Lesson 4.3: Image Compression

Objectives

In this lesson, students will:

- Learn how an image can be represented by a set of numbers
- Be introduced to the concept of image compression
- Learn about pixels
- Practice creating an image represented as numbers (using a compression technique)

Agenda

1. Introduction	10 mins
2. Pixels and Using Numbers to Represent a Picture	10 mins
3. Student Activity: What is the Mystery Image, and Extended Activities.	20 mins
4. Wrap Up and Reflections	10 mins

Preparation

- ❑ Print student activity worksheet
- ❑ Print extension student activity worksheets (for extension activities)
- ❑ Optionally print exhibit A and B (alternatively display the images)

Resources & Links

- ❑ None

1. Introduction

Prompt students:

- In what situations would computers need to store pictures? (A drawing program, a game with graphics, storing selfies, ...)
- How can computers store pictures when they can only use/understand numbers?

In the previous lessons, we learned how computers can represent letters and numbers using binary. But how can we store pictures and images in binary? If we could convert the image to a set of numbers, the problem could be solved (as we know how to write numbers in binary). In this activity we will learn how pictures can be represented by a set of numbers. These numbers are then stored in the computer.

Not only can images be represented by a set of numbers, but they can be converted in such a way that they need less space to store them. When we convert an image to remove repetition or other techniques to use the least amount of numbers without changing what an image looks like, it is called image **compression**.

Images are often **compressed** to a much smaller size of their original size to allow more pictures to be stored on a computer, and it means that viewing them over the web will take a fraction of the time.

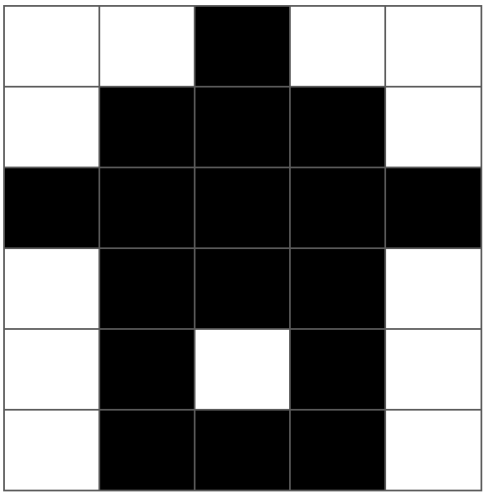
In this lesson we will learn how to convert an image into numbers and numbers into an image using a compression technique called ***run-length coding.***

2. Pixels and Using Numbers to Represent an Image

Display exhibit A.

Computer screens are divided up into a grid of small dots called pixels (picture elements). In a black and white picture, each pixel is either black or white.

This image of a small house has been magnified to show the pixels. When a computer stores a picture, it just needs to store which dots are black and which are white.



2, 1, 2

1, 3, 1

0, 5

1, 3, 1

1, 1, 1, 1, 1

1, 3, 1

The image above shows us how a picture can be represented by numbers.
The first line consists of 2 white pixels, then 1 black, then 2 white. Therefore, the first row of pixels of this image can be represented as 2, 1, 2.

Rules for representing an image: (write them on the board)

- The first number always represents the number of white pixels. If the first pixel is black the line will begin with a zero.
- The next number that follows represents how many pixels are black, then white again and they continue to alternate.

Continue to explain the other rows of the image of the house..

Display exhibit B.

It would be helpful to do this one with the class by having different students give the values for each row.

3. Student Activity: What Is the Mystery Image?

Distribute the student activity. Using the rules, students will fill in squares for each image represented by numbers. It might be helpful to give an example of the activity by drawing in squares for the first row of one of the activity images.

Extension Activities:

If time permits or for more advanced students, you can distribute the extension student activity worksheet. Using the extension student activity worksheet II, students can also create their own image and then have another student translate the image into numbers.

4. Wrap Up and Reflections

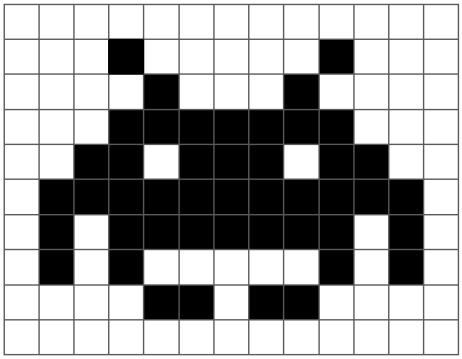
Color pictures and images also have a lot of repetition in them. To save the amount of storage space needed to store such images, programmers can use a variety of compression techniques.

The method used in this activity is called 'run-length coding', and is an effective way to compress images. If we didn't compress images it would take much longer to transmit pictures and require much more storage space. This would make it difficult to send photos to our friends or download from a web page.

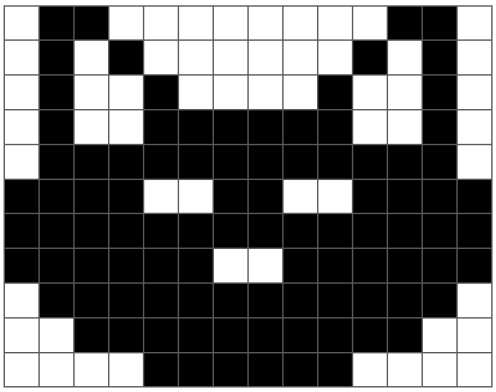
Reflection Points:

- When a picture is compressed, does it use more or less storage space?
- Why are images compressed?
- What are pixels?
- Can everything stored in a computer be represented by numbers?

Solution to Student Activity: What Is the Mystery Image?

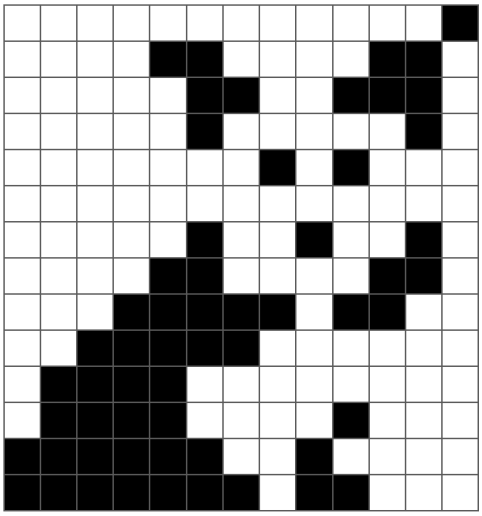


13
3,1,5,1,3
4,1,3,1,4
3,7,3
2,2,1,3,1,2,2
1,11,1
1,1,1,7,1,1,1
1,1,1,1,5,1,1,1,1
4,2,1,2,4
13



1,2,8,2,1
1,1,1,1,6,1,1,1,1
1,1,2,1,4,1,2,1,1
1,1,2,6,2,1,1
1,12,1
0,4,2,2,2,4
0,14
0,6,2,6
1,12,1
2,10,2
4,6,4

Extension:



11,1
4,2,4,2,1
5,2,2,3
5,1,5,1
7,1,1,1
13
5,1,2,1,2,1
4,2,4,1
3,5,1,2
2,5
1,4
1,4,4,1
0,6,2,1
0,7,1,2

Exhibit A

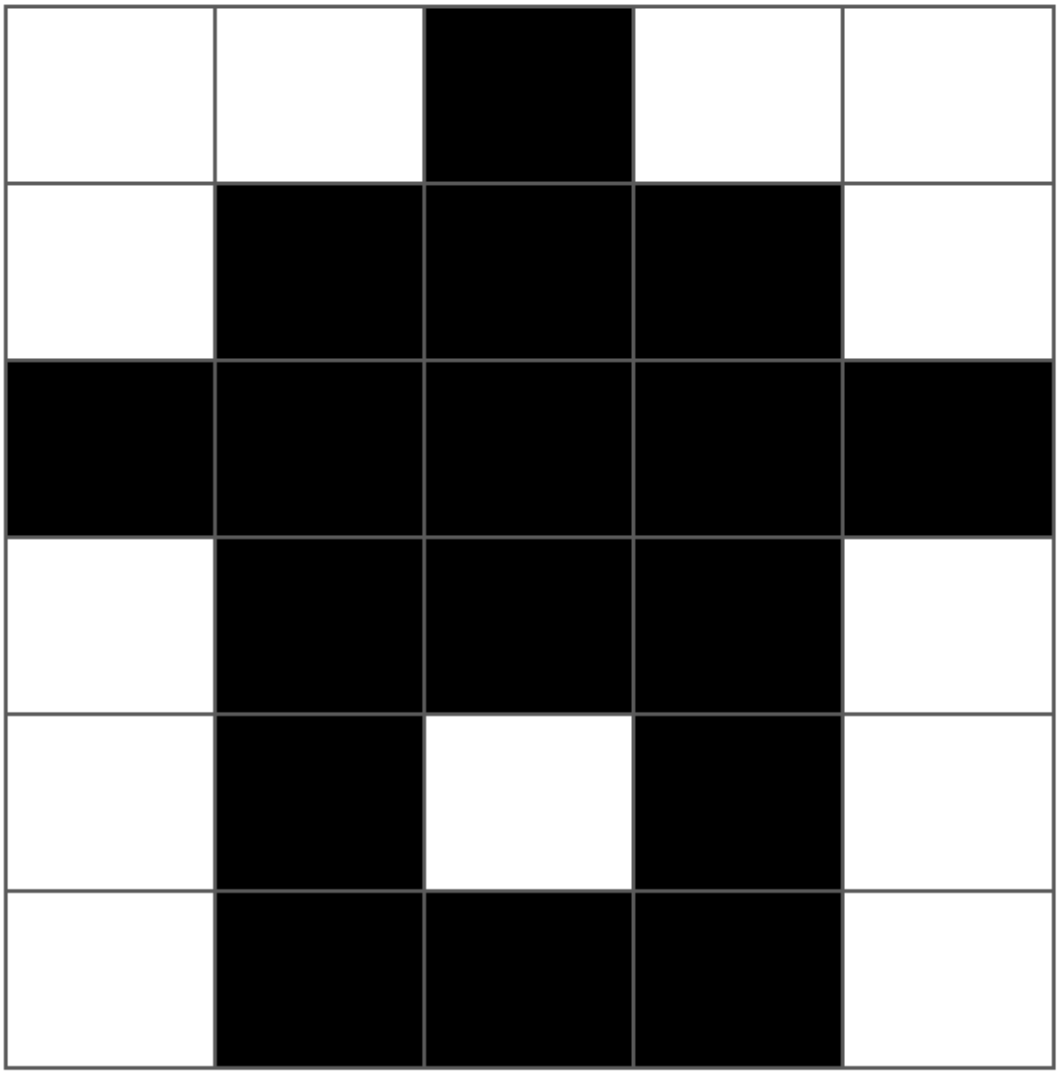
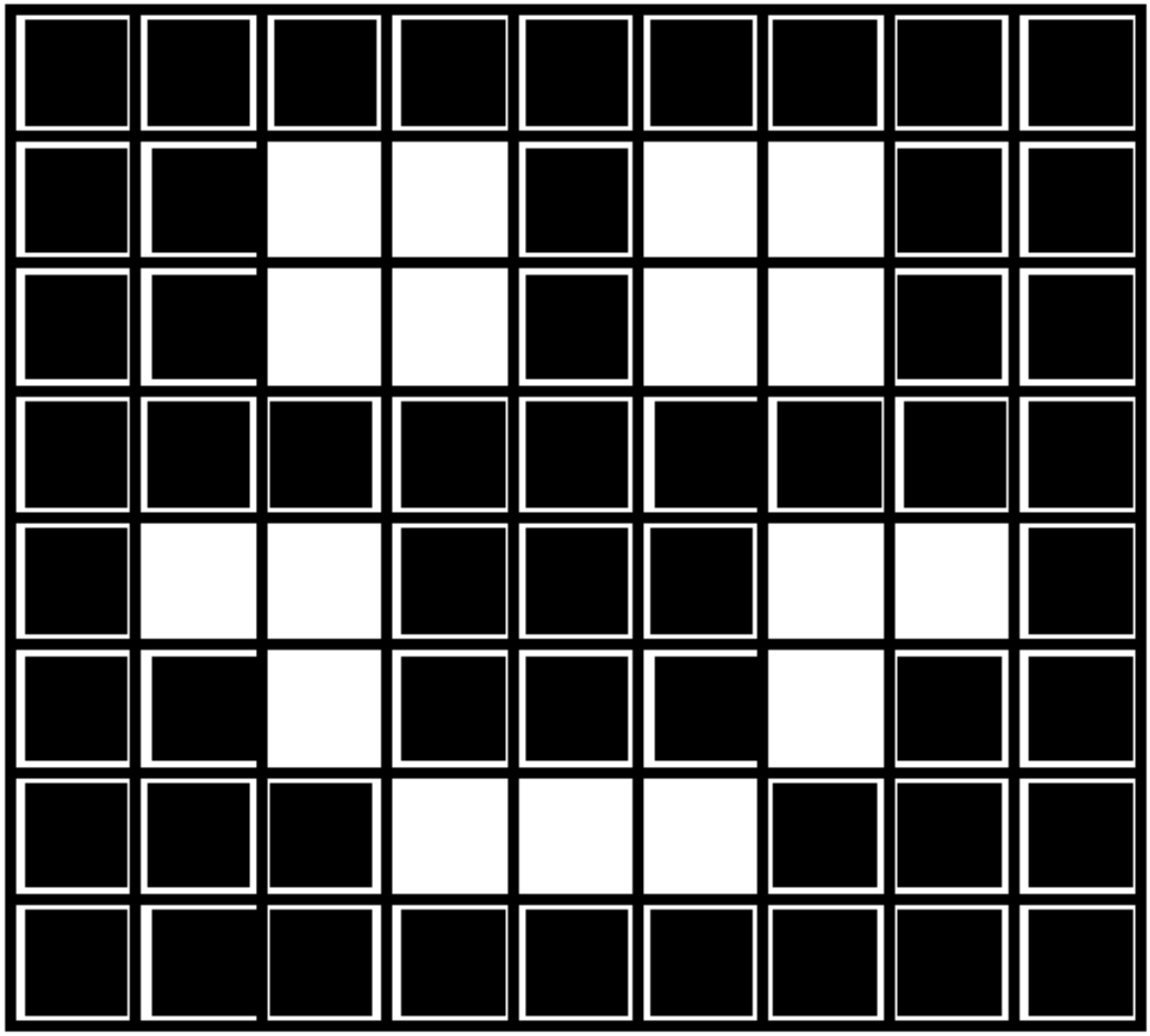
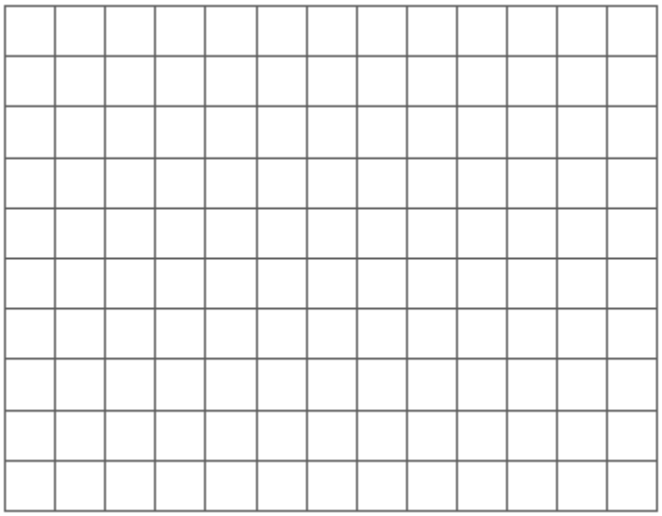


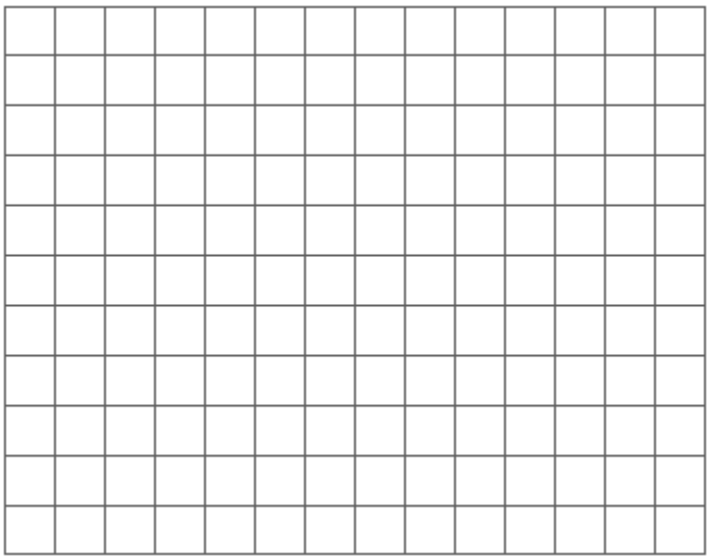
Exhibit B



Student Worksheet: What Is the Mystery Image?

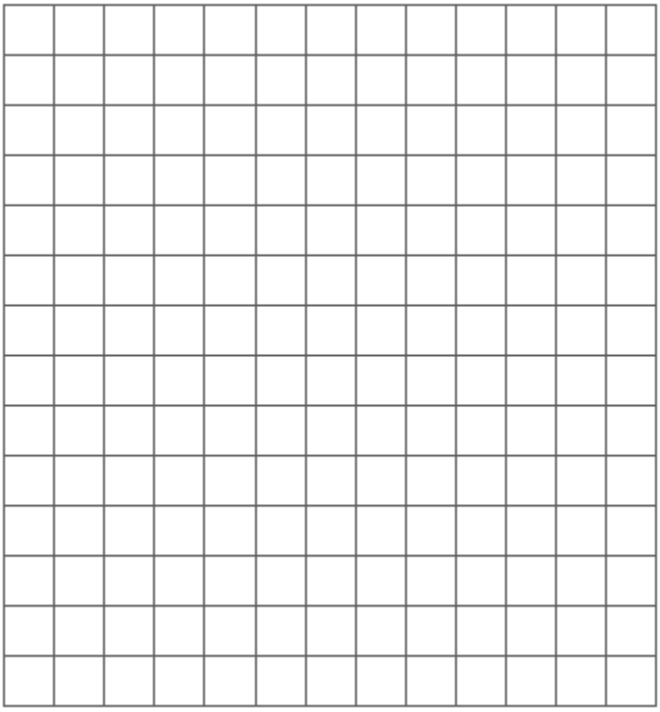


13
3,1,5,1,3
4,1,3,1,4
3,7,3
2,2,1,3,1,2,2
1,11,1
1,1,1,7,1,1,1
1,1,1,1,5,1,1,1,1
4,2,1,2,4
13



1,2,8,2,1
1,1,1,1,6,1,1,1,1
1,1,2,1,4,1,2,1,1
1,1,2,6,2,1,1
1,12,1
0,4,2,2,2,4
0,14
0,6,2,6
1,12,1
2,10,2
4,6,4

Extension Student Worksheet: What is the Mystery image?



11,1
4,2,4,2,1
5,2,2,3
5,1,5,1
7,1,1,1
13
5,1,2,1,2,1
4,2,4,1
3,5,1,2
2,5
1,4
1,4,4,1
0,6,2,1
0,7,1,2

Extension Student Activity Worksheet II

Create your own image and number representation of your image.