Lesson 3.6: Storing Data

Objectives

In this lesson, students will:

- Review the binary number system and learn about the fundamentals of storing data in files.
- Gain an understanding of file formats for text and images and their storage requirements.
- Learn about image compression methods.

Agenda

1. Binary and Data	10 mins
2. Student Activity: Binary and Data	10 mins
3. Storing Text Data	10 mins
4. Student Activity: Do I have enough storage	10 mins
5. Student Activity: Storing Images	15 mins
6. Wrap Up and Reflections	5 mins

Preparation

- ❑ Projector and speakers for video
- ❑ Student activity worksheet printouts (one per student or one per student pair)

Resources & Links

- ❑ Binary and Data video: https://tinyurl.com/y8egzrzu
- ❑ Terms Search: https://techterms.com/search

1. Overview

In this lesson students will review the binary system and learn how data and images are stored.

2. Binary and Data

You may have heard that everything in a computer is stored as 0s and 1s. Well it's true. Computers and storage devices use the binary system to store data.

Let's watch a video to learn about storing data and the binary system.
https://tinyurl.com/y8egzrzu

2. Student Activity: Binary and Data

In this activity students revisit what they learned in the video. Students can work in pairs or on their own. Distribute the activity worksheet for Binary and Data.

Follow up with a class discussion of the answers.

Solution to Student Activity

1.

9	1001
6	0110

2. Can an image file or sound file be represented with numbers?
   True

3. Which statements are true about images?

   Images cannot be represented by binary numbers

   ✅Images are made of tiny dots called pixels
   ✅Each pixel has a color and the color can be represented by a number
   ✅Images can be represented by numbers

4. HI DOGGIE

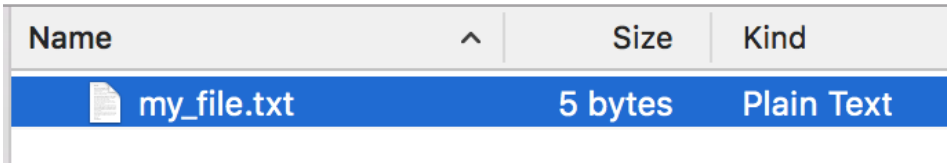
3. Storing Text Data

No matter what device you use to send a text, take a picture, listen to music or watch a video, the data has to be stored somewhere. The data are the binary numbers that represent the photos or text and all saved data requires space to store it.

But how much storage do we need to store the data? That depends on the type of data we are saving. Data on computers are typically stored in files which are like containers with a name for your data. If you store some text, a picture or music, the computer uses a different kind of file for each one. For example you may have heard of a text file which is used for text, or a JPEG which is a different type of file used for pictures or images.

You learned that to represent a letter the computer uses a sequence of 0s and 1s or bits. For each letter you need 8 bits. And 8 bits is a byte. So to store a letter we need 1 byte of storage.

Let's say we store the word "hello" in a text file. This is what it would look like on some computer (image is available in exhibit A).



Do you notice the size is 5 bytes? Why is that? It takes 5 bytes to represent the word '**hello'**, one byte for each letter.

4. Student Activity: Do I Have Enough Storage?

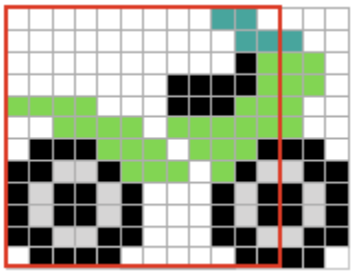
In this activity students will experiment fitting their text message onto a memory chip. Point out to students that a blank space is like a letter and requires 1 byte of storage.

Explain the activity to students and distribute the activity worksheet.

5. Storing Images

Let's take a look at a very simple image (available in exhibit B).

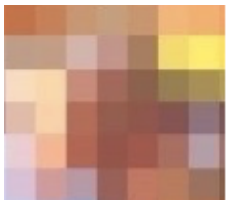
Let's take a look at a very simple image



You remember that images are made up of pixels. Typically you cannot see individual pixels in a photo or image because there are so many in each square inch (one inch by inch inch of the image). When images have lots of pixels in every square inch they have what is called a high **resolution**. It makes them look very smooth to the human eye.

This image, however, is pixelated, which means you can see the individual pixels. Imagine the box in the image is a square inch. This **square inch** only has 12 x 12 pixels, or a total of 144. You can actually count the pixels.

You could also see pixels in a high resolution photo if you zoom in enough. You probably would not recognize much of the original picture though.



So how much storage do we need to store this image? Each color pixel typically requires 3 bytes of storage (one byte each for red, green and blue - RGB). The combination of these 3 colors creates all colors you see in the image.

Let's do some math to figure out how much storage we need. The motorcycle image has a total of 180 pixels (15x12). To calculate how many bytes of storage we need we simply multiply 180 by 3 which is 540 bytes. Not much.

But a photo of a dog that has 1 million pixels for example, would need 3 million bytes of storage.

6. Student Activity: Storing Images

In this activity students will experiment mapping images onto their memory chip to determine how many images they can store.
Explain the activity to students and distribute the activity worksheet. Make sure they don't miss the questions at the end of the activity.

7. Wrap Up and Reflections

Reflection Points:

- Can images be represented by numbers?
- For images, what determines how many bytes of storage are needed to store it on a memory chip for example? (# of pixels)
- Why would 2 images that are the same size in inches require different amounts of storage to save it? (The 2 images have different resolution, number of pixels per inch)
- How many bytes of storage are required to save a file with the word "**bye**" in it?

Student Activity: Binary and Data

Work with your partner to complete the following questions:

1. You have 4 bits to store data. The number 2 is represented as 0010 in binary. What is the binary representation of the two numbers in the table below?

9	
6	

2. Can an image file or sound file be represented with numbers?

   True or False?

3. Which statements are true about images?

   - ❑ Images cannot be represented by binary numbers
   - ❑ Images are made of tiny dots called pixels
   - ❑ Each pixel has a color and the color can be represented by a number
   - ❑ Images can be represented by numbers

4. If letters are represented by the numbers in the table, what does this string of numbers say?

   0110 0111 0010 1000 0101 0101 0111 0011

   _____

Letter	Decimal	Binary
A	1	0001
D	2	0010
E	3	0011
F	4	0100
G	5	0101
H	6	0110
I	7	0111
O	8	1000

Student Activity: Do I Have Enough Storage?

You have a new texting device which is super fast, but the memory chip to store data is not very big. Let's find out if there is enough storage for your texting needs.

1) Write a text sending an invitation to your party. Make sure you let your friends know what time to be there.

_____

_____

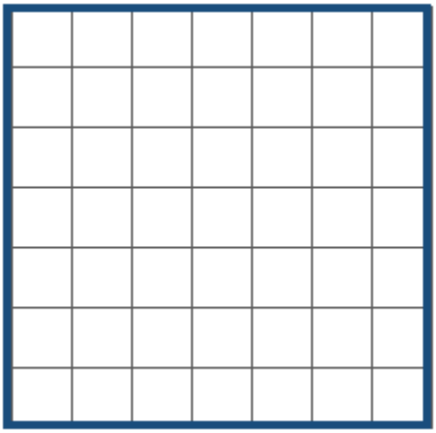
_____

2) This is your memory chip MXT-1 which stores your data on your device.

   Color in every square you need for your message. Each square can store 1 BYTE of data.

   If the invitation doesn't fit, change it until you have enough storage for your message.

MXT-1 Memory Chip

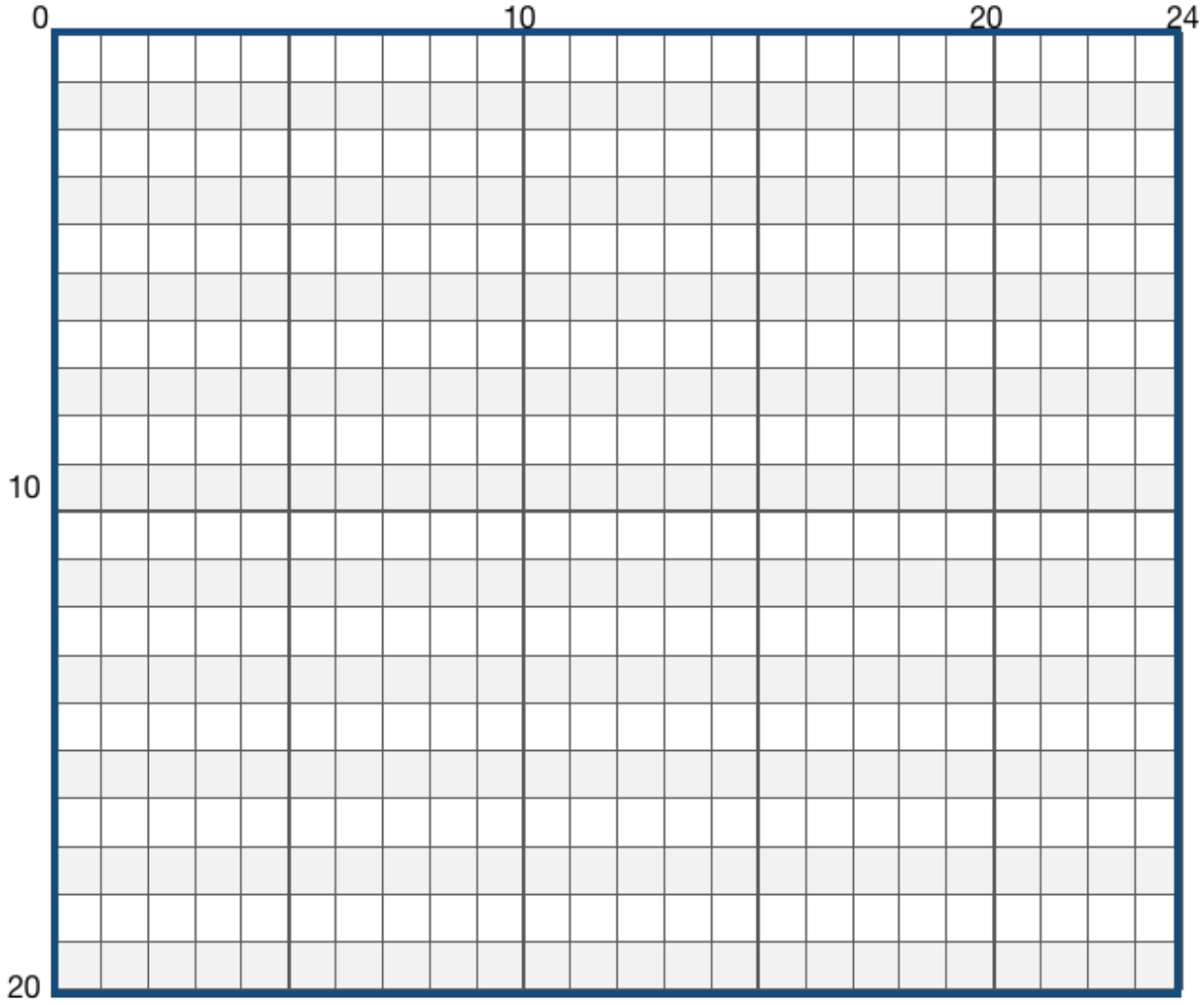


Student Activity: Storing Images

You have an MXT-3 memory chip in your device to store images. Let's see how many of these images you can store on your device.

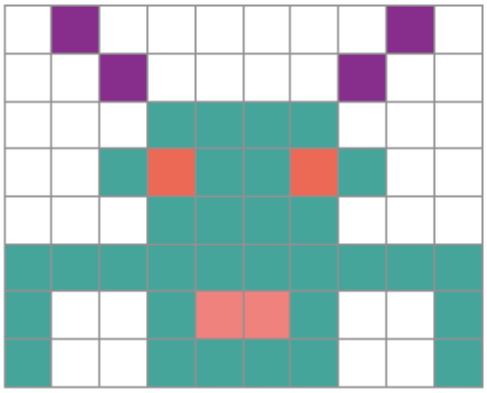
Draw each image outline onto the memory chip or cut them out and place them on the chip.

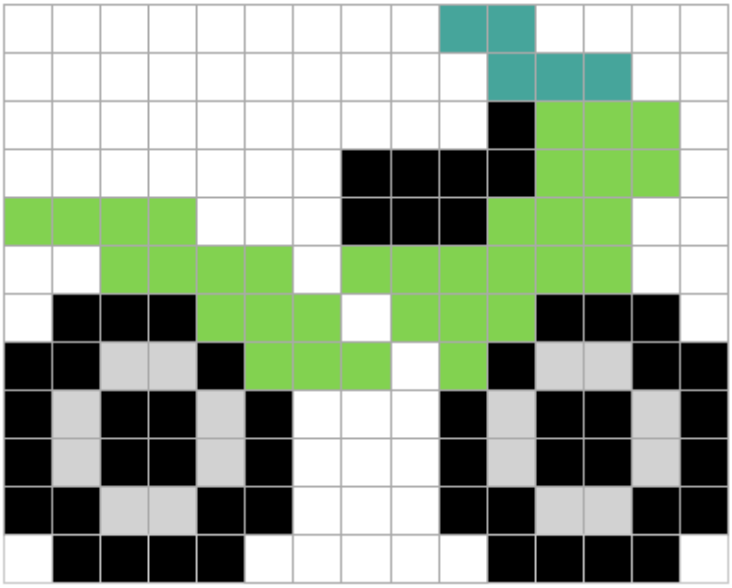
MXT-3 Memory Chip (1 square = 3 bytes)

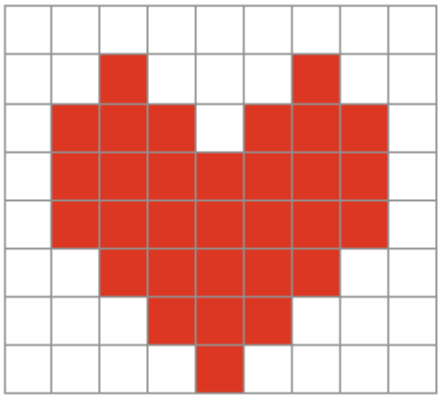


Each visible square = 1 pixel

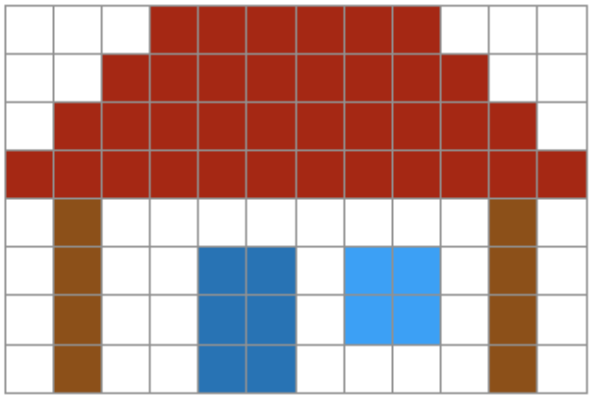
Image A







216 x 216 Pixels



In your journal write down answers to the questions:

1. Were you able to fit all images on your memory chip?

   _____

2. Which image(s) did not fit and why?

   _____

   _____

   _____

3. How much storage in bytes did image A need on the chip? (you can show the formula only).

   _____

4. Of all the images, which one needs the most space to store it?

   _____

Exhibit A and B: