Algorithms & Data Structures

LAB 5
LOSSLESS IMAGE COMPRESSION
(4p + 3p (challenge))

Delta coding + statistical compression is arguably the simplest lossless image compression algorithm. Assuming 24-bit (RGB) pixels, each value is replaced with a difference (=delta) to the value 3 bytes back. I.e. the red color component of the current pixel is replaced with the difference between the current red component and the red component of the previous pixel, and so for the other color channels.

1. Implement the delta coding filter for 24-bit BMP images. Their header has 54 bytes (to be copied verbatim). Also, copy verbatim the first pixel. Assume that the image width modulo 4 is 0 (read point 4) for explanation why this assumption is convenient).
   Implement also the inverse filter (for decoding). (2.5 p.)

2. Test it on two given BMP images; on the filter output apply *gzip -k* and Huffman coding (*shcodec*; run it without parameters in command line to learn the syntax). Compare the results to those of *gzip* and *shcodec* on original images (0.5 p.).

3. Calculate the order-0 entropy of each color channel separately: a) for original images; b) for filtered images. (1 p.)
   Implementation hint: log_2(x) = log_10(x) / log_10(2).

Challenge.

4. In the 24-bit BMP format each line is padded with unspecified bytes (maybe 0s, maybe not…) to the nearest multiple of 4. E.g. if the image width == 99, which means 3*99 = 297 bytes, then the line actually has 300 bytes, where the last 3 bytes are not specified and don't contain pixel data. (Note that assuming image width % 4 == 0 implies that 0 bytes are appended to each line and the issue disappears; point 1 above.)
   Modify your filter (forward and inverse) to handle images of arbitrary width.
   (1 p.)

5. (A more sophisticated filter) Use two delta predictors: the west pixel (=the previous pixel, like above) and the north pixel (=upper neighbor). Choose the predictors for ranges of 32 successive pixels and for each such a block write one extra bit (in a separate stream) telling which predictor was chosen. For the first line of the image use only the west pixel predictor. As the selection criterion, use the order-0 entropy (the prediction of the two that makes the entropy lower is chosen). (2 p.)