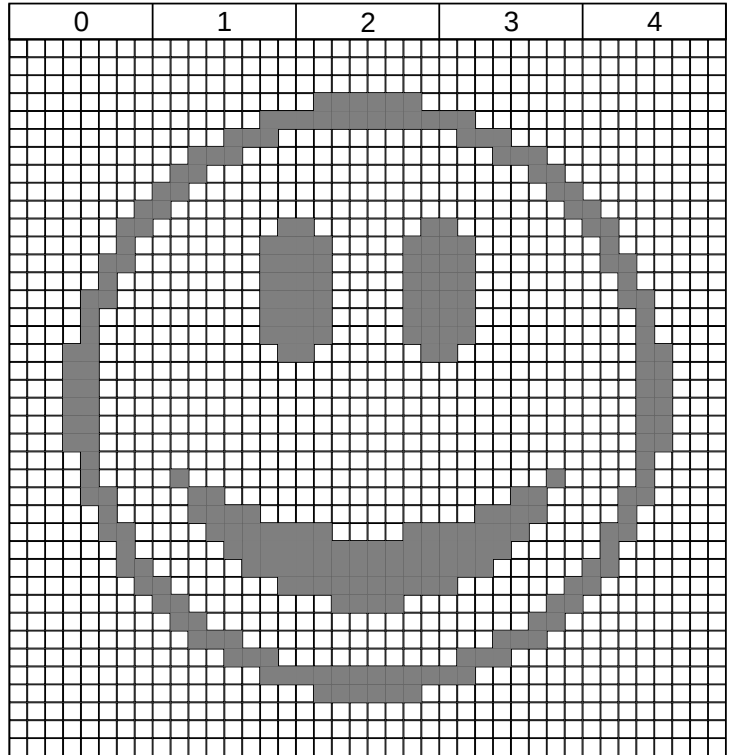


# Worksheet: Run-Length Encoding

1. Examine the raster image to the right. The hexadecimal values for the first few rows of the bitmap format pixel array is given below, using the color table values of zero ( 0 ) for black and one ( 1 ) for white. For simplicity, we will not pad the rows to a multiple of 32 bits (4 bytes).

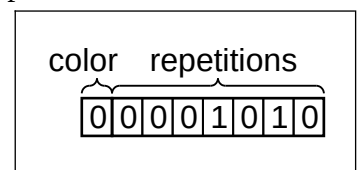


		byte				
		0	1	2	3	4
row	0	FF	FF	FF	FF	FF
	1	FF	FF	FF	FF	FF
	2	FF	FF	FF	FF	FF
	3					
	4					
	5					

- Complete the missing values from the table, above.
- The image above is 40 pixels high. How many bits are required to store the entire pixel array?
- Convert the number of bits in part (b) to bytes. How many bytes are required to store the entire pixel array?


2. Now we will encode the first few rows of the bitmap using **run-length encoding**. Recall that run-length encoding stores the value of the data, followed by the number of repetitions of that data.

For our encoding, we will use a single byte, with the first bit representing the color of the pixels, and the remaining 7 bits representing the number of pixels of that color. This encoding is represented in the diagram in the box to the right.



- Count the number of white pixels from the start of the image, traversing each row, left to right, until the first black pixel. How might we represent this using our run-length encoding scheme?  
*Hint: we will not be able to represent it in a single byte as there are too many repetitions.*

Binary:

Hexadecimal:

- Continue for the next sixteen bytes; write the binary.


## Worksheet: Run-Length Encoding

3. Use the compression ratio formula given to the right to complete the following.

$$\text{compression ratio} = \frac{\text{original size}}{\text{compressed size}}$$

- a) In part (2a), how many bits of the pixel array were encoded into two bytes (16 bits) using run-length encoding?
- b) Use the information in part (3a) to calculate the *compression ratio* of the first two bytes of the run-length encoding.
- c) In part (2b), how many bits were encoded into the subsequent sixteen bytes (128 bits) of run-length encoding?
- d) Use the information in part (3c) to calculate the *compression ratio* of the subsequent 16 bytes of the run-length encoding.


4. Consider the 1x8 pixel two-color image to the right.



- a) How many bits would be necessary to encode the image as a pixel array?
- b) How many bytes would be necessary to encode the image using the above run-length encoding scheme?
- c) What is the *compression ratio* when the above run-length encoding scheme is used to compress this image?


5. Answer in complete sentences.

- a) What type of data does run-length encoding work well on (provide good compression)?

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- b) Comment on the characteristics of and the storage space for the 8-pixel image in question 4.

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- c) Why might run-length encoding not work well on a high-color image (such as those on page 142 of your textbook)?

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- d) Describe how to interpret different ranges of values for the *compression ratio*.

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