

Data compression

Run-Length Encoding (RLE): RLE effectively compresses consecutive repeated characters by expressing them as a single character followed by the number of repeats. This is because messages in a network may contain repetitive patterns or content. Because of its simplicity and ease of implementation, this method is appropriate for brief messages in a network setting.

Compression using RLE:

Detailed Steps:

- Original message: "Hello world".
- Traverse the message character by character:
- "H" occurs once.
- "e" occurs once.
- "l" occurs twice.
- "o" occurs once.
- " " occurs once.
- "w" occurs once.
- "o" occurs once.
- "r" occurs once.
- "l" occurs once.
- "d" occurs once.

Encode consecutive repeated characters:

- "H1"
- "e1"
- "l2"
- "o1"
- " "1
- "w1"

- "o1"
- "r1"
- "l1"
- "d1"
- Construct the compressed message: "H1e1l2o1 1w1o1r1l1d1"

Decompression using RLE:

1. Traverse the compressed message: Start with the compressed message "H1e1l2o1 1w1o1r1l1d1" and traverse it from left to right.
2. Decode the message: For each character followed by a count, repeat the character the specified number of times.
3. Output the decompressed message: Concatenate the decoded characters.

Detailed Steps:

- Start with the compressed message: "H1e1l2o1 1w1o1r1l1d1".
- Traverse the message character by character:
 - "H1" becomes "H".
 - "e1" becomes "e".
 - "l2" becomes "ll".
 - "o1" becomes "o".
 - " "1" becomes " ".
 - "w1" becomes "w".
 - "o1" becomes "o".
 - "r1" becomes "r".
 - "l1" becomes "l".
 - "d1" becomes "d".

- Concatenate the decoded characters: "Hello world".

Worst Case Time Complexity:

- RLE compression: $O(n)$, where n is the message's original length. This is because RLE requires that in order to recognize successive repeated characters, the full message must be traversed once.
- RLE decompression: $O(n)$, where n is the message's length in compressed form. Comparably, in order to reconstitute the original message during decompression, the entire compressed message must be traversed once.

When employing RLE for both compression and decompression, the worst-case time complexity is $O(n)$, where n is the message length. This is due to the fact that both procedures need a linear exploration of the message data.