3.3.8 Data compression (Introduction and Run Length Encoding (RLE))

Lesson plan and printable activities

Materials needed

1. 3.3.8 (Introduction and RLE) Lesson.
2. Quiz 1 and Quiz 2.
3. Students will need internet access (see slide 2, Quiz 1 and slide 8).
4. Squared paper (optional – see slide 10).

Lesson aims

1. To get students to think about how different kinds of data streams can be reduced in size.
2. To think why it is an advantage to be able to compress data.
3. To see that there are different methods available for compressing data.
4. To realise that not all data can be efficiently compressed.

Lesson objectives

1. Know approximate values for the sizes of some commonly found electronic file formats.
2. Know why it is useful to be able to reduce the size of digital files.
3. Name two data compression techniques.
4. Explain how data can be compressed using Run Length Encoding (RLE).
5. Use Run Length Encoding (RLE) to transform bitmapped images into compressed files.

Starter activity (5 minutes)

1. Hand out Quiz 1. Get students to do some quick research identifying the rough sizes of a set of specific data file types.

Main activities (40 minutes)

1. **Slides 5–6:** Having gained a rough idea of file sizes, ask students to think about why the development of the internet has generated a need to keep file sizes as small as possible? At this level, students might identify that there is a need to transfer data over what may prove to be relatively slow links.

   Point out that whilst these days everyone takes services such as 'broadband transmission' (eg using ADSL) or 'cable' (eg Sky) for granted, such fast transfer speeds to the home are relatively recent innovations. Just a few years ago, transmission speeds were very low indeed, to the point that downloading anything other than plain-text streams could take a long time and would incur large call charges, eg to a local dial-up number. In addition, this doesn't include the use of mobile devices using wireless connections, where download speeds are slower still.

   On the basis of this information, ask students to give two reasons why it might be useful to be able to compress the size of data files.

Reason	Explanation
To be able to transfer data files more rapidly.	**Reasons discussed above.**
To save on storage space.	**Compressing files would enable you to save on storage space when keeping lots of files.**

2. **Slide 7:** Information on data compression techniques.

3. **Slide 8:** Students will need to access the internet to search for information on Run Length Encoding (RLE). They should find one advantage and one disadvantage.

   Advantages and disadvantages (Source: prepressure.com/library/compression-algorithm/rle) *'This algorithm is very easy to implement and does not require much CPU horsepower. RLE compression is only efficient with files that contain lots of repetitive data. These can be text files if they contain lots of spaces for indenting, but line-art images that contain large white or black areas are far more suitable. Computer-generated colour images (eg architectural drawings) can also give fair compression ratios.'*

4. **Slide 9:** worked example.

Plenary activity

Slide 10: Use Quiz 2 to show that learning has taken place.

Lesson

3.3 Fundamentals of data representation

3.3.8 Data compression (Introduction and RLE)

Lesson

Starter

Complete Quiz 1

Objectives

- Know approximate values for the sizes of some commonly found electronic file formats.
- Know why it is useful to be able to reduce the size of digital files.

Objectives

- Name two data compression techniques.
- Explain how data can be compressed using RLE.
- Use RLE to transform bitmapped images into compressed files.

Introduction

Why compress data at all?

Give two good reasons for needing to compress data file sizes.

To be able to transfer data files more rapidly.

To save on storage space.

Key definition

What is data compression?

The process of reducing the quantity of bits required in order to represent a piece of information.

Common data compression techniques

There are a number of available techniques for data compression.

Technique:	Quick description:
Run length encoding (RLE)	
Huffman coding	
Dictionary methods	

What is RLE?

You have five minutes to come up with a definition that you can explain to the rest of the class without having to read it out.

Include in your definition:
- one advantage of this method
- one disadvantage of this method.

TIME UP

Start

RLE is suitable for compressing both bitmap image and text files containing a large frequency of similar content.

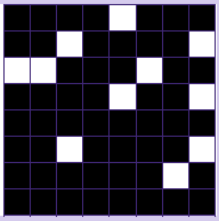
RLE – Worked example

This is a bitmapped image.

Each black cell is 'off' and has a value of 0.
Each white cell is 'on' and has a value of 1.

Row 1 can be represented by:
0 0 0 0 1 0 0 0

Using RLE this becomes:
4 0 1 1 3 0



How has this been worked out?

To round things off…

Complete Quiz 2

After you finish, try making your own design on squared paper and writing the RLE for it.

Quiz 1 – What are the approximate sizes of these data files?

Question 1	Answer
A **plain text** file of approximately one side of A4 if printed.	

Question 2	Answer
An A4 RGB **bitmap colour image,** eg as created in Photoshop.	

Question 3	Answer
One minute of **CD-quality** stereo sound.	

Question 4	Answer
One minute of **DVD-quality** video.	

Quiz 1 – What are the approximate sizes of these data files? – answers

All answers are approximate, any reasonable equivalent is acceptable as long as the student can demonstrate the source of the response given.

Question 1	Answer
A **plain text** file of approximately one side of A4 if printed.	Between 4–8 kB. *Get students to create in Notepad and check pagination with MS Word.*

Question 2	Answer
An A4 RGB **bitmap colour image,** eg as created in Photoshop.	Approximately 25MB.

Question 3	Answer
One minute of **CD-quality** stereo sound.	Approximately 10MB.

Question 4	Answer
One minute of **DVD-quality** video.	Approximately 40MB.

Quiz 2

Question 1: Using Run Length Encoding (RLE) to encode bitmapped images

Apply the following Run Length Encoding (RLE) technique in order to compress the bitmapped image provided.
The image is a black-and-white bitmap, the encoding rules are:

Each black cell is ‘off’ – value of 0
Each white cell is ‘on’ – value of 1

■	■	■	■	□	■	■	■	**Row 1:**
■	■	□	■	■	■	■	□	**Row 2:**
□	□	■	■	■	□	■	■	**Row 3:**
■	■	■	■	□	■	■	□	**Row 4:**
■	■	■	■	■	■	■	■	**Row 5:**
■	■	□	■	■	■	■	□	**Row 6:**
■	■	■	■	■	□	■	■	**Row 7:**
■	■	■	■	■	■	■	■	**Row 8:**

Question 2: Create a bitmapped image from a Run Length Encoding (RLE) data file

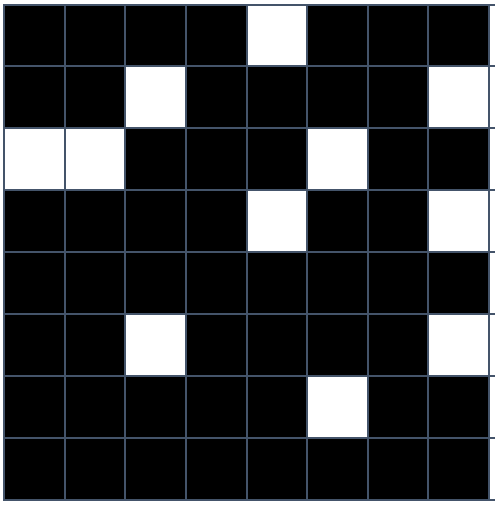
Convert the following Run Length Encoding (RLE) data into a bitmapped image.
The image is a black-and-white bitmap, the encoding rules are:

Each black cell is ‘off’ – value of 0
Each white cell is ‘on’ – value of 1

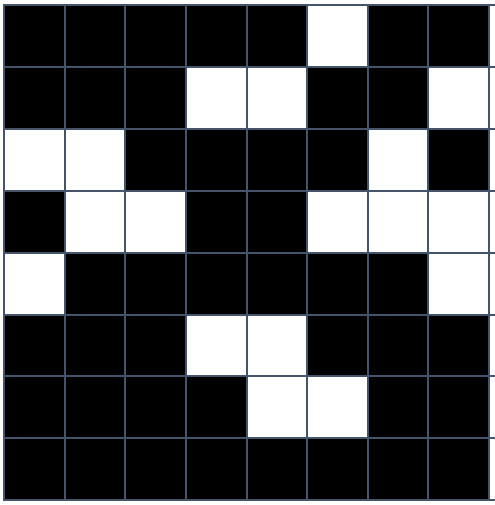
								Row 1: 5 0 1 1 2 0
								Row 2: 3 0 2 1 2 0 1 1
								Row 3: 2 1 4 0 1 1 1 0
								Row 4: 1 0 2 1 2 0 3 1
								Row 5: 1 1 6 0 1 1
								Row 6: 3 0 2 1 3 0
								Row 7: 4 0 2 1 2 0
								Row 8: 8 0

Quiz 2 – answers

Question 1: Using Run Length Encoding (RLE) to encode bitmapped images

	**Row 1: 4 0 1 1 3 0**
	Row 2: 2 0 1 1 4 0 1 1
	Row 3: 2 1 3 0 1 1 2 0
	Row 4: 4 0 1 1 2 0 1 1
	Row 5: 8 0
	Row 6: 2 0 1 1 4 0 1 1
	Row 7: 5 0 1 1 2 0
	Row 8: 8 0

Question 2: Create a bitmapped image from a Run Length Encoding (RLE) data file

	**Row 1: 5 0 1 1 2 0**
	Row 2: 3 0 2 1 2 0 1 1
	Row 3: 2 1 4 0 1 1 1 0
	Row 4: 1 0 2 1 2 0 3 1
	Row 5: 1 1 6 0 1 1
	Row 6: 3 0 2 1 3 0
	Row 7: 4 0 2 1 2 0
	Row 8: 8 0