TASK:

Develop a Java prototype program to help you explore differences in compression performances.

I. Develop a program that converts a matrix of decimal integers to a matrix of binary code (codewords) and to a matrix of Gray code.
The input and output of your program should be read from and sent to a text file, namely input.txt and output.txt, respectively. The program should be able to read at least the following data as the input:
(a) A one dimensional array of integers (decimal values ranging from 0 to 255, i.e. [0,255], inclusive 0 and 255)
(b) Two dimensional array of integers [0,255]
(c) Three dimensional array of integers [0,255].

The output of the program should contain the following:
(a) A one dimensional array of binary codewords and their Gray codes
(b) Two dimensional array of binary codewords and their Gray codes
(c) Three dimensional array of binary codewords and their Gray codes.

II. You should apply ONE of the lossless compression algorithms below to the sources of the binary and Gray code:
(1) Run-length
(2) Huffman coding
(3) Shannon-Fano coding
(4) Arithmetic coding
(5) Dictionary compression

III. Your program should report statistics of changes in the process. The compression efficiency should also be reported using the analytical techniques learnt from the course. While being encouraged to design good user interfaces, you are welcome to use essential user interfaces, such as tables (or diagrams).

ANSWER:

A. Algorithms

The flow-chart of Run Length Algorithm applied. (Rachesti, et al., 2017)

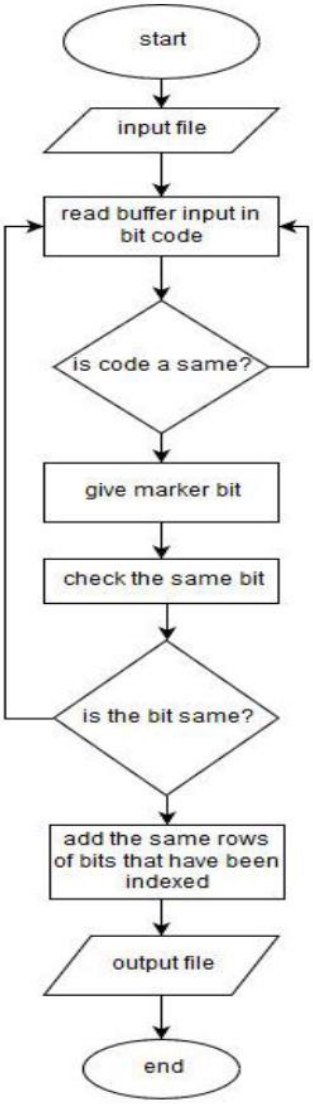


Figure 1 Run Length Algorithm flow-chart

B. Design

The class diagram for assignment code. For this class diagram creation, online tool draw.io https://www.draw.io/ was used.

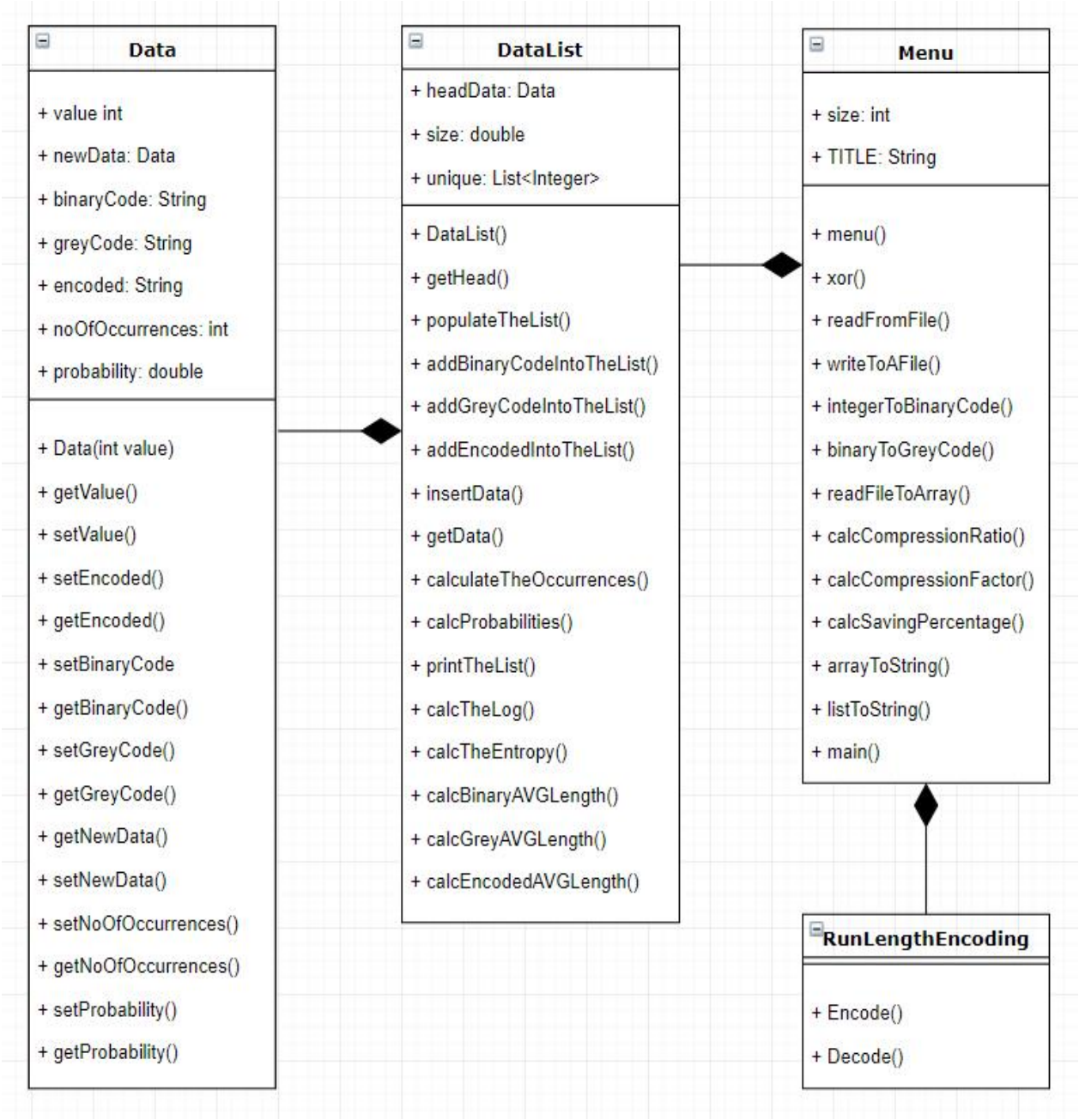


Figure 2 Class diagram

C. Demonstration

1. The **input.txt** file data for testing a program.

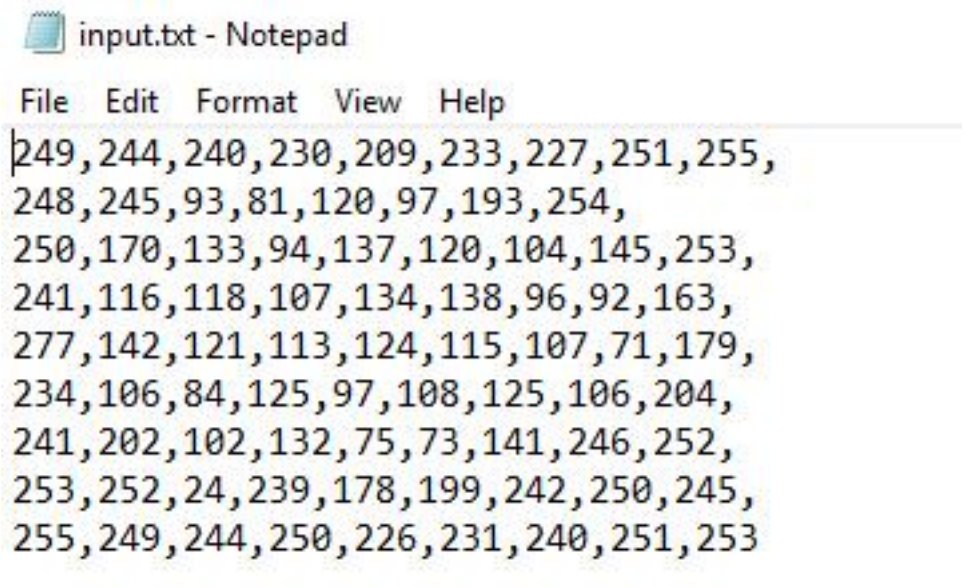
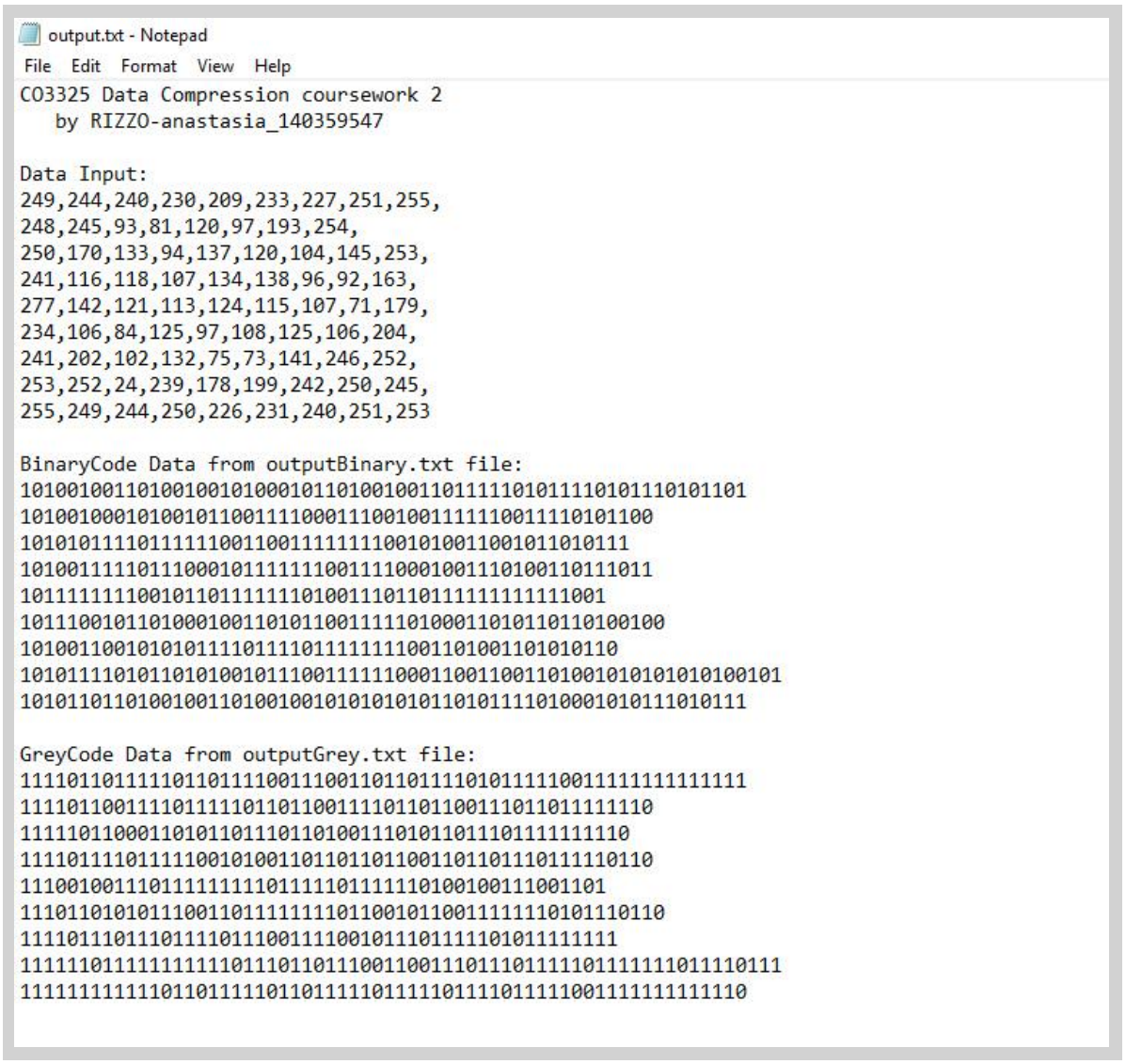


Figure 3 Input.txt file

2. The **output.txt** files . The output of the program code, consist of:

File 1:

- Data Input (original input.txt file);
- Binary data from outputBinary.txt file;
- Grey data from outputGrey.txt file;



output.txt - Notepad

File Edit Format View Help

```
CO3325 Data Compression coursework 2
   by RIZZO-anastasia_140359547

Data Input:
249,244,240,230,209,233,227,251,255,
248,245,93,81,120,97,193,254,
250,170,133,94,137,120,104,145,253,
241,116,118,107,134,138,96,92,163,
277,142,121,113,124,115,107,71,179,
234,106,84,125,97,108,125,106,204,
241,202,102,132,75,73,141,246,252,
253,252,24,239,178,199,242,250,245,
255,249,244,250,226,231,240,251,253

BinaryCode Data from outputBinary.txt file:
1010010011010010010100010110100100110111110101111010111010101101
1010010000101001011001111000111001001111110011110101100
1010101111011111100110011111111100101001100101101011
1010011111011100010111111100111100010011101001101111011
1011111111001011011111110100111011011111111111111001
1011100101101000100110101100111110100011010110110100100
1010011001010101111011110111111110011010011010101110
1010111101011010100101110011111100011001100110100101010101010100101
1010110110100100110100100101010101011010111101000101011101011101111
1111011011111011011110011100110110111010111001111111111111111
1111011001111011111011011001111011011001110111011111111110
1111101100011010110111011010011101011011101111111110
1111011110111111001010011011011011001101101110111110110
1110010011101111111111011111011111101001001110011011
1110110101011100110111111111011001011001111111101011101110
1111011101110111101110011110010111011111101011111111
1111110111111111111011101101110011001110111011111011111011110111
1111111111110110111110110111110111110111101111100111111111110
```

Figure 4 File 1

File 2:

- Binary data after Run Length Encoding;
- Grey data after Run Length Encoding;

```
BinaryCode Data RLE:
1110112011202110112011201110113011102110112011202110511011104110111031101110211011
1110112011301110112011102120413031201120612041101110212 0
1110111011104110612021208120111011202120111021101110 31
1110112051103130111071204130112031101120211031102 1
1110812011102110711011203110211012120 11
1110312011102110113011202110111021205110113021101110211021101120 120
1110112021201110111011104110411081202110112021101110111021 10
1110111041101110211011101120111031206130212021202110112011101110111011101110111011201110 11
1110111021102110112011202110112011201110111011101110111021101110411011301110111031101110 31

GreyCode Data RLE:
4110211051102110412031202110211041101110512014 1
4110212041105110211021204110211021203110211071 10
5110213021101110211031102110112031101110211031109110
4110411051201110112021102110211021202110211031105110211 0
3120112031109110511061101120112031202110 11
3110211011101110312021108110212011102120711011103110211 0
4110311031104110312041201110311051101110 81
```

Figure 5 File 2

File 3:

- Encoded input data from input.txt file;
- Decoded input from encoded data;

```
Encoded data:
12141912241214101213101210191223221712151111225
12141812141519131821121019171119131215 14
12151011171011231914111317111210111014111415121513
12143116211811101711131411131819161912111613
12271114121112311311124211511102721171 9
12131411101618141112151917111018111215111016121014
12141112101211101211131217151713111411121416121512
12151312152214121319111718112912142215101214 15
12251214191224121510221612131111214101215111215 13

Decoded data:
24924424023020923322725125 5
248245938112097193254
25017013394137120104145253
24111611810713413896921 63
27714212111312411510771179
23410684125971081251062 04
24120210213275731412462 52
25325224239178199242250245
25524924425022623124025 1253
```

Figure 6 File 3

File 4:

Calculations:

- Compression Ratio;
- Entropy;
- Average length;
- Compression factor;
- Saving percentage.

```
Compression Ratio [Integer to Binary code] = 2.2052401746724892
Compression Ratio [Integer to Grey code] = 2.2052401746724892
Compression Ratio [Integer to Encoded data] = 1.7991266375545851

Entropy [Integer] = 84.64981096063539

Average length [Binary code] = 62.64473684210525
Average length [Grey code] = 62.64473684210525

Compression Factor [Integer to Binary code] = 0.4534653465346535
Compression Factor [Integer to Grey code] = 0.4534653465346535
Compression Factor [Integer to Encoded data] = 0.5558252427184466

Saving percentage [Integer to Binary code] = -120.5240174672489
Saving percentage [Integer to Grey code] = -120.5240174672489
Saving percentage [Integer to Encoded data] = -79.91266375545851
```

Figure 7 File 4

D. Discussion

In **Task I** the program code read an input data from input.txt file, convert it to the Binary and Grey codes, and send the result to the text file called *outputBinary.txt* and *outputGrey.txt* . The decision to create 2 files instead of 1 (file *output.txt*) was made in order to have a better code visualisation.

The number of a greyscale images, which represented together with its an array of integers, were found in internet after a quite long search.

The first choice was given to an image of handwriting number 8 used for machine learning purposes (Figure 8). Unfortunately, this image has a lot of zeros and only a little bit of visual data. During testing it shows confusing results.

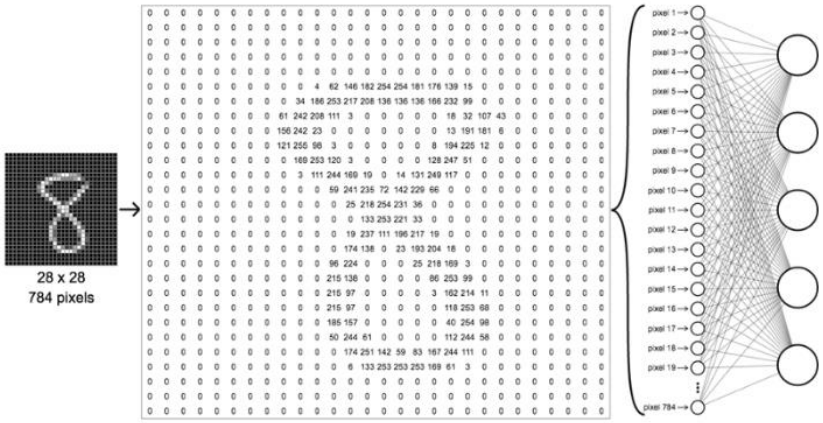


Figure 8 Grayscale image

Therefore, another image with better array of an integers was chosen from Hamamatsu web site, “Basic Properties of Digital Images” publication (Spring, et al., n.d.):

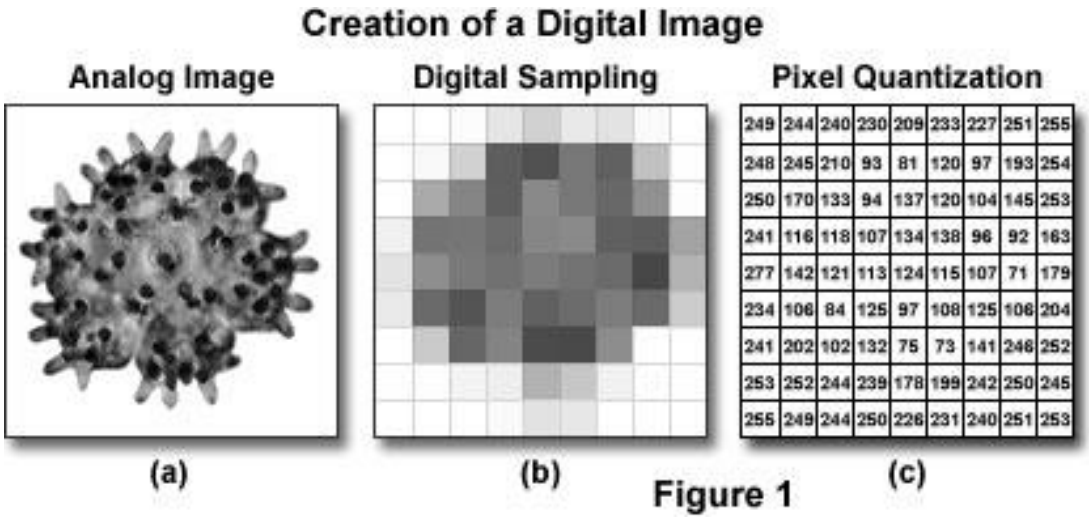


Figure 9 Screenshot form http://hamamatsu.magnet.fsu.edu/articles/digitalimagebasics.html

For testing purposes 4 different input files were created from array of integers [0-255]: separated by space; separated by commas; separated by commas and space; all together in 1 line without spaces or commas between.
For this coursework was chosen an input file separated by commas without spaces.

In **Task II** the Run Length lossless compression algorithm (RLE) was implemented in a program code and applied to the data from *outputBinary.txt* and *outputGrey.txt.* The encoded Binary and Grey codes data were shown as a result.

Please, note: The Run Length algorithm was taken from the GitHub source (Yang, 2014) , but changes in original code were applied as well.

In **Task III** the code, which reports statistics of changes in the process, was implemented. The following calculations was made:

- Compression Ratio;
- Entropy;
- Average length;
- Compression factor;
- Saving percentage.

An input file was decoded back through Run length decoding. All data were printed as an output.

After all calculations has been made, the statistic report of changes in a table below shows:

- the Compression ratio of Binary and Grey codes are the same (2.2052401746724892), but of RLE is smaller (1.7991266375545851);
- the AVG length of Binary and Grey codes are the same (62.64473684210525);
- the Compression factor of Binary and Grey codes are the same (0.4534653465346535), but of RLE is bigger (0.5558252427184466);
- the Saving percentage of Binary and Grey codes are the same (-120.5240174672489), but of RLE is bigger (-79.91266375545851);

Table for reporting statistics of changes in the process.

Parts	Prompt for Input	Display for Output
Encoding	249,244,240,230,209,233,227,251,255,248,245,93,81,120,97,193,254,250,170,133,94,137,120,104,145,253,241,116,118,107,134,138,96,92,163,277,142,121,113,124,115,107,71,179,234,106,84,125,97,108,125,106,204,241,202,102,132,75,73,141,246,252,253,252,24,239,178,199,242,250,245,255,249,244,250,226,231,240,251,253	12141912241214101213101210191223221712151112251214181214151913182112101917111913121514121510111710112319141113171112101110141114151215131214311621181110171113141113181916191211161312271114121112311311121421151110272117191213141110161814111215191711101811121511101612101412141112101211101211131217151713111411121416121522151312152214121319111718112912142215101214151225121419122412151022161213111214101215111121513
Decoding	12141912241214101213101210191223221712151112251214181214151913182112101917111913121514121510111710112319141113171112101110141114151215131214311621181110171113141113181916191211161312271114121112311311121421151110272117191213141110161814111215191711101811121511101612101412141112101211101211131217151713111411121416121522151312152214121319111718112912142215101214151225121419122412151022161213111214101215111121513	249244240230209233227251255248245938112097193254250170133941371201041452532411161181071341389692163277142121113124115107711792341068412597108125106204241202102132757314124625225325224239178199242250245255249244250226231240251253
Binary Data from output Binary.txt file	249,244,240,230,209,233,227,251,255,248,245,93,81,120,97,193,254,250,170,133,94,137,120,104,145,253,241,116,118,107,134,138,96,92,163,277,142,121,113,124,115,107,71,179,234,106,84,125,97,108,125,106,204,241,202,102,132,75,73,141,246,252,253,252,24,239,178,199,242,250,245,255,249,244,250,226,231,240,251,253	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11
Grey Data from output Grey.txt file	249,244,240,230,209,233,227,251,255,248,245,93,81,120,97,193,254,250,170,133,94,137,120,104,145,253,241,116,118,107,134,138,96,92,163,277,142,121,113,124,115,107,71,179,234,106,84,125,97,108,125,106,204,241,202,102,132,75,73,141,246,252,253,252,24,239,178,199,242,250,245,255,249,244,250,226,231,240,251,253	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1 0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0 1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10

Binary Data from output Binary.txt file after Run Length Encoding	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11	111011201120211011201120111011301110211011201120211051101110411011103110111021102110112011301110112011102120413031201120612041101110212011101110111041106120212081201110112021201110211011104110112051103130111071204130112031101120211031103110812011102110711011203110211012120211031201110211011301120211011102120511011302110111021102110112011201110112021201110111011104110411081202110112021101110111021101110111041101110211011101120111031206130212021202110112011101110111011101110112011102110111021102110112011202110112011201110111011101110111021101110411011301110111031101110311
Grey Data from output Grey.txt file after Run Length Encoding	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1 0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0 1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10	411021105110211041203120211021104110111051201811021204110511021102120411021102120311021107110511021302110111021103110211011203110111021103110911041104110512011101120211021102110212021102110311051102110312011203110911051106110112011203120211041102110111011103120211081102120111021207110111031102110411031103110411031204120111031105110111014110111103110211031202120311031105110711041101511021105110211051105110411051201211 0
Computing		
Compression Ratio (Binary)	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11	2.2052401746724892
	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1	

Compression Ratio (Grey)	0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0 1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10	2.2052401746724892
Compression Ratio (RLE)	12141912241214101213101210191223221712151112251214181214151913182112101917111913121514121510111710112319141113171121011101411141512151312143116211811101711131411131819161912111611312711412111231131112142115111027211719121314111016181411121519171110181112151110161210141214111210121110121113121715171311141112141612152215131215221412131911171811291214221510121415122512141912241215102216121311121410121511121513	1.7991266375545851
Entropy (Integer)	249,244,240,230,209,233,227,251,255,248,245,93,81,120,97,193,254,250,170,133,94,137,120,104,145,253,241,116,118,107,134,138,96,92,163,277,142,121,113,124,115,107,71,179,234,106,84,125,97,108,125,106,204,241,202,102,132,75,73,141,246,252,253,252,24,239,178,199,242,250,245,255,249,244,250,226,231,240,251,253	84.64981096063539
AVG length (Binary)	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11	62.64473684210525
AVG length (Grey)	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1 0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0	62.64473684210525

	1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10	
Compression Factor (Binary)	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11	0.4534653465346535
Compression Factor (Grey)	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1 0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0 1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10	0.4534653465346535
Compression Factor (RLE)	12141912241214101213101210191223221712151112251214181214151913182112101917111913121514121510111710112319141113171121011101411141512151312143116211811101711131411131819161912111613122711141211123113111214211511102721171912131411101618141112151917111018111215111016121014121411121012111012111312171517131114111214161215221513121522141213191117181129121422151012141512251214191224121510221612131112141012151112151 3	0.5558252427184466

Saving percentage (Binary)	10 100 1001 10 100 100 10 100 0 10 11 0 10 0 1001 10 11 11 10 10 111 10 101 1 10 101 101 10 100 1000 10 100 101 1001 11 1000 1 1 10 0 1001 111 1 1001 11 10 101 100 10 101 0 1 111 0 1 11 11 1001 100 1 11 111 1 10 0 1 0 100 1 100 101 10 101 11 10 100 1 1 1 110 1 1 1000 1 0 111 1 11 100 1 11 1000 1001 110 1001 10 1 110 11 10 111 111 1 100 10 1 10 1 1 1 11 1 10 100 1 1 101 1 0 111 111 1 1 111 1001 10 11 100 1 0 110 1000 100 1 10 101 1001 111 1 0 1000 1 10 101 1 0 110 10 0 100 10 100 1 10 0 10 1 0 10 1 11 10 111 101 111 11 1 100 1 10 100 110 10 101 10 10 101 11 10 101 10 10 100 10 11 1001 1 111 1000 1 1001 1001 10 100 10 10 101 0 10 100 101 10 101 101 10 100 1001 10 100 100 10 101 0 10 10 110 10 11 1 10 100 0 10 101 1 10 101 11	-120.5240174672489
Saving percentage (Grey)	11 110 1101 11 110 110 11 110 0 11 10 0 11 0 1101 11 10 10 11 11 100 11 111 1 11 111 111 11 110 1100 11 110 111 1101 10 1100 1 1 11 0 1101 100 1 1101 10 11 111 110 11 111 0 1 100 0 1 10 10 1101 110 1 10 100 1 11 0 1 0 110 1 110 111 11 111 10 11 110 1 1 1 101 1 1 1100 1 0 100 1 10 110 1 10 1100 1101 101 1101 11 1 101 10 11 100 100 1 110 11 1 11 1 1 1 10 1 11 110 1 1 111 1 0 100 100 1 1 100 1101 11 10 110 1 0 101 1100 110 1 11 111 1101 100 1 0 1100 1 11 111 1 0 101 11 0 110 11 110 1 11 0 11 1 0 11 1 10 11 100 111 100 10 1 110 1 11 110 101 11 111 11 11 111 10 11 111 11 11 110 11 10 1101 1 100 1100 1 1101 1101 11 110 11 11 111 0 11 110 111 11 111 111 11 110 1101 11 110 110 11 111 0 11 11 101 11 10 1 11 110 0 11 111 1 11 111 10	-120.5240174672489
Saving percentage (RLE)	12141912241214101213101210191223221712151112251214181214151913182112101917111913121514121510111710112319141113171121011101411141512151312143116211811101711314111381916191211161312271141211123113111214211511102721171912131411101618141112151917111018111215111016121014121411121010211101211131217151713111411121416121522151312152214121319111718112912142215101214151225121419122412151022161213111214101215111213	-79.91266375545851

Figure 10. Table for reporting statistics of changes in the process

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