# Implementacja szyfratorów strumieniowych oraz badanie ich właściwości

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## 1.Implementacja:

Do implementacji użyto języka Python w wersji 3.9.2 oraz 3.10 z biblotekami: math, collections, time oraz random

### BlumBlumShub:

Zaimplementowano podstawowy wariant algorytmu BlumBlumShub wykorzystujac generowane automatycznie odpowiednio duże liczby Bluma

```
class BlumBlumShub(object):
    def __init__(self, seed=None):
        self.modulus = makeModulus()
        self.state = seed if seed is not None else randint(2, self.modulus - 1)
        self.state = self.state % self.modulus

    def seed(self, seed):
        self.state = seed

    def bitstream(self):
        while True:
            yield parity(self.state)
            self.state = pow(self.state, 2, self.modulus)

    def bits(self, n=20):
        outputBits = ''
        for bit in self.bitstream():
            outputBits += str(bit)
            if len(outputBits) == n:
                break

        return outputBits
```

Za pomocą powyższej implementacji wygenerowano 4 pliki z czego 3 zawieraja po 20 000 bitów a jeden zawiera 1 000 000 wygenerowanych bitów.

## Testowanie:

Testy zostały zaimplementowane zgodnie z podana literatura, tzn. standard FIPS 140-2, zostały one umieszczone w pliku stest.py, dla kazdego wywołania informuja one czy test został zaoknczony pomyślnie (PASSED) czy nie (FAILED) oraz sam wynik testu w postaci liczb np. wartosci testu pokerowego.

Test pojedynczych bitów:

```python
def bits_test(s: list):
    ones = s.count('1')
    if 9725 < ones < 10275:
        print(f"BITS TEST: PASSED, Value of test {ones}")
    else:
        print(f"BITS TEST: FAILED, Value of test {ones}")
```

Test serii:

```python
def series_test(s: string):
    result_ones = []
    result_zeros = []
    for i in range(1, 26):
        result_ones.append(s.count(i * '1'))
        result_zeros.append(s.count(i * '0'))
    result_ones[6] = sum(result_ones[6:])
    result_ones = result_ones[:6]
    result_zeros[6] = sum(result_zeros[6:])
    result_zeros = result_zeros[:6]

    for i in range(6):
        result_ones[i] = result_ones[i] - sum(result_ones[i+1:])
        result_zeros[i] = result_zeros[i] - sum(result_zeros[i+1:])

    intervals = [(2315, 2685), (1114, 1386), (527, 723),
                 (240, 384), (103, 209), (103, 209)]
    result = 1
    for i in range(6):
        if not(intervals[i][0] < result_ones[i] < intervals[i][1]):
            result = 0
    if result == 1:
        print(
            f"SERIES TEST: PASSED, Value of test 1:{result_ones}, 0:{result_zeros}")
    else:
        print(
            f"SERIES TEST: PASSED, Value of test 1:{result_ones}, 0:{result_zeros}")
```

Test długiej serii:

```python
def long_series_test(s: list):
    ones = s.count(26*'1')
    zeros = s.count(26*'0')

    if zeros == 0 and ones == 0:
        print(f"LONG SERIES TEST: PASSED, Value of test 1:{ones}, 0:{zeros}")
    else:
        print(f"LONG SERIES TEST: FAILED, Value of test 1:{ones}, 0:{zeros}")
```

Test pokerowy:

```python
def poker_test(s: string):
    splitted = textwrap.wrap(s, 4)
    bits = {
        '0000': 0,
        '0001': 0,
        '0010': 0,
        '0011': 0,
        '0100': 0,
        '0101': 0,
        '0110': 0,
        '0111': 0,
        '1000': 0,
        '1001': 0,
        '1010': 0,
        '1011': 0,
        '1100': 0,
        '1101': 0,
        '1110': 0,
        '1111': 0,
    }
    for hex_number in splitted:
        bits[hex_number] += 1

    result = []
    for val in bits:
        x = bits[val]**2
        result.append(x)
    result = sum(result)
    result = 16/5000 * result - 5000
    if 2.16 < result < 46.17:
        print(f"POKER TEST: PASSED, Value of test {result}")
    else:
        print(f"POKER TEST: FAILED, Value of test {result}")
```

Dla wszystkich testowanych plików o długości 20 tysięcy bitów, generowanych z zaimplementowanego powyżej algorytmem BBS testy zostały ukończone pomyślnie co znaczy o prawidłwym działaniu algorytmu.

```
BITS TEST: PASSED, Value of test 9965
SERIES TEST: PASSED, Value of test 1:[4140, 679, 297, 156, 175, 158], 0:[4115, 786, 297, 225, 163, 146]
LONG SERIES TEST: PASSED, Value of test 1:0, 0:0
POKER TEST: PASSED, Value of test 15.94880000000012
```

```
BITS TEST: PASSED, Value of test 10023
SERIES TEST: PASSED, Value of test 1:[3956, 695, 242, 202, 168, 171], 0:[3981, 674, 257, 156, 163, 180]
LONG SERIES TEST: PASSED, Value of test 1:0, 0:0
POKER TEST: PASSED, Value of test 16.652799999999843
```

Algorytm został także poddany testom NIST i otrzymał nastepujący wynik:

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RESULTS FOR THE UNIFORMITY OF P-VALUES AND THE PROPORTION OF PASSING SEQUENCES

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| C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | P-VALUE | PROPORTION | STATISTICAL TEST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | block-frequency |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 0.0000 * | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |

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| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |

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| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
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| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1.#IND00 | 1.0000 | nonperiodic-templates |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | overlapping-templates |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | universal |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | apen |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | serial |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1.#IND00 | 1.0000 | serial |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | -1.#IND00 | 1.0000 | linear-complexity |

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The minimum pass rate for each statistical test with the exception of the random excursion (variant) test is approximately = 0.691504 for a sample size = 1 binary sequences.

For further guidelines construct a probability table using the MAPLE program provided in the addendum section of the documentation.

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Co znowu jest odpowiednim wynikiem świadczącym o prawidłowośi algorytmu

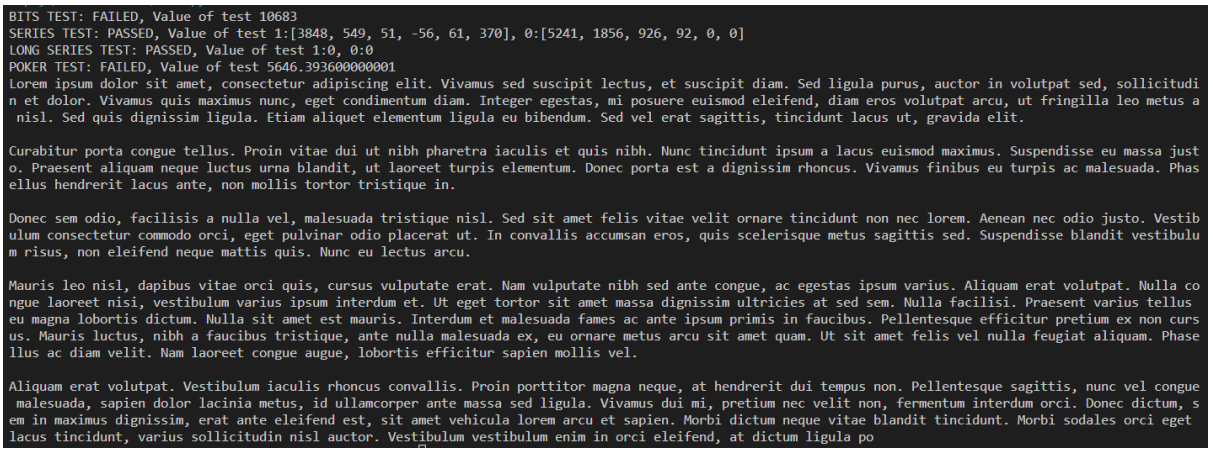
## Szyfrator strumieniowy:

Zaimplementowany wyżej generator ciągu pseudolosowego użyto do implementacji szyfratora strumieniowego:

```python
def encrypt(bits, key):
    xored = [xor(a, b) for (a, b) in zip(bits, key)]
    return xored


def decrypt(bits, key):
    xored = [xor(a, b) for (a, b) in zip(bits, key)]
    return xored
```

Nastepnie zaszyfrowano wygenerowany plik o długości ~2500 bajtów czyli około 20 000 bitów zawierajacy Lorem ipsum (bardzo długie) przeprowadzajac jednoczesnie testy FIPS na zaszyfrowanej wiadomosci. Otrzymano nastepujacy wynik:




Testy zakonczone porazka oznaczaja, że zaszyfrowana wiadomosc nie jest ciagiem pesudolosowym.

## Wnioski:

Szyfratory strumieniowe nie naleza do najbezpieczniejszych rozwiazań mimo pozorów. Są one narażone na wiele rodzajów ataków przez wykonywanie prostych operacji, dodatkowo posiadajac klucz jestesmy odszyfrowac każda wiadomośc zaszyfrowana danym kluczem co jest oczywsita słabościa wymagajaca dodatkowo bepziecznego przechowywania klucza szyfrujacego.