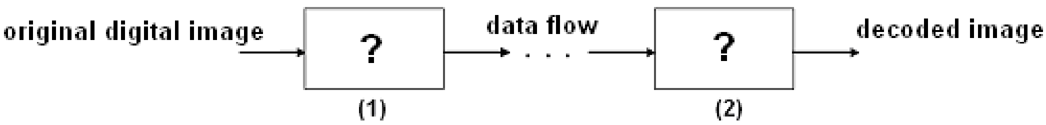
Chapter 1 – Introduction to digital image processing

TEST

1 – In the table below, use YES and NO to indicate whether the ***Objective*** given is in relation with the image processing ***Domain*** indicated.

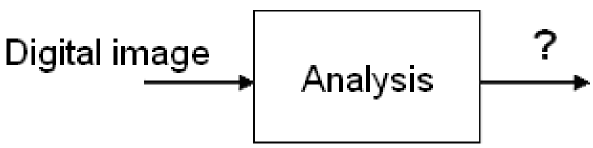
Domain / ***Objective***	Data compression (coding)	Image synthesis	Image enhancement and restoration	Image analysis
Measuring the size of an object				
Visualizing the image of an object				
Reducing noise				
Compressing the binary flow				
Determining the color of an object				
Enhancing image contrast				
Recognizing a pattern in an image				

2 – This diagram represents very briefly a digital image or video compression application:



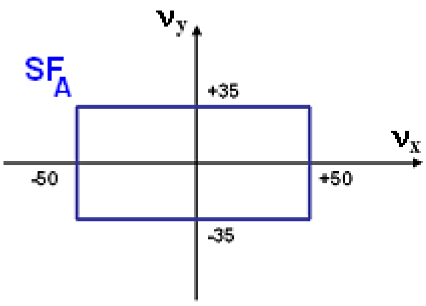
What is the object of each of these two main functions (boxes (1) and (2))?

3 – For an image analysis application, give two examples of data output from the Analysis block.



4 – <u>Sampling</u>

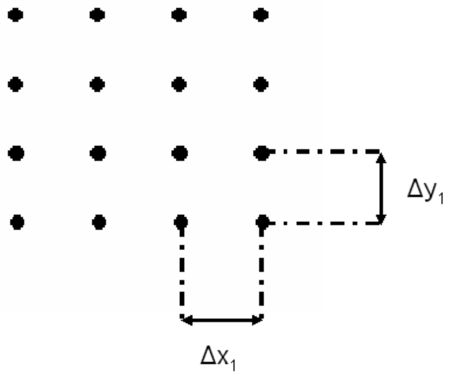
Let I_A be an analog input image (image signal $f_A(x, y)$). Its spectrum F_A is band-limited and the spectrum support $SF_A(\nu_x, \nu_y)$ is represented below:



- ν_x, ν_y : respectively horizontal and vertical spatial frequencies.

We sample this image I_A by a square sampling structure E_1 with three step values $(\Delta x_1, \Delta y_1)$:

- a) $\Delta x_1 = \Delta y_1 = 1/40$
- b) $\Delta x_1 = \Delta y_1 = 1/80$
- c) $\Delta x_1 = \Delta y_1 = 1/120$

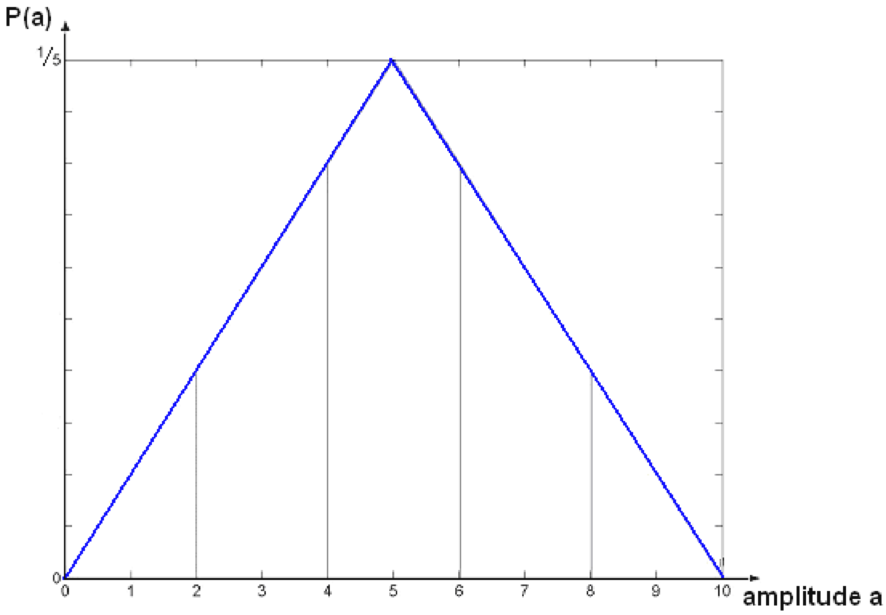


For each of these cases, a), b), and c), indicate if there is an *aliasing* effect in the horizontal structure or in the vertical structure. Justify your answer each time.

What conclusion do you reach about the differences with sampling purely time signals?

5 – Quantization

Given a sampled monochrome image, whose luminance follows the probability distribution below:



This is a symmetric linear law in relation to 5.
We want to quantize the luminance over 5 levels. To do this we fix beforehand 4 decision thresholds t_i so that the 5 intervals $[t_i, t_{i+1}[$ measure the same. So we have: $t_0=0$; $t_1=2$; $t_2=4$; $t_3=6$; $t_4=8$; $t_5=10$.

a) For each of these 5 intervals $[t_i, t_{i+1}[$; i = {0, 1, 2 , 3, 4, 5} determine the optimal quantization level r_i that minimizes the mean square error.

b) From these 5 optimal quantization values r_1, r_2, r_3, r_4, r_5, what would be the optimal values for the four decision thresholds t_1, t_2, t_3, t_4 ?

We can note that we could simply reiterate this set of 2 stages to arrive at a law of optimal quantization, after stabilization of the quantization and decision values.