connectivity*. What is the *center of mass* of the largest BLOB?

1. (4.3, 1.5)
2. (3.7, 1.7)
3. (2.5, 2.5)
4. (1.7, 2.1)
5. (1.2, 1.7)
6. Do not know

Question 17.25

Using *dynamic programming* an *optimal path* is found from the top to the bottom of the image in Figure 16. A Matlab matrix coordinate system is used. What is the value in the *backtracing image* at the position (4,2)?

1. 1
2. 4
3. 2
4. 3
5. 5
6. Do not know

199	240	209	18	175	237
99	244	4	115	47	198
62	147	11	139	94	124
103	15	43	76	160	111
25	60	166	190	199	114
34	90	187	48	21	78

Figure 16: Grayscale image.

Answers

Opgave	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Svar	1	3		5	5	2	2	5		3	5	1	4	2	1

Opgave	16	17	18	19	20	21	22	23	24	25
Svar	4	5	3	4	3	2		5	2	4