Compression

1.2.5 · Computer systems (Paper 1) · revision notes

Why files are compressed, and the differences between lossy and lossless compression, including which type suits a given file or situation. Expect definitions, 'describe the differences' and 'which type should be used, and why?' questions.

Key facts

- Compression: reducing the size of a file
- Lossy: permanently removes data; the original cannot be restored; much smaller files
- Lossy for photos, music and video (JPEG, MP3, MP4)
- Why: less storage, faster transfer, less bandwidth, less buffering
- Lossless: no data lost; the original can be reconstructed exactly; smaller reduction in size
- Lossless for text, program code, executables and spreadsheets (ZIP, PNG)

Notes

Why compress files

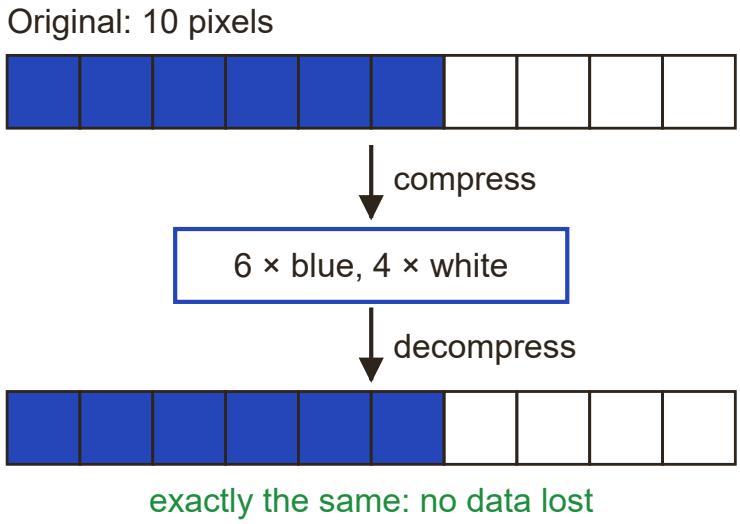
- **Compression** reduces the size of a file.
- Smaller files take up less storage space, so more files fit on a device.
- Smaller files are quicker to upload, download and send; they use less bandwidth and less of a mobile data allowance, and streamed video and music buffer less.
- Email services and websites often limit the size of attachments and uploads, so compression can help a file fit.

Lossy compression

- **Lossy** compression permanently removes some of the data, usually detail that people are least likely to notice (e.g. tiny differences in colour, or sounds that are hard to hear).
- The original file cannot be recovered from the compressed file.
- It usually reduces the file size much more than lossless compression.
- It is used for photos (e.g. JPEG), music (e.g. MP3) and video (e.g. MP4), especially for streaming and web pages.
- Too much lossy compression causes a noticeable drop in quality, e.g. blurry or blocky images.

Lossless compression

- **Lossless** compression reduces the file size **without losing any data**: the original file can be reconstructed exactly.
- It works by finding patterns and repetition and storing them more efficiently, e.g. recording a run of 50 identical pixels once, with a count, instead of 50 times.



Lossless: a run of repeated pixels is stored once with a count, and the original is rebuilt exactly

- It usually reduces the file size less than lossy compression.
- It is used where every bit matters: text documents, program code, executable files, spreadsheets, and images with sharp edges or text (e.g. PNG). ZIP files are lossless.

How to answer each type of question

Give reasons for compressing files 1 to 2 marks **Grade 3**

1. Start with 'it reduces the file size'.
2. Then give the benefit linked to the situation: storage, sending time, bandwidth or size limits.

Example. Give **two** reasons why a file might be compressed before it is sent by email. [2]

Model answer. It reduces the file size, so it is quicker to upload and download (1). It may then be under the maximum attachment size allowed by the email service (1). Also accept: it uses less storage space / less bandwidth.

Explain the differences between lossy and lossless

4 marks | Grade 5

1. Describe lossy: some data permanently removed; the original cannot be restored.
2. Describe lossless: no data lost; the original can be reconstructed exactly.
3. Compare the size reduction: lossy usually gives smaller files.
4. Write about both types: describing only one limits your marks.

Example. Explain **two** differences between lossy and lossless compression. [4]

Model answer. Lossy compression permanently removes some of the data (1), whereas lossless compression keeps all of the data (1). A lossy file cannot be restored to the original, whereas the original can be reconstructed exactly from a lossless file (1). Lossy compression usually reduces the file size by more than lossless (1).

Choose lossy or lossless for a file and justify

2 marks per file | Grade 6

1. State the type for each file.
2. Justify it using the file: must it stay exactly the same, or is a small loss of quality acceptable?

Example. A student is sending two files to a friend: (a) a Python program they have written, and (b) a 10-minute video of a football match.
For each file, state which type of compression should be used and justify your choice. [4]

Model answer.

(a) Lossless (1). Any change to the code could stop the program working, so it must be restored exactly (1).

(b) Lossy (1). The video file is very large and lossy compression makes it much smaller; the small loss of quality will hardly be noticed (1).

Discuss compression choices in a scenario

4 to 6 marks | Grade 8

1. Identify each use of the file and what matters most for it (quality, speed, storage).
2. Recommend a type for each use.
3. Justify each recommendation with an advantage and admit its drawback where relevant.

Example. A photographer takes high-quality photos that a client will print as large posters. She also puts smaller versions of the same photos on her website. Discuss the type of compression she should use for each purpose. [4]

Model answer. For the posters, lossless compression (1), because every detail is needed and any loss of detail would be visible when the photo is printed large (1). For the website, lossy compression (1), because the much smaller files load faster for visitors and use less bandwidth, and the small loss of detail is hard to see on a screen (1).

Don’t lose marks

- Saying lossy compression 'deletes part of the picture'. It removes fine detail across the whole file, not a chunk of it.
- Saying a lossy file can be decompressed back to the original.
- Choosing lossy for text or program code: changing even one character could change the meaning or stop the program working.
- Saying 'it saves space' for both types without explaining how they differ in the amount saved and the cost to quality.

More tips

Memory tricks

- Lossy = 'lost for good'. Lossless = 'less size, nothing lost'.
- Ask: 'Must the file come back exactly the same?' Yes (text, code, programs) → lossless. No, a little lost detail is fine (photos, songs, videos) → lossy.
- A lossy file is like a summary of a book: shorter, but you can't get the exact original back from it.

Exam technique

- For 'which type' questions, link the reason to the file: 'the code must stay exactly the same or it will not run'.
- Use the key phrases 'permanently removes data' (lossy) and 'the original can be reconstructed exactly' (lossless).
- In 'differences' questions, write about both types, ideally joined with 'whereas'.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State why files are compressed**
To make files smaller, so they take up less storage space and are quicker to send.

Grade 4 — **Define lossy and lossless compression**
Lossy permanently removes some data; lossless reduces the file size without losing any data.

Grade 5 — **Give suitable uses of each type**
Lossy: photos, music and video; lossless: text, program code and spreadsheets.

Grade 6 — **Choose a compression type for a file**
Pick lossy where a small loss of quality is acceptable and lossless where the file must stay exactly the same.

Grade 7 — **Explain advantages and disadvantages of each type**
Lossy gives much smaller files but loses quality; lossless keeps every bit but saves less space.

Grade 8 — **Evaluate compression choices in a scenario**
Weigh storage, download time, bandwidth and the quality the user needs.

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