Adaptation of Bit Recycling to Arithmetic Coding
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Objectives
The bit recycling compression technique has been introduced to minimize the redundancy caused by the multiplicity of encodings feature present in many compression techniques. This work aims to adapt Huffman-based Bit Recycling (HuBR) to Arithmetic Coding Bit Recycling (ACBR) in order to achieve better compression and a much wider applicability.

Multiplicities of Encodings
The simplest case: LZ77 Example. Encoding the string "ababababab". A message is either a literal message, denoted by [l], or a match message, denoted by [M].

Huffman-Based Bit Recycling (HuBR)
The Principle of HuBR. How does the HuBR encoder exploit the multiplicity of encodings?

HuBR: the decompressor’s bit stream
Instant I: 11110001101101010101...
Instant II: 00110110101010...
Instant III: 10011011010101...

The Weakness of HuBR
1. Huffman coding is constrained to generate codewords of integral lengths.
2. HuBR imposes an additional burden (dropping the costly messages) to avoid some situations that affect its performance negatively.

\[ NC = \sum_{i=1}^{n} (c_i \neq [l_i]) \cdot \frac{1}{2|I_i|} \]

Let \( p_1, p_2, \) and \( p_3 \) be 0.0625, 0.03125, and 0.0000305 respectively.
- \( NC \) for \( M_1, M_2, \) and \( M_3 \) is 5.6 bits.
- \( NC \) for \( M_1 \) and \( M_2 \) is 3.5 bits.
- \( NC \) for \( M_2 \) is 4 bits.

But the minimum (bit-fractional) \( NC = -\log_2 \sum_{i=1}^{n} p_i = 3.414 \) bits.

Solution: Arithmetic Coding Bit Recycling

Comparison of HuBR and ACRB performance with uniform distribution.

Comparison of HuBR and ACRB performance with two skewed choices.

Conclusion and Future Work
The theoretical analysis showed that ACRB achieves perfect recycling in all cases whereas HuBR achieves perfect recycling only in particular cases. Consequently, a significantly better compression can be achieved by ACRB. We intend to adjust the ACRB scheme so that it can be implemented using fixed-length registers, since it currently uses arbitrary-precision calculations. Afterwards, ACRB can be implemented and applied on many applications include the multiplicity of encoding property, such as LZ77 and its variants, some variants of Prediction by Partial Matching (PPM) technique, Volf and Williams switching-compression technique, and Knuth’s algorithms for the generation of balanced codes.