

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«БЕЛГОРОДСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНОЛОГИЧЕСКИЙ
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Кафедра программного обеспечения вычислительной техники и
автоматизированных систем

Лабораторная работа №3
по дисциплине: «Теория информации»

Выполнил: ст. группы ПВ-211

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Проверил:

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Белгород 2023 г.

Тема: «Исследование возможности применения методов энтропийного кодирования для обработки двоичных последовательностей»

Вариант 12

Содержание отчета

1. Аналитика касательно построения кодов для исходной двоичной последовательности
2. Примеры кодовой реализации п.3, п.3, п.4 и п.6.
3. Результаты обработки кодов, полученных в п.5.
4. Текстовая последовательность, восстановленная к читаемому виду.
5. Общие выводы

Ход работы:

Задание 1. Открыть файл Лабораторная работа 3 (задание).txt. Рассмотреть возможность построения кода по методам Хаффмана и Шеннона-Фано для бинарной последовательности. Сделать выводы.

Задание 2. Рассмотреть варианты обработки цепочек символов, а именно:

- 2 символа;
- 4 символа;
- 8 символов.

Для этого разработать консольное приложение, разбивающее сплошной массив символов на цепочки заданной длины.

Код модуля:

```
std::vector<simb> breakToParts(std::string &message, int size) {
    std::vector<simb> res;
    for (int i = 0; i < message.size(); i += size) {
        std::string latter;

        for (int j = 0; j < size; ++j)
            latter.push_back(message[j + i]);
        res.push_back(simb(latter));
    }

    return res;
}
```

Задание 3. Рассматривая каждую цепочку (2, 4 и 8 символов длиной) как отдельный символ, построить коды по методу Хаффмана и Шеннона-Фано

Кодировка сообщений при разбиении на 2

Shenon		
00	00	750
11	01	516
01	10	391
10	11	390
hoffman		
00	11	750
11	10	516
01	01	391
10	00	390

Кодировка сообщения при разбиении на 4:

Shenon		
1101	000	247
0000	001	236
1011	01	183
0001	1000	86
1000	1001	83
0010	101	70
1110	11000	28
0101	11001	21
1100	1101	21
0011	111000	14
1010	111001	9
1111	11101	9
0111	111100	5
0110	111101	5
0100	111110	4
1001	1111110	2
10	1111111	1

hoffman		
1101	10	247
0000	01	236
1011	111	183
0001	000	86
1000	1101	83
0010	0011	70
1110	00101	28
0101	00100	21
1100	110011	21
0011	110000	14
1010	1100100	9
1111	1100011	9
0111	11001011	5
0110	11001010	5
0100	11000101	4
1001	110001001	2
10	110001000	1

Кодировка сообщения при разбиении на 8:

Shanon		
11010000	00	163
11010001	010	68
00100000	011	41
10111110	10000	24
10110000	10001	21
10110101	10010	18
10111101	10011	15
10111011	10100	14
10111000	10101	13
10000001	10110	12
10000000	10111	11
10000010	110000	10
10001011	110001	9
10111100	110010	9
10110010	110011	8
10000011	110100	8
00101100	110101	7
10111010	11011	7
10110011	1110000	6
10110001	1110001	6
10111111	111001	6
10001100	111010	5
10110111	111011	4
10110110	11110000	4
10001111	11110001	3
10000101	1111001	3
10110100	1111010	3
00101110	1111011	2
10001110	11111000	2
10001000	11111001	2
10010010	11111010	1
10100010	11111011	1
10100100	111111000	1
10000111	111111001	1
10000110	11111101	1
10001101	111111100	1
10111001	111111101	1
101110	11111111	1

hoffman		
11010000	11	163
11010001	100	68
00100000	1011	41
10111110	0011	24
10110000	0000	21
10110101	10100	18
10111101	01100	15
10111011	01011	14
10111000	01001	13
10000001	00101	12
10000000	00011	11
10000010	00010	10
10001011	101010	9
10111100	011111	9
10110010	011100	8
10000011	011011	8
00101100	011010	7
10111010	010101	7
10110011	010001	6
10110001	010000	6
10111111	001001	6
10001100	1010111	5
10110111	0111011	4
10110110	0111010	4
10001111	0101001	3
10000101	0101000	3
10110100	0010001	3
00101110	01111010	2
10001110	01111001	2
10001000	01111000	2
10010010	00100001	1
10100010	00100000	1
10100100	101011011	1
10000111	101011010	1
10000110	101011001	1
10001101	101011000	1
10111001	011110111	1
101110	011110110	1

Задание 4. Составить последовательности из полученных кодов символов для каждого случая

Метод Шеннона-Фано:

Разбиение на 2:

```
011000011100011011000001101101001100011011000001101101001100011000000001100001100011010000100110000011010011
0110000011011100011000101100001001100011011000001101101001100000110111010011010000110000011000001101001101100000
110111000110000011011001011000001101101101100000110100001100000110111010011010000110000011011110110001011000000
011000101100010101100010110010100110001011000011011000110000011011010011000001100000110111000011000001100000
11010001011000101100000110110000110110000110110100110000011011101001100000110000011010110011000001101000000110000
01100010110000000110000011010000011000001101100101100000110101100110001011001101010000011010100000110000011011101
011000001101000001100000110110000110001011001101001101100110000011010100011000001101011001100000110000011011011
0110000011010000011000001101110101100000110101101100000110100100110000011010110110000011010100001101010000110000
0110001011000011011110110000011011101100000110001011000001101101101100000110101000011000001100000110000001100000
110111000110000011010100001101010000110000011010001101100000110111011000001101011011000011010110001011000001100000
1101111011000001101011101100000110101000011010000110000011010000110110000011010110011000001100000110100010100010
1100000001100010110000010110000011010010011000101001101011000001101010000110000011000001100000110000011000010
1100001001100000110101110110000011010011011000101100110101100000110101000011000001100000110000011000001100010
110000100110000011011110110000011000001100000110110000011010110110000011010100001100000110000011000001100000
1101000011000101100001101110110000011000001101001101100000110100110110000011010000110000011011010011000001100000
1101011101100000110101100011000001100001100000110100110110000011010110110001011000111001100000110000011010010
011000001101011101100000110101001100000110100110110000110100011000110001100011000110001100011000110101010
0110001011000010011000001101101001100000110111101100010110000010011011100110000011000001111100001100000
1101011101100000110101100110000011010000011000101100000110110000110000011000101100000110000011000001100010
1100001101100110000011010110011000001100000110100000110100000110100000110100000110100000110100000110100000
01100000110101110110000011010001100001100000110101101100001101000011000001101011001100001101011000001100000
110101000110000011000001101001001100000110110001100000110100011000001101000110000011010001100000110100010
01100000110101110110000011010100110000011010001100000110100011000001101000110000011010101100000110101010
011000101100001001100000110110100110000011011110110001011000001001101110011000001100000110000011000001100000
110100001100010110001001100000110110001100000110110001100000110110001100000110100011000010011000001100000
11010110011000001101000001100000110001011000011010001011000000011000001101011101100010110000110100011010000
110100000110001011000000110001011000110100011010000110000011010001101000011010000110100001101000011010000
11011101011000001101110001100001100010110000110000011000001100000110000011000001100000110000011000001100000
1101000011000001100000110000011000011000001101000110000000110000011010011011000101100001101000011010000
11011101011000001101110001100001100010110000110000011000001100000110000011000001100000110000011000001100000
11000110011000001101111011000001101110001100000110101011000001100000110000011010110110000011011000011010000
01100000110111010110000011010111011000110001100001100000110100001100000110101001100000110111000110000
011000001101110000110000011000001101010110001100000001100000110101110110001011001010011000001101011011000001101011
01100000110111000110001011001010001100011010001101011101100010110010100110000011010110110000011011011
```

Разбиение на 4:

```
00000111111101000001011100100010001001101000001011100100010001001101000100010011000000001011010000010110010001000
10011000000100010011010000010111001000001010110110110100010000010110010000010111100000001011110100000101001
00000101011011101101001000001011110010001000100100100010001110100010001001110010001000100110100000101110010000010101
10100100000101100110100100000101110000001000100111000000001011110000000101110010000010101101001000001010000000101001
101001000100010010010000010100100000101111000000010100000010001001010000010111001101001000001010000010100100000101111
11000100010001011011100010100100000111000110100000101110001010010000010111101000001010010000010100000101100000000101
100000000101000000100010010100000101110110100100010001001101000001011100000000101000000001011100100000101000000100010011
10100000101111001000001011001000001011100000000101100000000101000000101100000010001001100000000101
111001000001011100000000101110110110110100100010001001101000001011100001000100010001000100010011110
00000001011000000100010010100000101110110100100000101100000000101001000100010011000000001011000000001011010001000100101
0000010111011010010001000100100100000101001000100010011000000010111001000001010010001000100110000000010111
011010010001000100100100000101001000100010011000000010111010000010111001000001010100000101010100100000101
110000000010100010010001000100110000000010110000001011100000010001001100000001011100000001011100000001011100
100000101101000100010011110000010001001100010100100000101110100000101100100010001001100000000101100100000101000000
010111100100010001001111000101100010100100000111001111100000010110000000010100000000101001000100010001000001011001
101001000100010011110000010001001110000001000100110100010001001110110100100000101111000000010100100000101110100000101
110010001000100110100000101000000010111000101001000001011100000001011100000000101110000000010100000010110001011001
1010010001000100110000000010111001000001011010001000001011100000001011100000001011100000000101100000001011100
0000100010010010000010111000000001011100100000101000000010001001000001011100110100100000101100000000101110010000010100
01000100101000001011100110100100010001001110010000010101000000101110000000010111010001000100111011010010
001000100110000000010100000000101110010000010111100000000100010110110110100100000101110000000010110010000010
10100010001001110100000101000000001011000101001000100010011000000100010010000010111010000010100100000101101000100010
01100100000101100100000101110010001000100010001000100011101101001000001010000000101000000010100000001010000000100
100100000101110000001000100110100010001001110000000010100100010001000100010001001101101101001000001010000000010100
110100100010001001111000000001010100000101100100010001000100111101000100010011000000001010000000010100010100
100010001001000000001011100100000101100100000101110100000100010000010111010000010100100110110101001000001010000001
011100000010001001100100000101001000001011111000000101110010000010111110100100000101100101001000001011101000100010
0100100000101110000010001001110010000010111000000001011110100000101001000100010011100110111000
```


Разбиение на 8:

```
00111110100010010010110000001001010111011010101100011001100101000101011001011000000100100010101101010110011001100101
000011101010011101100100010010101110101011001101101011110010101110000101100000010010001010101100101000110011100
00010101010000111101000100100010101011001001100100010110101011001000100111010100100110010101001000100
1111010010110001111101101100111101100100000110011101100100010010101001000000111000100100110101100010011001010110000
001000000100110010010001001101011101000011011001010000110010011001110000001000000101010010000010101100011011001000000110
010110101011010110000001000001100111000001010111010110100001110001010110001001100100110001001000110001001000100010000001
1001101011000100110010011010101110010001010110001011100100010101100000010000001100101101010111001000101011000111001
001001000110011001000100101010110010000010011010101100011001100100010011111000011001100010010000001001000110011010
11010001011111000011001110010010010010101100010010001001100110110101101001111100000100000010011001000101010
111001010001101011111001010110100010110000010111010001100111010100010011001000100100110000001001100100000110011001
00010100001110000001000100101010001010101100011011001100110011001000000111010101110100011001000000111000001010111001
0000001100100010011010110001001001100111000100100010101010110001001001101011110000010100010000001100101011101
0001011110010110101100010011001001000111000000100011101011001000000111000100101000101011011010000100110010000110
10101100101100010011100100100010011001101011110010010000100100101011100101100100110010001011010110000010101110
010000010110000010110100010001010111010110001110101011001001100100010110101010000101001010000101111101010110100110
1010110010011001000101101011111100011011001010000111001001000100111011001010011010101100101000100000101111100100100010
0111101000100100011111110110010100011001110010101110010000010111100001000000111011001010001011110001110101
```

Метод Хаффмана:

Разбиение на 2:

```
100111110001110010011111001001100111010011110010011100111010011111110011111001111001110100111110011100101100
10011111001000111001110100111101100111010011110010011110010011001111001000101100101110011110011110010110010011111
0010001111001001110010011100100111001001111001001111001001111001000101100101111001111001111001111001111100111111
1001110100111010001110100111010011110010011110010011110010011100111100100011110011110011111001111100111111
0010111010011101001111100100111100111100100111001111001000101100111110011111001100110011111001111110011111
1001110100111111001111100111110011110010011001111001001100111100100110011110010011111001111100111100100010
10011111001011111001111100100010100111110010100110011110010100110011110010001100111100101011110011111001111
1001110100111100100111100100010011110010100110011110010010110011110010100110011110011110010000010011111
00100011100111100101011100111100111100101110100111100101000100111100100010100111100101000100111101001111010011111
0010000010011110010100010011110010101110011110011110011110011100100111100111100111100101110011110011110011101
001111110011101001111010011110010110100111010011001010011110011110011110011110011110011110011110011110011101
0011111001011110011110010100111100100110011110010110011110010110011110011110011110011110011110011110011111
00101000100111100101001110011110011110010110011110010110011110010110011110011110011110011110011110011110011111
100111100101000100111100100111001111001111001010011110011110011110011110011110011110011110011110011110011111
0010010111001111100111110010110110011111001000101001111100100010100111100100101110011110011110011110011110011101
10011110010001010011110010100010011110010101001110100111011001110101100111100111010011110011110011110011100101001
100111110010010110011111001011101001111100101111001011110011110010110011110011110011110011110011110011111
00100010100111100111011100111100101001100111100100010011110011100111100111001110011100111001110011110011111
0010111100111010011111100111010011001011100111110011110011110011110011110011110011110011110011110011111
001000101001111001000111001110100110010011110011110011110011110011110011110011110011110011110011110011110011101
00111001100111110010000010011110010001110011110010101001111001011110011110010010011110010001111001011110011111
10011110010001010011110010100010011101001100111100111100101111001111001001111001111001000111001111
100111110010001111001111001111001010100111100111110011110010100010011101001101011001111100101000100111100100100
1001111100100011100111010011010111001000
```

Разбиение на 4:

```

100100110100110010011110010010000110111001001110010010000110101110001100001101000100111110010011111011000011010001000
0110111001001110010010011111111000011111000100111110010011111011001110011100111001110011100111111111
0000111111000110011110011100100001101011000011010010011000011011100100111001001001111111100011001111110
11100011001110011001000011010011001001111001101010011110010010011111110001100111101001110011000110101001111
011001111001110111001111010000110111110011110010011000110011111110011110011100110101100001101111100001101110001100
100111001100100111100101100011100111001110011100111001110011100111001111001111100001111110001100001
10111001001111001011100011001111001100100001101011000011010011001001110001000011011110011111000110011100010011
1101100001101000100111100101100111111001000011011110011110011111000110000110101100111101100001101001110011001001
1110110000110111001001111001011001111110001100001101011001111011000011010001001110011011100111100100100111110010
0111101100111111110001100111100101100111110110001100001101000100111110010011100101110001100111100010011
1100101100111100100100111111001000011010011001000011010011100011001111001110011110010010011110010010011
11101001111001110011000001101001100110000110101100111100101100111110100111011000011010110011111011
100011000011010011101110000110100110010000110100111110001100111001110110011110110011110110011110011110011100100
1000011011100100111110100111100101100011001111001111101100111100110010011110110011111110011111011100011000011
01000100111100111001001111100100111100111001110000110100111110001100111100101100111100110010000110101100111
100101100111100111110011110100001101111100111100100110001100111111000011011111000011011111000111100100110001
1000011010010011111110011110010110011110011110011110000110100111110000110100111110000110100010011110100111100100
10011110011001001111011100001111110001100111100101100111100010011111101100111111100001101001111100111100101110
001100001101000100001101111100111100101110011110110011111100100001101110110011110010010000110100010000110100
11011110001100111110100111101110001100001101110010000110101100111100101100001101110010000110100111101100001101011
000011011111000011111100011001111101001111011100011000011010011001001111111001111101100001101001110101000011010011001
100001111110001100111111010011110111000110000110110011110011111001111001111001111001111001111001110011100111001111
11011100001111110001100111111100111100101100001101110110011110011110011110011100111001110011100111001110011111
10111000110011110011011100001101011001111001011000011010010010011110011100111100111010111110110000110100110011000010
1

```

Разбиение на 8:

```

1101001011110100100000111010010000011101110000110110111001101111000011010000011011101001101011101110011010
1111011110001101110111100001101001101010111101001110000011100010010010001110101000001101101001101110111101
000010001101111010001111010011010101011110110011000011011000001111000011011110011011001001010111010011101010110000
110100011100101001000101011110101101111001011110111000011010101100101100111110110010010101101111011100000
101100101101100111010011011001001010111110100111101111011110100001100101010110010100001101101001111001101011
1110110101011100000101100101011110100001000001110001101111001111001010101111101111001111100001000001101100101101110
01001010101101111101110000011110000100001101101001111000010000010110010110111110111000001110000100001101100111011010
0110111001100001101010111110010110010111000011011001100110010001111010111110011111001111001101110010001101110
001111010101111001110111010010000110111010011011001110001101110100101011110101101100110000100000111101
01110111001010110011000110111000001010010101111011110111001100001101111111010010000010110110011001111101011
11010000110000110101011010111011100001101101001111011100110010111100110010101111011110010110000010000011100101101111
111011001001010101110100101110011111101001101001001010111001011100011010110101100111001110001001011100010010
010111000011011100111010011010000110000011010101111001011001111110101110101001010111101100110010101110000110100101
01011001110110000110111001000100101111010111101001000011010001001001111011001100001011100000101000001110010100000101
00011011110000100000111001010100110101111011001100001101110011011101010110010111000100011011011010101111011001
100001011100011110111101001111010111100111011000011011101111010110101011110101100101000100101111000011010001111101
001101111011010111101011110011110011101000001110010100011101100101101111011110111100111100110010010

```

Задание 5. По результатам работы в п.3 сделать выводы по поводу полученных результатов для каждого из методов (простота, скорость, полученные результаты (рассчитать коэффициенты сжатия)).

	N = 2	N = 4	N = 8
Хаффмана	1	1.32	2.04
Шеннона-Фано	1	1.23	2.03

Задание 6. Написать программу, восстанавливающую последовательности, полученные в п.3 в исходный вид согласно вариантам, приведенным в п.2.

Код программы:

```
std::vector<simb> createAlp() {
    std::cout << "input size of alp: ";
    int size;
    std::cin >> size;

    std::vector<simb> alp;

    for (int i = 0; i < size; ++i) {
        simb sb;
        std::string s;
        std::cin >> s;

        int j = 0;
        std::string liter;
        while (s[j] != '-') {
            liter.push_back(s[j]);
            j++;
        }
        sb.liter = liter;
        j++;
        liter = "";
        while (s[j] != '-') {
            liter.push_back(s[j]);
            j++;
        }
        sb.code = liter;
        j++;
        int n = 0;
        while (j < s.size()) {
            n += s[j] - '0';
            j++;
        }
        sb.ratio = n;

        alp.push_back(sb);
    }

    return alp;
}

void decodeMessage(std::string &message, std::vector<simb> &alp) {
    int iStart = 0;
    int iEnd = 0;

    std::string liter;
    while (iStart < message.size() - 1) {
        liter.push_back(message[iEnd]);

        int i = -1;
        bool isFound = false;
        while (i != alp.size() - 1 && !isFound) {
            i++;
            if (liter == alp[i].code)
                isFound = true;
        }
    }
}
```

```

iEnd++;

if (isFound) {
    std::cout << alp[i].liter;
    liter = "";
    iStart = iEnd;
}
}
}
}

```

Входные данные:

```

001111101000100100101100000010010010101101101010110001100110010100010101100101101
input message: input alph:input size of alp: 37
11010000-00-103
11010001-010-69
00100000-011-41
10111110-10000-24
10110000-10001-21
10110101-10010-18
10111101-10011-15
10111000-10100-14
10111011-10101-14
10000001-10110-12
10000000-10111-11
10000010-110000-10
10001011-110001-9
10111100-110010-9
10110010-110011-8
10000011-110100-8
00101100-110101-7
10111010-11011-7
10110011-1110000-6
10110001-1110001-6
10111111-111001-6
10001100-1110100-5
10110111-1110101-4
10110110-111011-4
10000101-1111000-4
10001111-1111001-3
10110100-1111010-3
00101110-1111011-3
10001110-11111000-2
10001000-11111001-2
10010010-11111010-1
10100010-11111011-1
10100100-111111000-1
10000111-111111001-1
10000110-11111101-1

```

Результат работы программы:

110100001001001011010000101101011101000110000010110100001011010111010001
100000000010000011010001100000011101000010110010110100001011100011010001
100000011101000110000010110100001011010111010000101110110010110000100000
11010000101100101101000010111000110100001011011110100001011011011010000
101100001101000010111011001011000010000011010000101110101101000110000000
1101000110001111110100011000010111010001100000101101000010110101110100001
0111011001000001101000010111000001000001101000010110011110100011000001111
010000101101001101000010110101110100001011101100100000110100001011110111
010000101100000010000011010001100000001101000010110000110100001011011111
0100001011110111010001100010111101000010110101001000001101000010111011110
100001011000011010000101101001101000110001011001011100010000011010000101
000101101000010111110001000001101000010110110110100001011000011010000101
1101111010000101111101101000010110001110100001011110111010001100010111101
000010111100001000001101000110000010110100001011110110100001011110111010
0001011010111010000101111011101000110001100110100001011101011010000101110
0011010000101111000010000011010000101100111101000010111110110100001011101
1110100001011111011010001100000011101000010111010110100001011111011010000
101111000010110000100000110100011000001011010000101111100010000011010000
1011001111010001100000001101000110000011110100001011000111010001100010111
101000010111100001000001101000010110001110100001011000011010001100000011
1010000101111101101000010110010110100011000101111010000101111000010000011
010001100000001101000010110000110100011000000111010000101110101101000010
110000110100011000001011010000101111101101000010111100001000001101000110
000000110100001011000011010001100000011101000010111111101000010110101110
100001011001011010000101100001101000010111011001000001101000010111110110
100001011110100100000110100011000000111010000101100101101000010111110110
1000110001110001000001101000010110001110100001011111011010000101101011101
000010110010110100011000001111010001100011100010000011010000101111111010
0001011010111010001100000011101000010110101110100001011110111010000101110
101101000110000011001011100010000011010000101001001101000010111110110100
001011110111010000101100001101000110000000110100001011100000100000110100
011000011111010001100000111101000110000010110100011000110000100000110100
0010110111110100001011000011010000101111001101000010110101110100011000001
0110100001011110111010000101111100010000011010000101111001101000010111000
1101000010110011110100001011000011010000101110111101000010111000001000001
101000110000001110100001011101011010000101100101101000010111110110100001
0110111110100011000110000100000110100001011111011010000101100111101000110
0000001101000010111110110100001011110011010000101111011101000110001011110
100001011010100100000110100001011000111010000101101011101000010111011110
100011000101111010000101101010010000011010001100001011101000010111011110
100001011111011010000101111111010001100011001101000110001111001000001101
0001100000011101000010111101110100001011010111010000101100111101000010110
000001011000010000011010000101111101101000010110001110100001011100011010
0001011101111010001100011001101000010111101110100001011111000100000110100
011000000111010001100010111101000010111111101000010110000110100001011001
011010001100010001101000010111000110100001011010111010001100000011101000
110001111001000001101000010111101110100001011000000100000110100011000001
011010001100000001101000010111110110100011000001011010001100000111101000
010110000110100011000000011010001100010110010110000100000110100001011110
1110100001011000000100000110100011000001111010000101110111101000010111000
110100011000011011010001100000110010110000100000110100001011110111010000

```
101100000010000011010001100011011101000010111010110100001011100011010000
1011111111010000101100001101000010110110110100001011100000101100001000001
101000010111011110100001011111011010001100010001101000010110000110100001
01101001101000010110101110100001011100100100000110100001011100000100000
1101000010111111110100011000000011010000101111101101000110000101110100001
0111110110 10000101101101101000010111000110100011000010100101110
```

Результат совпадает с исходным сообщением.

Задание 7. Восстановить исходный текст из полученных последовательностей, пользуясь сервисом <https://onlineutf8tools.com/convert-binary-to-utf8>.

Исходный текст: Ветер свистел, визжал, кряхтел и гудел на разные лады. То жалобным тоненьким голоском, то грубым басовым раскатом распевал он свою боевую песенку. Фонари чуть заметно мигали сквозь огромные белые хлопья снега, обильно сыпавшиеся на тротуары, на улицу, на экипажи, лошадей и прохожих