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Криптографія

Лабораторна №1

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1 Порядок виконання роботи

1. Уважно прочитати методичні вказівки до виконання комп'ютерного практикуму.
2. Написати програми для підрахунку частот букв і частот біграм в тексті, а також підрахунку H1 та H2 за безпосереднім означенням. Підрахувати частоти букв та біграм, а також значення H1 та H2 на довільно обраному тексті російською мовою достатньої довжини (щонайменше 1Мб), де імовірності замінити відповідними частотами. Також одержати значення H1 та H2 на тому ж тексті, в якому вилучено всі пробіли.
3. За допомогою програми CoolPinkProgram оцінити значення H(10), H(20), H(30)
4. Використовуючи отримані значення ентропії, оцінити надлишковість російської мови в різних моделях джерела.

2 Методичні вказівки

Звичайні текстові файли містять багато символів окрім власне літер; для обчислення значень ентропій вони повинні пройти попередню фільтрацію: всі символи, окрім текстових, повинні вилучатись або замінюватись на пробіли; прописні літери - замінюватись на відповідні стрічні; послідовність пробілів (або інших розділових знаків, наприклад, символів кінця рядку) повинна трактуватись як один пробіл або вилучатись, якщо пробіл не входить до алфавіту.

При підрахунку частот біграм треба розглядати як пари букв, що перетинаються, так і пари букв, що не перетинаються (тобто рухатися вздовж тексту з кроком 2). Одержані результати не повинні суттєво відрізнятись, однак в першому випадку використовується більше статистики, а тому чисельні дані більш точні. Таблицю частот символів потрібно подавати відсортованою за спаданням частот. Таблицю частот біграм зручно подавати у вигляді квадратної матриці, індексованої першою та другою літерами біграм.

Програма CoolPinkProgram використовує текст, що лежить у допоміжному файлі text. Цей текст написаний російською мовою без знаків пунктуації та великих літер; буква «ё» замінена буквою «е», а «ъ» – буквою «ь». Пробіл також вважається буквою. Таким чином, кількість букв алфавіту m=32. При підрахунку H(10), H(20), H(30) виконати не менш ніж 50 експериментів.

3 Частота

3.1 Монограмы

3.1.1 Монограми без пробіла

```
    count  percentage
о: 162385, 11.50640%
е: 123629, 8.76020%
а: 117081, 8.29622%
н:  98121, 6.95273%
и:  93860, 6.65080%
т:  84627, 5.99656%
с:  75105, 5.32185%
л:  70907, 5.02438%
в:  66549, 4.71558%
р:  56282, 3.98807%
к:  48456, 3.43353%
д:  41627, 2.94964%
м:  40517, 2.87098%
у:  38126, 2.70156%
п:  34091, 2.41565%
я:  30439, 2.15687%
ь:  27849, 1.97335%
ы:  26210, 1.85721%
г:  25689, 1.82029%
б:  24717, 1.75142%
ч:  23851, 1.69005%
з:  23117, 1.63804%
ж:  16018, 1.13502%
й:  14860, 1.05296%
ш:  12067, 0.85505%
х:  10981, 0.77810%
ю:   8811, 0.62434%
э:   5018, 0.35557%
щ:   4054, 0.28726%
ц:   3992, 0.28287%
ф:   1779, 0.12606%
ъ:    412, 0.02919%
ё:     31, 0.00220%
---
Entropy: 4.44178288163354
Redundancy 0.8654005187383775
---
```

3.1.2 Монограми з пробілом

```
    count  percentage
 : 281670, 16.63804%
о: 162385, 9.59196%
е: 123629, 7.30267%
а: 117081, 6.91589%
н:  98121, 5.79593%
и:  93860, 5.54424%
т:  84627, 4.99885%
с:  75105, 4.43640%
л:  70907, 4.18842%
в:  66549, 3.93100%
р:  56282, 3.32454%
к:  48456, 2.86226%
д:  41627, 2.45888%
м:  40517, 2.39331%
у:  38126, 2.25207%
п:  34091, 2.01373%
я:  30439, 1.79801%
ь:  27849, 1.64502%
ы:  26210, 1.54821%
г:  25689, 1.51743%
б:  24717, 1.46001%
ч:  23851, 1.40886%
з:  23117, 1.36550%
ж:  16018, 0.94617%
й:  14860, 0.87777%
ш:  12067, 0.71279%
х:  10981, 0.64864%
ю:   8811, 0.52046%
э:   5018, 0.29641%
щ:   4054, 0.23947%
ц:   3992, 0.23580%
ф:   1779, 0.10508%
ъ:    412, 0.02434%
ё:     31, 0.00183%
---
Entropy: 4.3521146215748905,
Redundancy: 0.8719966287772091
---
```

3.2 Биграмы

3.2.1 Біграми з пробілами та з перетинами

--- Bigrams with spaces intersected ---

	_	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о	п
_	0.0000%	0.3148%	0.6664%	1.4764%	0.3435%	0.7277%	0.5206%	0.2526%	0.4105%	1.1049%	0.0002%	0.9018%	0.3611%	0.5526%	1.6232%	1.3468%	1.4013%
а	1.8619%	0.0013%	0.0587%	0.3024%	0.0583%	0.2152%	0.1018%	0.1111%	0.4133%	0.0126%	0.0523%	0.4138%	0.9527%	0.2385%	0.4592%	0.0006%	0.0588%
б	0.0383%	0.0826%	0.0001%	0.0084%	0.0005%	0.0032%	0.1975%	0.0005%	0.0002%	0.0768%	0.0000%	0.0236%	0.0794%	0.0057%	0.0297%	0.1953%	0.0000%
в	0.5403%	0.5420%	0.0016%	0.0022%	0.0031%	0.0308%	0.4234%	0.0001%	0.0527%	0.4483%	0.0000%	0.0149%	0.0769%	0.0143%	0.1253%	0.6950%	0.0203%
г	0.0681%	0.0828%	0.0001%	0.0007%	0.0002%	0.1135%	0.0354%	0.0005%	0.0001%	0.0743%	0.0000%	0.0118%	0.1486%	0.0001%	0.0171%	0.8303%	0.0000%
д	0.0954%	0.4183%	0.0022%	0.0753%	0.0004%	0.0038%	0.4459%	0.0014%	0.0001%	0.2023%	0.0000%	0.0206%	0.0787%	0.0069%	0.1506%	0.3655%	0.0064%
е	1.8716%	0.0051%	0.1272%	0.2477%	0.3621%	0.2417%	0.2137%	0.0781%	0.1153%	0.0096%	0.2477%	0.1735%	0.5696%	0.3964%	0.7234%	0.0191%	0.1331%
ж	0.0273%	0.1372%	0.0043%	0.0000%	0.0005%	0.0759%	0.4018%	0.0011%	0.0000%	0.1445%	0.0000%	0.0089%	0.0004%	0.0002%	0.0981%	0.0044%	0.0000%
з	0.1003%	0.5280%	0.0158%	0.0797%	0.0511%	0.0758%	0.0235%	0.0103%	0.0058%	0.0299%	0.0000%	0.0093%	0.0182%	0.0273%	0.1923%	0.0354%	0.0021%
и	1.8078%	0.0093%	0.0380%	0.2632%	0.0412%	0.1526%	0.2391%	0.0309%	0.1769%	0.0608%	0.1322%	0.1568%	0.4378%	0.2757%	0.4081%	0.0091%	0.0138%
й	0.7184%	0.0000%	0.0005%	0.0000%	0.0000%	0.0201%	0.0001%	0.0000%	0.0001%	0.0000%	0.0000%	0.0064%	0.0085%	0.0052%	0.0272%	0.0002%	0.0000%
к	0.4631%	0.7650%	0.0000%	0.0166%	0.0000%	0.0005%	0.0496%	0.0014%	0.0004%	0.2832%	0.0000%	0.0017%	0.0324%	0.0001%	0.0614%	0.7762%	0.0001%
л	0.7159%	0.7544%	0.0017%	0.0004%	0.0115%	0.0014%	0.5192%	0.0372%	0.0003%	0.5223%	0.0000%	0.0280%	0.0251%	0.0002%	0.0292%	0.5734%	0.0042%
м	0.6948%	0.2453%	0.0012%	0.0004%	0.0028%	0.0002%	0.2933%	0.0001%	0.0003%	0.2607%	0.0000%	0.0052%	0.0090%	0.0041%	0.1253%	0.3109%	0.0056%
н	0.5424%	1.0878%	0.0013%	0.0008%	0.0100%	0.0627%	0.9794%	0.0004%	0.0014%	0.7675%	0.0000%	0.0249%	0.0000%	0.0002%	0.2881%	0.9640%	0.0001%
о	2.3486%	0.0008%	0.3407%	0.7268%	0.4572%	0.4162%	0.2456%	0.1877%	0.1008%	0.0708%	0.3037%	0.1531%	0.5441%	0.4787%	0.8273%	0.0183%	0.1123%
п	0.0042%	0.1138%	0.0007%	0.0000%	0.0000%	0.0000%	0.2076%	0.0000%	0.0000%	0.0803%	0.0000%	0.0057%	0.0452%	0.0000%	0.0063%	0.8091%	0.0024%
р	0.0653%	0.6815%	0.0224%	0.0299%	0.0354%	0.0334%	0.5210%	0.0297%	0.0015%	0.4365%	0.0000%	0.0557%	0.0049%	0.0129%	0.0659%	0.6840%	0.0058%
с	0.2871%	0.1763%	0.0051%	0.1798%	0.0010%	0.0311%	0.4343%	0.0025%	0.0018%	0.1310%	0.0000%	0.5007%	0.2506%	0.0809%	0.0937%	0.2386%	0.1657%
т	0.4367%	0.4914%	0.0012%	0.2640%	0.0006%	0.0115%	0.4957%	0.0005%	0.0002%	0.3787%	0.0000%	0.0473%	0.0254%	0.0021%	0.1065%	1.4266%	0.0048%
у	0.6556%	0.0037%	0.0516%	0.1095%	0.0959%	0.1497%	0.0253%	0.1688%	0.0291%	0.0003%	0.0118%	0.0743%	0.1113%	0.1152%	0.0214%	0.0004%	0.0564%
ф	0.0038%	0.0088%	0.0000%	0.0000%	0.0000%	0.0000%	0.0121%	0.0000%	0.0000%	0.0308%	0.0000%	0.0000%	0.0024%	0.0006%	0.0002%	0.0096%	0.0000%
х	0.2741%	0.0807%	0.0000%	0.0094%	0.0001%	0.0001%	0.0035%	0.0000%	0.0000%	0.0111%	0.0000%	0.0000%	0.0084%	0.0048%	0.0097%	0.2190%	0.0001%
ц	0.0260%	0.0463%	0.0001%	0.0037%	0.0000%	0.0000%	0.0663%	0.0000%	0.0000%	0.0190%	0.0000%	0.0109%	0.0001%	0.0001%	0.0000%	0.0270%	0.0001%
ч	0.0759%	0.2203%	0.0000%	0.0004%	0.0000%	0.0000%	0.3335%	0.0000%	0.0000%	0.1276%	0.0000%	0.0307%	0.0042%	0.0005%	0.0481%	0.0048%	0.0000%
ш	0.0063%	0.0893%	0.0000%	0.0083%	0.0000%	0.0000%	0.2230%	0.0000%	0.0000%	0.1500%	0.0000%	0.0350%	0.0533%	0.0005%	0.0362%	0.0275%	0.0006%
щ	0.0008%	0.0286%	0.0000%	0.0000%	0.0000%	0.0000%	0.1294%	0.0000%	0.0000%	0.0658%	0.0000%	0.0000%	0.0000%	0.0000%	0.0031%	0.0001%	0.0000%
ъ	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0119%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ы	0.4208%	0.0000%	0.0457%	0.0963%	0.0088%	0.0132%	0.0939%	0.0024%	0.0061%	0.0005%	0.1178%	0.0160%	0.2542%	0.1145%	0.0324%	0.0000%	0.0112%
ь	1.0406%	0.0002%	0.0089%	0.0028%	0.0049%	0.0025%	0.0480%	0.0001%	0.0166%	0.0402%	0.0000%	0.1167%	0.0000%	0.0213%	0.1163%	0.0008%	0.0004%
э	0.0003%	0.0000%	0.0001%	0.0001%	0.0002%	0.0002%	0.0000%	0.0000%	0.0006%	0.0000%	0.0003%	0.0039%	0.0042%	0.0002%	0.0024%	0.0000%	0.0021%
ю	0.3351%	0.0002%	0.0620%	0.0003%	0.0004%	0.0234%	0.0000%	0.0006%	0.0004%	0.0001%	0.0000%	0.0004%	0.0014%	0.0016%	0.0027%	0.0000%	0.0008%
я	1.1097%	0.0000%	0.0024%	0.0255%	0.0274%	0.0525%	0.0075%	0.0282%	0.0311%	0.0038%	0.0118%	0.0106%	0.0802%	0.0318%	0.0656%	0.0000%	0.0054%
ё	0.0016%	0.0000%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

	р	с	т	у	ф	х	ц	ч	ш	щ	ъ	ы	ь	э	ю	я	ё
_	0.3851%	1.6075%	0.7826%	0.4130%	0.0496%	0.1528%	0.0259%	0.6246%	0.0698%	0.0102%	0.0000%	0.0001%	0.0001%	0.2893%	0.0031%	0.2202%	0.0001%
а	0.2324%	0.3484%	0.4141%	0.0051%	0.0253%	0.0836%	0.0119%	0.0775%	0.0630%	0.0201%	0.0000%	0.0000%	0.0000%	0.0006%	0.0830%	0.2382%	0.0000%
б	0.1086%	0.0079%	0.0008%	0.0963%	0.0000%	0.0054%	0.0006%	0.0006%	0.0008%	0.0246%	0.0110%	0.4101%	0.0015%	0.0000%	0.0005%	0.0494%	0.0000%
в	0.1051%	0.3430%	0.0227%	0.0652%	0.0000%	0.0057%	0.0023%	0.0077%	0.1052%	0.0008%	0.0004%	0.2369%	0.0186%	0.0000%	0.0002%	0.0259%	0.0000%
г	0.0675%	0.0029%	0.0006%	0.0581%	0.0001%	0.0001%	0.0000%	0.0037%	0.0005%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0004%	0.0000%	0.0000%
д	0.1462%	0.0334%	0.0184%	0.1773%	0.0000%	0.0060%	0.0173%	0.0027%	0.0100%	0.0001%	0.0057%	0.0524%	0.0761%	0.0000%	0.0007%	0.0389%	0.0000%
е	0.5173%	0.3810%	0.4515%	0.0090%	0.0011%	0.0776%	0.0159%	0.0890%	0.0917%	0.0602%	0.0000%	0.0000%	0.0000%	0.0000%	0.0390%	0.0349%	0.0000%
ж	0.0001%	0.0094%	0.0000%	0.0239%	0.0000%	0.0000%	0.0001%	0.0040%	0.0000%	0.0000%	0.0000%	0.0000%	0.0040%	0.0000%	0.0001%	0.0000%	0.0000%
з	0.0201%	0.0051%	0.0013%	0.0256%	0.0000%	0.0000%	0.0004%	0.0054%	0.0006%	0.0000%	0.0014%	0.0376%	0.0157%	0.0000%	0.0004%	0.0469%	0.0000%
и	0.0530%	0.2121%	0.3779%	0.0010%	0.0014%	0.1294%	0.0807%	0.1860%	0.0387%	0.0146%	0.0000%	0.0000%	0.0000%	0.0001%	0.0246%	0.1716%	0.0000%
й	0.0002%	0.0491%	0.0250%	0.0000%	0.0004%	0.0000%	0.0041%	0.0070%	0.0051%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
к	0.1367%	0.0917%	0.0409%	0.1394%	0.0001%	0.0001%	0.0007%	0.0000%	0.0011%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
л	0.0000%	0.1195%	0.0024%	0.1173%	0.0004%	0.0000%	0.0001%	0.0115%	0.0004%	0.0001%	0.0000%	0.0920%	0.3492%	0.0000%	0.0995%	0.1716%	0.0002%
м	0.0071%	0.0108%	0.0053%	0.2703%	0.0001%	0.0000%	0.0009%	0.0018%	0.0004%	0.0005%	0.0000%	0.0916%	0.0069%	0.0000%	0.0003%	0.0380%	0.0000%
н	0.0084%	0.1047%	0.0416%	0.2404%	0.0016%	0.0001%	0.0343%	0.0251%	0.0001%	0.0156%	0.0000%	0.2879%	0.1217%	0.0000%	0.0152%	0.1682%	0.0000%
о	0.5394%	0.5826%	0.6467%	0.0053%	0.0161%	0.0338%	0.0089%	0.1583%	0.1222%	0.0146%	0.0000%	0.0000%	0.0000%	0.0043%	0.0780%	0.0493%	0.0000%
п	0.6143%	0.0008%	0.0048%	0.0507%	0.0001%	0.0000%	0.0014%	0.0031%	0.0013%	0.0003%	0.0000%	0.0248%	0.0035%	0.0000%	0.0003%	0.0330%	0.0000%
р	0.0016%	0.0204%	0.0453%	0.2236%	0.0011%	0.0095%	0.0028%	0.0067%	0.0207%	0.0030%	0.0000%	0.1211%	0.0849%	0.0000%	0.0110%	0.0871%	0.0000%
с	0.0120%	0.0599%	1.0423%	0.0509%	0.0008%	0.0133%	0.0057%	0.0422%	0.0060%	0.0002%	0.0022%	0.0325%	0.2771%	0.0002%	0.0123%	0.2968%	0.0016%
т	0.2402%	0.0846%	0.0082%	0.1147%	0.0021%	0.0010%	0.0060%	0.0271%	0.0001%	0.0012%	0.0034%	0.1460%	0.6149%	0.0002%	0.0045%	0.0516%	0.0000%
у	0.0547%	0.0991%	0.1040%	0.0002%	0.0035%	0.0291%	0.0004%	0.0857%	0.0685%	0.0194%	0.0000%	0.0000%	0.0000%	0.0015%	0.0947%	0.0113%	0.0000%
ф	0.0247%	0.0011%	0.0018%	0.0025%	0.0007%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0005%	0.0053%	0.0000%	0.0001%	0.0001%	0.0000%
х	0.0067%	0.0041%	0.0009%	0.0148%	0.0000%	0.0000%	0.0000%	0.0001%	0.0009%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ц	0.0000%	0.0001%	0.0001%	0.0206%	0.0000%	0.0000%	0.0007%	0.0000%	0.0000%	0.0000%	0.0000%	0.0148%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ч	0.0059%	0.0005%	0.4345%	0.0897%	0.0000%	0.0000%	0.0000%	0.0000%	0.0165%	0.0000%	0.0000%	0.0000%	0.0158%	0.0000%	0.0000%	0.0000%	0.0000%
ш	0.0001%	0.0000%	0.0063%	0.0279%	0.0001%	0.0000%	0.0002%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0477%	0.0000%	0.0004%	0.0000%	0.0000%
щ	0.0005%	0.0000%	0.0000%	0.0087%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0023%	0.0000%	0.0000%	0.0000%	0.0000%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0007%	0.0116%	0.0000%
ы	0.0273%	0.0755%	0.0702%	0.0005%	0.0000%	0.0816%	0.0001%	0.0172%	0.0416%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0002%	0.0000%
ь	0.0000%	0.0809%	0.0073%	0.0000%	0.0002%	0.0001%	0.0100%	0.0060%	0.0401%	0.0015%	0.0000%	0.0000%	0.0000%	0.0002%	0.0382%	0.0401%	0.0000%
э	0.0007%	0.0004%	0.2805%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ю	0.0040%	0.0166%	0.0257%	0.0000%	0.0002%	0.0010%	0.0011%	0.0040%	0.0025%	0.0327%	0.0000%	0.0000%	0.0000%	0.0000%	0.0034%	0.0000%	0.0000%
я	0.0045%	0.0832%	0.1351%	0.0001%	0.0000%	0.0185%	0.0034%	0.0120%	0.0047%	0.0198%	0.0000%	0.0000%	0.0000%	0.0000%	0.0098%	0.0133%	0.0000%
ё	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

--- Entropy: 3.945625089661013, Redundancy: 0.8804356033436057 ---

3.2.2 Біграми без пробілів та з перетинами

--- Bigrams without spaces intersected ---

	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о	п	р
а	0.0531%	0.1522%	0.5679%	0.1156%	0.3559%	0.2135%	0.1527%	0.5424%	0.1627%	0.0627%	0.6369%	1.1921%	0.3507%	0.7775%	0.2029%	0.2476%	0.3235%
б	0.1009%	0.0004%	0.0113%	0.0009%	0.0040%	0.2388%	0.0006%	0.0005%	0.0966%	0.0000%	0.0288%	0.0956%	0.0072%	0.0368%	0.2474%	0.0007%	0.1303%
в	0.6583%	0.0184%	0.0341%	0.0334%	0.0764%	0.5344%	0.0064%	0.0733%	0.5616%	0.0000%	0.0718%	0.1050%	0.0384%	0.1955%	0.8796%	0.0863%	0.1490%
г	0.1005%	0.0042%	0.0100%	0.0014%	0.1422%	0.0452%	0.0015%	0.0026%	0.0940%	0.0000%	0.0167%	0.1793%	0.0020%	0.0283%	1.0012%	0.0115%	0.0832%
д	0.5041%	0.0074%	0.0983%	0.0030%	0.0081%	0.5382%	0.0030%	0.0040%	0.2513%	0.0000%	0.0325%	0.0967%	0.0111%	0.1954%	0.4451%	0.0151%	0.1785%
е	0.0345%	0.2601%	0.5010%	0.4797%	0.3986%	0.3063%	0.1223%	0.2195%	0.1607%	0.2971%	0.3022%	0.7379%	0.6056%	1.0495%	0.1870%	0.3673%	0.6782%
ж	0.1649%	0.0065%	0.0022%	0.0008%	0.0929%	0.4835%	0.0015%	0.0010%	0.1756%	0.0000%	0.0120%	0.0009%	0.0011%	0.1218%	0.0077%	0.0033%	0.0004%
з	0.6347%	0.0215%	0.1051%	0.0649%	0.0984%	0.0315%	0.0137%	0.0093%	0.0402%	0.0000%	0.0219%	0.0243%	0.0403%	0.2392%	0.0482%	0.0140%	0.0281%
и	0.0363%	0.1353%	0.5362%	0.0942%	0.2776%	0.3481%	0.0600%	0.2717%	0.1957%	0.1587%	0.3029%	0.5692%	0.3959%	0.6952%	0.1971%	0.2320%	0.1150%
й	0.0422%	0.0302%	0.0714%	0.0220%	0.0723%	0.0125%	0.0186%	0.0179%	0.0794%	0.0000%	0.0590%	0.0288%	0.0356%	0.0960%	0.0565%	0.0752%	0.0318%
к	0.9265%	0.0393%	0.0574%	0.0094%	0.0235%	0.0714%	0.0247%	0.0101%	0.3711%	0.0000%	0.0325%	0.0501%	0.0203%	0.1433%	0.9760%	0.0344%	0.1745%
л	0.9191%	0.0218%	0.0846%	0.0294%	0.0257%	0.6776%	0.0488%	0.0144%	0.6763%	0.0000%	0.0827%	0.0637%	0.0164%	0.0988%	0.8007%	0.0597%	0.0151%
м	0.3081%	0.0305%	0.0711%	0.0264%	0.0377%	0.3650%	0.0143%	0.0193%	0.3792%	0.0000%	0.0558%	0.0293%	0.0273%	0.2207%	0.4412%	0.0789%	0.0273%
н	1.3405%	0.0355%	0.0645%	0.0239%	0.0993%	1.1850%	0.0069%	0.0234%	0.9579%	0.0000%	0.0514%	0.0098%	0.0142%	0.4231%	1.1926%	0.0737%	0.0220%
о	0.0299%	0.5518%	1.1322%	0.5990%	0.6124%	0.3833%	0.2840%	0.1853%	0.2336%	0.3643%	0.3030%	0.7077%	0.6596%	1.2699%	0.2920%	0.3571%	0.7082%
п	0.1367%	0.0011%	0.0004%	0.0000%	0.0001%	0.2492%	0.0002%	0.0001%	0.0970%	0.0000%	0.0073%	0.0544%	0.0001%	0.0079%	0.9710%	0.0029%	0.7370%
р	0.8193%	0.0298%	0.0419%	0.0444%	0.0430%	0.6265%	0.0359%	0.0038%	0.5326%	0.0000%	0.0735%	0.0069%	0.0176%	0.0866%	0.8276%	0.0136%	0.0034%
с	0.2187%	0.0170%	0.2398%	0.0106%	0.0551%	0.5280%	0.0227%	0.0087%	0.1676%	0.0000%	0.6272%	0.3083%	0.1097%	0.1580%	0.3053%	0.2221%	0.0232%
т	0.5996%	0.0298%	0.3643%	0.0081%	0.0364%	0.6159%	0.0100%	0.0108%	0.4892%	0.0000%	0.0826%	0.0419%	0.0215%	0.1799%	1.7435%	0.0444%	0.3003%
у	0.0222%	0.0843%	0.1961%	0.1277%	0.2149%	0.0458%	0.2134%	0.0509%	0.0750%	0.0142%	0.1412%	0.1482%	0.1647%	0.1223%	0.0534%	0.1271%	0.0799%
ф	0.0113%	0.0004%	0.0010%	0.0001%	0.0000%	0.0145%	0.0000%	0.0000%	0.0373%	0.0000%	0.0002%	0.0029%	0.0009%	0.0006%	0.0116%	0.0002%	0.0297%
х	0.1023%	0.0129%	0.0372%	0.0093%	0.0192%	0.0108%	0.0055%	0.0072%	0.0413%	0.0000%	0.0186%	0.0228%	0.0176%	0.0370%	0.2902%	0.0320%	0.0174%
ц	0.0563%	0.0013%	0.0077%	0.0009%	0.0012%	0.0802%	0.0003%	0.0008%	0.0249%	0.0000%	0.0150%	0.0001%	0.0011%	0.0028%	0.0353%	0.0033%	0.0007%
ч	0.2656%	0.0027%	0.0126%	0.0013%	0.0036%	0.4011%	0.0006%	0.0037%	0.1588%	0.0000%	0.0403%	0.0063%	0.0018%	0.0667%	0.0123%	0.0113%	0.0090%
ш	0.1072%	0.0006%	0.0104%	0.0002%	0.0001%	0.2675%	0.0001%	0.0001%	0.1805%	0.0000%	0.0424%	0.0641%	0.0012%	0.0438%	0.0333%	0.0016%	0.0004%
щ	0.0344%	0.0000%	0.0001%	0.0000%	0.0000%	0.1553%	0.0000%	0.0000%	0.0789%	0.0000%	0.0000%	0.0001%	0.0001%	0.0038%	0.0002%	0.0002%	0.0006%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0143%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
ы	0.0076%	0.0797%	0.1610%	0.0210%	0.0397%	0.1249%	0.0091%	0.0257%	0.0432%	0.1414%	0.0443%	0.3137%	0.1544%	0.1017%	0.0308%	0.0604%	0.0411%
ь	0.0169%	0.0424%	0.1197%	0.0232%	0.0503%	0.1258%	0.0116%	0.0510%	0.1426%	0.0000%	0.2133%	0.0235%	0.0629%	0.2553%	0.0977%	0.0972%	0.0266%
э	0.0000%	0.0003%	0.0002%	0.0003%	0.0002%	0.0000%	0.0000%	0.0007%	0.0000%	0.0004%	0.0047%	0.0050%	0.0002%	0.0030%	0.0000%	0.0026%	0.0009%
ю	0.0103%	0.0836%	0.0271%	0.0096%	0.0449%	0.0111%	0.0133%	0.0096%	0.0350%	0.0000%	0.0255%	0.0119%	0.0150%	0.0322%	0.0329%	0.0308%	0.0194%
я	0.0343%	0.0503%	0.1482%	0.0596%	0.1160%	0.0546%	0.0531%	0.0701%	0.1106%	0.0142%	0.0873%	0.1236%	0.0765%	0.2602%	0.0855%	0.1092%	0.0333%
ё	0.0000%	0.0000%	0.0005%	0.0001%	0.0000%	0.0001%	0.0000%	0.0001%	0.0001%	0.0000%	0.0001%	0.0000%	0.0001%	0.0001%	0.0004%	0.0001%	0.0000%

	с	т	у	ф	х	ц	ч	ш	щ	ъ	ы	ь	э	ю	я	ё
а	0.6275%	0.5969%	0.0595%	0.0359%	0.1163%	0.0169%	0.1633%	0.0843%	0.0249%	0.0000%	0.0000%	0.0000%	0.0413%	0.1002%	0.3195%	0.0000%
б	0.0108%	0.0013%	0.1205%	0.0001%	0.0065%	0.0008%	0.0009%	0.0011%	0.0295%	0.0133%	0.4920%	0.0018%	0.0103%	0.0006%	0.0614%	0.0000%
в	0.4869%	0.0711%	0.0883%	0.0017%	0.0101%	0.0047%	0.0273%	0.1313%	0.0010%	0.0005%	0.2842%	0.0223%	0.0293%	0.0005%	0.0344%	0.0000%
г	0.0123%	0.0029%	0.0722%	0.0004%	0.0004%	0.0000%	0.0054%	0.0009%	0.0000%	0.0000%	0.0000%	0.0000%	0.0010%	0.0004%	0.0006%	0.0000%
д	0.0545%	0.0278%	0.2149%	0.0004%	0.0074%	0.0208%	0.0077%	0.0122%	0.0001%	0.0069%	0.0629%	0.0913%	0.0025%	0.0009%	0.0475%	0.0000%
е	0.6747%	0.6440%	0.0705%	0.0074%	0.1229%	0.0214%	0.1706%	0.1184%	0.0736%	0.0000%	0.0000%	0.0000%	0.0367%	0.0471%	0.0653%	0.0000%
ж	0.0136%	0.0030%	0.0293%	0.0000%	0.0001%	0.0001%	0.0051%	0.0001%	0.0000%	0.0000%	0.0000%	0.0048%	0.0010%	0.0001%	0.0017%	0.0000%
з	0.0195%	0.0091%	0.0348%	0.0004%	0.0005%	0.0010%	0.0089%	0.0017%	0.0000%	0.0017%	0.0451%	0.0188%	0.0039%	0.0005%	0.0568%	0.0000%
и	0.4653%	0.5589%	0.0628%	0.0091%	0.1742%	0.1014%	0.2887%	0.0570%	0.0196%	0.0000%	0.0000%	0.0000%	0.0287%	0.0300%	0.2338%	0.0001%
й	0.1445%	0.0592%	0.0175%	0.0047%	0.0083%	0.0074%	0.0340%	0.0113%	0.0010%	0.0000%	0.0000%	0.0000%	0.0075%	0.0002%	0.0077%	0.0000%
к	0.1591%	0.0728%	0.1782%	0.0016%	0.0091%	0.0016%	0.0179%	0.0031%	0.0009%	0.0000%	0.0000%	0.0000%	0.0133%	0.0001%	0.0112%	0.0000%
л	0.2359%	0.0402%	0.1594%	0.0024%	0.0043%	0.0015%	0.0655%	0.0043%	0.0004%	0.0000%	0.1103%	0.4189%	0.0157%	0.1193%	0.2112%	0.0002%
м	0.0952%	0.0379%	0.3456%	0.0027%	0.0096%	0.0021%	0.0526%	0.0072%	0.0010%	0.0000%	0.1098%	0.0082%	0.0084%	0.0007%	0.0578%	0.0000%
н	0.1948%	0.0740%	0.3133%	0.0028%	0.0096%	0.0422%	0.0488%	0.0026%	0.0188%	0.0000%	0.3454%	0.1460%	0.0049%	0.0183%	0.2076%	0.0000%
о	0.9533%	0.9329%	0.0763%	0.0267%	0.0650%	0.0136%	0.3296%	0.1557%	0.0191%	0.0000%	0.0000%	0.0000%	0.0553%	0.0939%	0.1117%	0.0000%
п	0.0017%	0.0060%	0.0608%	0.0001%	0.0000%	0.0017%	0.0038%	0.0016%	0.0004%	0.0000%	0.0298%	0.0042%	0.0001%	0.0004%	0.0397%	0.0000%
р	0.0334%	0.0567%	0.2703%	0.0018%	0.0115%	0.0034%	0.0094%	0.0251%	0.0038%	0.0000%	0.1453%	0.1018%	0.0004%	0.0133%	0.1055%	0.0000%
с	0.0976%	1.2797%	0.0753%	0.0018%	0.0183%	0.0074%	0.0555%	0.0084%	0.0004%	0.0027%	0.0390%	0.3324%	0.0063%	0.0149%	0.3580%	0.0019%
т	0.1514%	0.0353%	0.1487%	0.0052%	0.0052%	0.0078%	0.0529%	0.0015%	0.0020%	0.0041%	0.1751%	0.7376%	0.0146%	0.0057%	0.0713%	0.0000%
у	0.1873%	0.1618%	0.0133%	0.0062%	0.0414%	0.0012%	0.1538%	0.0842%	0.0238%	0.0000%	0.0000%	0.0000%	0.0089%	0.1137%	0.0249%	0.0000%
ф	0.0017%	0.0024%	0.0030%	0.0009%	0.0000%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0006%	0.0063%	0.0000%	0.0001%	0.0001%	0.0000%
х	0.0378%	0.0112%	0.0276%	0.0012%	0.0023%	0.0011%	0.0062%	0.0025%	0.0002%	0.0001%	0.0000%	0.0000%	0.0031%	0.0002%	0.0033%	0.0000%
ц	0.0030%	0.0013%	0.0257%	0.0000%	0.0001%	0.0010%	0.0006%	0.0001%	0.0000%	0.0000%	0.0178%	0.0000%	0.0009%	0.0000%	0.0006%	0.0000%
ч	0.0103%	0.5263%	0.1115%	0.0000%	0.0009%	0.0001%	0.0017%	0.0201%	0.0000%	0.0000%	0.0000%	0.0189%	0.0004%	0.0000%	0.0021%	0.0000%
ш	0.0005%	0.0081%	0.0336%	0.0001%	0.0004%	0.0003%	0.0003%	0.0003%	0.0000%	0.0000%	0.0000%	0.0572%	0.0002%	0.0004%	0.0001%	0.0000%
щ	0.0001%	0.0000%	0.0105%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0028%	0.0001%	0.0000%	0.0000%	0.0000%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0009%	0.0139%	0.0000%
ы	0.1408%	0.1050%	0.0106%	0.0013%	0.1049%	0.0008%	0.0317%	0.0512%	0.0004%	0.0000%	0.0000%	0.0000%	0.0052%	0.0001%	0.0057%	0.0000%
ь	0.2236%	0.0664%	0.0286%	0.0035%	0.0111%	0.0135%	0.0674%	0.0525%	0.0022%	0.0000%	0.0000%	0.0000%	0.0305%	0.0458%	0.0682%	0.0000%
э	0.0005%	0.3364%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ю	0.0563%	0.0472%	0.0123%	0.0033%	0.0039%	0.0026%	0.0240%	0.0067%	0.0398%	0.0000%	0.0000%	0.0000%	0.0062%	0.0042%	0.0055%	0.0000%
я	0.2275%	0.2204%	0.0268%	0.0041%	0.0339%	0.0065%	0.0563%	0.0099%	0.0245%	0.0000%	0.0000%	0.0000%	0.0186%	0.0120%	0.0295%	0.0000%
ё	0.0003%	0.0000%	0.0001%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%

--- Entropy: 4.123476319796595, Redundancy: 0.8750461721273759 ---

3.2.3 Біграми з пробілами та без перетинів

--- Bigrams with spaces not-intersected ---

	_	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о	п
_	0.0000%	0.3203%	0.6599%	1.4611%	0.3389%	0.7313%	0.5161%	0.2501%	0.4163%	1.0927%	0.0002%	0.8964%	0.3543%	0.5527%	1.6213%	1.3510%	1.4083%
а	1.8558%	0.0011%	0.0581%	0.3046%	0.0560%	0.2180%	0.1041%	0.1081%	0.4109%	0.0137%	0.0540%	0.4143%	0.9533%	0.2358%	0.4637%	0.0007%	0.0625%
б	0.0395%	0.0849%	0.0001%	0.0087%	0.0004%	0.0037%	0.1958%	0.0006%	0.0005%	0.0751%	0.0000%	0.0227%	0.0815%	0.0056%	0.0286%	0.2006%	0.0000%
в	0.5462%	0.5491%	0.0015%	0.0020%	0.0022%	0.0295%	0.4228%	0.0000%	0.0538%	0.4475%	0.0000%	0.0157%	0.0763%	0.0156%	0.1259%	0.7019%	0.0194%
г	0.0672%	0.0816%	0.0001%	0.0007%	0.0004%	0.1139%	0.0365%	0.0005%	0.0001%	0.0740%	0.0000%	0.0122%	0.1485%	0.0000%	0.0188%	0.8267%	0.0000%
д	0.0940%	0.4106%	0.0024%	0.0737%	0.0005%	0.0040%	0.4390%	0.0014%	0.0000%	0.2072%	0.0000%	0.0203%	0.0795%	0.0070%	0.1500%	0.3659%	0.0070%
е	1.8909%	0.0060%	0.1284%	0.2480%	0.3654%	0.2466%	0.2105%	0.0769%	0.1138%	0.0091%	0.2477%	0.1718%	0.5677%	0.4004%	0.7143%	0.0183%	0.1377%
ж	0.0304%	0.1407%	0.0045%	0.0000%	0.0006%	0.0774%	0.4130%	0.0011%	0.0000%	0.1458%	0.0000%	0.0083%	0.0006%	0.0002%	0.0970%	0.0046%	0.0000%
з	0.0956%	0.5290%	0.0158%	0.0823%	0.0541%	0.0737%	0.0211%	0.0093%	0.0064%	0.0289%	0.0000%	0.0082%	0.0197%	0.0273%	0.1898%	0.0372%	0.0019%
и	1.8033%	0.0090%	0.0404%	0.2614%	0.0409%	0.1576%	0.2316%	0.0313%	0.1819%	0.0605%	0.1336%	0.1556%	0.4344%	0.2776%	0.4051%	0.0096%	0.0139%
й	0.7131%	0.0000%	0.0004%	0.0000%	0.0000%	0.0206%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0061%	0.0087%	0.0050%	0.0275%	0.0000%	0.0000%
к	0.4665%	0.7659%	0.0000%	0.0169%	0.0000%	0.0002%	0.0497%	0.0011%	0.0002%	0.2888%	0.0000%	0.0022%	0.0319%	0.0001%	0.0621%	0.7807%	0.0001%
л	0.7197%	0.7574%	0.0020%	0.0005%	0.0104%	0.0015%	0.5221%	0.0359%	0.0004%	0.5211%	0.0000%	0.0260%	0.0245%	0.0002%	0.0291%	0.5796%	0.0047%
м	0.6923%	0.2447%	0.0009%	0.0005%	0.0027%	0.0001%	0.2891%	0.0000%	0.0002%	0.2627%	0.0000%	0.0060%	0.0083%	0.0045%	0.1271%	0.3029%	0.0059%
н	0.5346%	1.0943%	0.0012%	0.0011%	0.0098%	0.0625%	0.9790%	0.0004%	0.0015%	0.7769%	0.0000%	0.0278%	0.0000%	0.0001%	0.2852%	0.9698%	0.0000%
о	2.3471%	0.0008%	0.3367%	0.7166%	0.4636%	0.4169%	0.2419%	0.1842%	0.0994%	0.0704%	0.3070%	0.1511%	0.5411%	0.4824%	0.8289%	0.0190%	0.1099%
п	0.0046%	0.1126%	0.0002%	0.0000%	0.0000%	0.0000%	0.2033%	0.0000%	0.0000%	0.0767%	0.0000%	0.0065%	0.0442%	0.0000%	0.0066%	0.8115%	0.0027%
р	0.0662%	0.6820%	0.0230%	0.0298%	0.0337%	0.0330%	0.5304%	0.0276%	0.0009%	0.4470%	0.0000%	0.0564%	0.0046%	0.0132%	0.0644%	0.6841%	0.0054%
с	0.2906%	0.1761%	0.0046%	0.1832%	0.0007%	0.0297%	0.4353%	0.0021%	0.0018%	0.1304%	0.0000%	0.4997%	0.2562%	0.0816%	0.0938%	0.2353%	0.1660%
т	0.4424%	0.4794%	0.0012%	0.2631%	0.0006%	0.0118%	0.4919%	0.0005%	0.0004%	0.3772%	0.0000%	0.0434%	0.0245%	0.0022%	0.1082%	1.4273%	0.0051%
у	0.6617%	0.0031%	0.0529%	0.1089%	0.0958%	0.1528%	0.0266%	0.1656%	0.0297%	0.0002%	0.0102%	0.0757%	0.1090%	0.1144%	0.0220%	0.0004%	0.0555%
ф	0.0032%	0.0080%	0.0000%	0.0000%	0.0000%	0.0000%	0.0122%	0.0000%	0.0000%	0.0289%	0.0000%	0.0000%	0.0030%	0.0007%	0.0002%	0.0091%	0.0000%
х	0.2812%	0.0803%	0.0000%	0.0092%	0.0002%	0.0001%	0.0038%	0.0000%	0.0000%	0.0122%	0.0000%	0.0000%	0.0083%	0.0058%	0.0086%	0.2221%	0.0000%
ц	0.0273%	0.0475%	0.0000%	0.0043%	0.0000%	0.0000%	0.0672%	0.0000%	0.0000%	0.0200%	0.0000%	0.0108%	0.0001%	0.0002%	0.0000%	0.0279%	0.0000%
ч	0.0764%	0.2180%	0.0000%	0.0002%	0.0000%	0.0000%	0.3391%	0.0000%	0.0000%	0.1249%	0.0000%	0.0308%	0.0044%	0.0007%	0.0476%	0.0048%	0.0000%
ш	0.0066%	0.0917%	0.0000%	0.0098%	0.0000%	0.0000%	0.2279%	0.0000%	0.0000%	0.1454%	0.0000%	0.0344%	0.0548%	0.0006%	0.0343%	0.0295%	0.0005%
щ	0.0007%	0.0302%	0.0000%	0.0000%	0.0000%	0.0000%	0.1271%	0.0000%	0.0000%	0.0669%	0.0000%	0.0000%	0.0000%	0.0000%	0.0033%	0.0001%	0.0000%
ъ	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0115%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ы	0.4241%	0.0000%	0.0442%	0.0963%	0.0087%	0.0121%	0.0919%	0.0024%	0.0060%	0.0006%	0.1175%	0.0159%	0.2536%	0.1152%	0.0310%	0.0000%	0.0126%
ь	1.0513%	0.0004%	0.0080%	0.0034%	0.0048%	0.0024%	0.0473%	0.0001%	0.0176%	0.0419%	0.0000%	0.1170%	0.0000%	0.0239%	0.1148%	0.0012%	0.0001%
э	0.0004%	0.0000%	0.0001%	0.0000%	0.0002%	0.0002%	0.0000%	0.0000%	0.0007%	0.0000%	0.0001%	0.0037%	0.0033%	0.0004%	0.0030%	0.0000%	0.0022%
ю	0.3421%	0.0001%	0.0620%	0.0000%	0.0004%	0.0233%	0.0000%	0.0006%	0.0006%	0.0000%	0.0000%	0.0005%	0.0013%	0.0018%	0.0025%	0.0000%	0.0009%
я	1.1074%	0.0000%	0.0027%	0.0254%	0.0269%	0.0525%	0.0065%	0.0280%	0.0308%	0.0035%	0.0125%	0.0110%	0.0814%	0.0311%	0.0647%	0.0000%	0.0050%
ё	0.0014%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

	р	с	т	у	ф	х	ц	ч	ш	щ	ъ	ы	ь	э	ю	я	ё
_	0.3842%	1.6098%	0.7838%	0.4102%	0.0504%	0.1513%	0.0262%	0.6186%	0.0680%	0.0099%	0.0000%	0.0000%	0.0000%	0.2848%	0.0033%	0.2203%	0.0001%
а	0.2310%	0.3411%	0.4167%	0.0054%	0.0236%	0.0781%	0.0123%	0.0789%	0.0598%	0.0191%	0.0000%	0.0000%	0.0000%	0.0006%	0.0859%	0.2398%	0.0000%
б	0.1066%	0.0079%	0.0006%	0.0958%	0.0000%	0.0057%	0.0004%	0.0007%	0.0011%	0.0249%	0.0111%	0.4147%	0.0017%	0.0000%	0.0006%	0.0487%	0.0000%
в	0.1017%	0.3395%	0.0236%	0.0651%	0.0000%	0.0058%	0.0030%	0.0078%	0.1054%	0.0008%	0.0002%	0.2425%	0.0201%	0.0000%	0.0001%	0.0249%	0.0000%
г	0.0690%	0.0032%	0.0001%	0.0590%	0.0001%	0.0000%	0.0000%	0.0034%	0.0007%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0002%	0.0000%	0.0000%
д	0.1496%	0.0318%	0.0163%	0.1760%	0.0000%	0.0056%	0.0171%	0.0026%	0.0105%	0.0000%	0.0066%	0.0520%	0.0732%	0.0000%	0.0007%	0.0380%	0.0000%
е	0.5179%	0.3730%	0.4535%	0.0091%	0.0008%	0.0736%	0.0157%	0.0878%	0.0912%	0.0611%	0.0000%	0.0000%	0.0000%	0.0000%	0.0400%	0.0338%	0.0000%
ж	0.0001%	0.0082%	0.0000%	0.0240%	0.0000%	0.0000%	0.0001%	0.0044%	0.0000%	0.0000%	0.0000%	0.0000%	0.0037%	0.0000%	0.0001%	0.0000%	0.0000%
з	0.0195%	0.0056%	0.0017%	0.0235%	0.0000%	0.0000%	0.0005%	0.0063%	0.0006%	0.0000%	0.0013%	0.0370%	0.0161%	0.0000%	0.0006%	0.0442%	0.0000%
и	0.0542%	0.2139%	0.3762%	0.0011%	0.0015%	0.1323%	0.0783%	0.1868%	0.0387%	0.0149%	0.0000%	0.0000%	0.0000%	0.0001%	0.0256%	0.1667%	0.0000%
й	0.0001%	0.0483%	0.0276%	0.0000%	0.0006%	0.0000%	0.0026%	0.0069%	0.0051%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
к	0.1342%	0.0912%	0.0422%	0.1374%	0.0002%	0.0002%	0.0009%	0.0000%	0.0012%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
л	0.0000%	0.1151%	0.0015%	0.1167%	0.0005%	0.0000%	0.0001%	0.0119%	0.0004%	0.0001%	0.0000%	0.0943%	0.3516%	0.0000%	0.0992%	0.1713%	0.0002%
м	0.0078%	0.0106%	0.0054%	0.2689%	0.0001%	0.0000%	0.0008%	0.0017%	0.0001%	0.0005%	0.0000%	0.0887%	0.0076%	0.0000%	0.0002%	0.0400%	0.0000%
н	0.0093%	0.1073%	0.0408%	0.2417%	0.0015%	0.0000%	0.0314%	0.0246%	0.0001%	0.0172%	0.0000%	0.2913%	0.1193%	0.0000%	0.0131%	0.1706%	0.0000%
о	0.5361%	0.5875%	0.6409%	0.0057%	0.0177%	0.0345%	0.0085%	0.1617%	0.1152%	0.0144%	0.0000%	0.0000%	0.0000%	0.0039%	0.0719%	0.0470%	0.0000%
п	0.6086%	0.0007%	0.0053%	0.0496%	0.0002%	0.0000%	0.0015%	0.0037%	0.0009%	0.0004%	0.0000%	0.0237%	0.0030%	0.0000%	0.0004%	0.0330%	0.0000%
р	0.0013%	0.0188%	0.0444%	0.2214%	0.0006%	0.0110%	0.0030%	0.0069%	0.0209%	0.0033%	0.0000%	0.1210%	0.0835%	0.0000%	0.0119%	0.0869%	0.0000%
с	0.0122%	0.0608%	1.0536%	0.0507%	0.0005%	0.0132%	0.0040%	0.0410%	0.0053%	0.0002%	0.0020%	0.0317%	0.2696%	0.0002%	0.0136%	0.3004%	0.0018%
т	0.2371%	0.0854%	0.0083%	0.1172%	0.0021%	0.0008%	0.0061%	0.0263%	0.0001%	0.0017%	0.0037%	0.1434%	0.6114%	0.0002%	0.0040%	0.0556%	0.0000%
у	0.0566%	0.1001%	0.1047%	0.0000%	0.0033%	0.0279%	0.0004%	0.0852%	0.0699%	0.0180%	0.0000%	0.0000%	0.0000%	0.0018%	0.0918%	0.0117%	0.0000%
ф	0.0258%	0.0011%	0.0022%	0.0030%	0.0006%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0004%	0.0060%	0.0000%	0.0002%	0.0000%	0.0000%
х	0.0073%	0.0034%	0.0008%	0.0141%	0.0000%	0.0000%	0.0000%	0.0001%	0.0012%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ц	0.0000%	0.0000%	0.0002%	0.0216%	0.0000%	0.0000%	0.0011%	0.0000%	0.0000%	0.0000%	0.0000%	0.0145%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ч	0.0059%	0.0007%	0.4359%	0.0908%	0.0000%	0.0000%	0.0000%	0.0000%	0.0178%	0.0000%	0.0000%	0.0000%	0.0151%	0.0000%	0.0000%	0.0000%	0.0000%
ш	0.0001%	0.0000%	0.0065%	0.0318%	0.0000%	0.0000%	0.0001%	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%	0.0482%	0.0000%	0.0005%	0.0000%	0.0000%
щ	0.0001%	0.0000%	0.0000%	0.0085%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0026%	0.0000%	0.0000%	0.0000%	0.0000%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0006%	0.0116%	0.0000%
ы	0.0279%	0.0748%	0.0685%	0.0002%	0.0000%	0.0793%	0.0001%	0.0177%	0.0403%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0002%	0.0000%
ь	0.0000%	0.0809%	0.0069%	0.0000%	0.0004%	0.0001%	0.0106%	0.0048%	0.0413%	0.0012%	0.0000%	0.0000%	0.0000%	0.0005%	0.0376%	0.0390%	0.0000%
э	0.0008%	0.0004%	0.2848%	0.0000%	0.0004%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ю	0.0032%	0.0163%	0.0259%	0.0000%	0.0004%	0.0012%	0.0007%	0.0038%	0.0021%	0.0308%	0.0000%	0.0000%	0.0000%	0.0000%	0.0043%	0.0000%	0.0000%
я	0.0041%	0.0874%	0.1360%	0.0001%	0.0000%	0.0180%	0.0033%	0.0110%	0.0044%	0.0208%	0.0000%	0.0000%	0.0000%	0.0000%	0.0097%	0.0139%	0.0000%
ё	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

--- Entropy: 3.9449776487612955, Redundancy: 0.8804552227648093 ---

3.2.4 Біграми без пробілів без та без перетинів

--- Bigrams without spaces not-intersected ---

	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о	п
а	0.0580%	0.1557%	0.5825%	0.1173%	0.3526%	0.2141%	0.1539%	0.5324%	0.1628%	0.0597%	0.6299%	1.1968%	0.3520%	0.7724%	0.2011%	0.2486%
б	0.1026%	0.0001%	0.0106%	0.0007%	0.0041%	0.2336%	0.0006%	0.0004%	0.0999%	0.0000%	0.0282%	0.0958%	0.0067%	0.0368%	0.2503%	0.0007%
в	0.6400%	0.0177%	0.0327%	0.0326%	0.0738%	0.5187%	0.0071%	0.0737%	0.5693%	0.0000%	0.0721%	0.1023%	0.0410%	0.1968%	0.8737%	0.0873%
г	0.0965%	0.0037%	0.0118%	0.0016%	0.1436%	0.0459%	0.0011%	0.0026%	0.0964%	0.0000%	0.0186%	0.1777%	0.0024%	0.0308%	1.0103%	0.0118%
д	0.4957%	0.0062%	0.0978%	0.0031%	0.0078%	0.5439%	0.0038%	0.0033%	0.2487%	0.0000%	0.0316%	0.0944%	0.0094%	0.1988%	0.4602%	0.0147%
е	0.0316%	0.2650%	0.4996%	0.4740%	0.4043%	0.3036%	0.1186%	0.2195%	0.1665%	0.3023%	0.2977%	0.7374%	0.6019%	1.0426%	0.1838%	0.3710%
ж	0.1669%	0.0065%	0.0020%	0.0009%	0.0907%	0.4797%	0.0017%	0.0007%	0.1756%	0.0000%	0.0122%	0.0007%	0.0010%	0.1239%	0.0077%	0.0030%
з	0.6438%	0.0234%	0.1035%	0.0673%	0.1025%	0.0291%	0.0122%	0.0079%	0.0412%	0.0000%	0.0201%	0.0271%	0.0404%	0.2395%	0.0441%	0.0136%
и	0.0356%	0.1338%	0.5442%	0.0950%	0.2715%	0.3506%	0.0565%	0.2737%	0.1949%	0.1590%	0.2992%	0.5656%	0.3833%	0.6984%	0.1932%	0.2296%
й	0.0412%	0.0293%	0.0719%	0.0210%	0.0713%	0.0126%	0.0177%	0.0166%	0.0792%	0.0000%	0.0567%	0.0276%	0.0349%	0.0979%	0.0564%	0.0702%
к	0.9328%	0.0395%	0.0567%	0.0095%	0.0234%	0.0733%	0.0254%	0.0099%	0.3764%	0.0000%	0.0306%	0.0516%	0.0208%	0.1448%	0.9784%	0.0366%
л	0.9132%	0.0222%	0.0869%	0.0310%	0.0240%	0.6914%	0.0513%	0.0153%	0.6754%	0.0000%	0.0804%	0.0646%	0.0174%	0.0934%	0.7986%	0.0595%
м	0.3092%	0.0279%	0.0719%	0.0265%	0.0383%	0.3709%	0.0150%	0.0207%	0.3859%	0.0000%	0.0567%	0.0264%	0.0268%	0.2252%	0.4509%	0.0795%
н	1.3472%	0.0370%	0.0619%	0.0215%	0.1012%	1.1836%	0.0074%	0.0251%	0.9562%	0.0000%	0.0537%	0.0091%	0.0143%	0.4252%	1.1748%	0.0755%
о	0.0308%	0.5656%	1.1354%	0.5850%	0.6132%	0.3958%	0.2824%	0.1886%	0.2416%	0.3724%	0.2986%	0.6892%	0.6513%	1.2654%	0.2866%	0.3544%
п	0.1342%	0.0011%	0.0006%	0.0000%	0.0000%	0.2483%	0.0003%	0.0001%	0.0978%	0.0000%	0.0065%	0.0553%	0.0001%	0.0069%	0.9824%	0.0030%
р	0.8149%	0.0286%	0.0383%	0.0431%	0.0438%	0.6311%	0.0356%	0.0043%	0.5350%	0.0000%	0.0726%	0.0069%	0.0164%	0.0863%	0.8381%	0.0125%
с	0.2233%	0.0186%	0.2384%	0.0092%	0.0533%	0.5282%	0.0234%	0.0085%	0.1661%	0.0000%	0.6220%	0.3054%	0.1121%	0.1546%	0.3010%	0.2211%
т	0.5944%	0.0320%	0.3748%	0.0091%	0.0354%	0.6200%	0.0122%	0.0109%	0.4903%	0.0000%	0.0846%	0.0419%	0.0222%	0.1849%	1.7437%	0.0463%
у	0.0232%	0.0852%	0.1995%	0.1308%	0.2086%	0.0462%	0.2204%	0.0499%	0.0731%	0.0142%	0.1430%	0.1472%	0.1662%	0.1226%	0.0561%	0.1206%
ф	0.0108%	0.0004%	0.0010%	0.0001%	0.0000%	0.0153%	0.0000%	0.0000%	0.0347%	0.0000%	0.0003%	0.0034%	0.0010%	0.0006%	0.0119%	0.0003%
х	0.1037%	0.0126%	0.0367%	0.0092%	0.0194%	0.0103%	0.0050%	0.0081%	0.0431%	0.0000%	0.0193%	0.0235%	0.0173%	0.0363%	0.2904%	0.0310%
ц	0.0565%	0.0010%	0.0092%	0.0009%	0.0011%	0.0777%	0.0003%	0.0007%	0.0257%	0.0000%	0.0169%	0.0003%	0.0007%	0.0020%	0.0353%	0.0031%
ч	0.2678%	0.0028%	0.0130%	0.0014%	0.0035%	0.4045%	0.0009%	0.0040%	0.1610%	0.0000%	0.0421%	0.0074%	0.0014%	0.0676%	0.0123%	0.0136%
ш	0.1069%	0.0009%	0.0112%	0.0003%	0.0001%	0.2687%	0.0000%	0.0000%	0.1771%	0.0000%	0.0422%	0.0663%	0.0013%	0.0451%	0.0337%	0.0023%
щ	0.0334%	0.0000%	0.0003%	0.0000%	0.0000%	0.1599%	0.0000%	0.0000%	0.0798%	0.0000%	0.0000%	0.0003%	0.0001%	0.0038%	0.0003%	0.0003%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0142%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%
ы	0.0075%	0.0798%	0.1582%	0.0208%	0.0432%	0.1166%	0.0069%	0.0245%	0.0436%	0.1441%	0.0445%	0.3167%	0.1562%	0.1033%	0.0298%	0.0584%
ь	0.0157%	0.0419%	0.1202%	0.0227%	0.0486%	0.1202%	0.0133%	0.0472%	0.1414%	0.0000%	0.2134%	0.0237%	0.0602%	0.2493%	0.0985%	0.0955%
э	0.0000%	0.0003%	0.0001%	0.0003%	0.0000%	0.0000%	0.0000%	0.0004%	0.0000%	0.0007%	0.0041%	0.0051%	0.0004%	0.0028%	0.0000%	0.0027%
ю	0.0105%	0.0794%	0.0279%	0.0101%	0.0475%	0.0120%	0.0137%	0.0099%	0.0370%	0.0000%	0.0259%	0.0116%	0.0145%	0.0329%	0.0342%	0.0332%
я	0.0319%	0.0489%	0.1443%	0.0570%	0.1125%	0.0534%	0.0571%	0.0711%	0.1100%	0.0157%	0.0849%	0.1260%	0.0768%	0.2585%	0.0887%	0.1104%
ё	0.0000%	0.0000%	0.0007%	0.0001%	0.0000%	0.0000%	0.0000%	0.0001%	0.0003%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0003%	0.0000%

	р	с	т	у	ф	х	ц	ч	ш	щ	ъ	ы	ь	э	ю	я	ё
а	0.3220%	0.6340%	0.6020%	0.0605%	0.0360%	0.1158%	0.0162%	0.1613%	0.0794%	0.0259%	0.0000%	0.0000%	0.0000%	0.0429%	0.0981%	0.3285%	0.0000%
б	0.1244%	0.0098%	0.0013%	0.1246%	0.0001%	0.0062%	0.0011%	0.0009%	0.0009%	0.0255%	0.0140%	0.4862%	0.0009%	0.0094%	0.0007%	0.0584%	0.0000%
в	0.1474%	0.4901%	0.0717%	0.0894%	0.0020%	0.0098%	0.0050%	0.0252%	0.1319%	0.0009%	0.0003%	0.2866%	0.0248%	0.0293%	0.0007%	0.0337%	0.0000%
г	0.0866%	0.0128%	0.0031%	0.0734%	0.0004%	0.0003%	0.0000%	0.0047%	0.0009%	0.0000%	0.0000%	0.0000%	0.0000%	0.0013%	0.0003%	0.0003%	0.0000%
д	0.1837%	0.0526%	0.0269%	0.2129%	0.0007%	0.0068%	0.0204%	0.0064%	0.0122%	0.0001%	0.0068%	0.0662%	0.0937%	0.0028%	0.0011%	0.0472%	0.0000%
е	0.6827%	0.6791%	0.6289%	0.0700%	0.0072%	0.1236%	0.0208%	0.1733%	0.1156%	0.0730%	0.0000%	0.0000%	0.0000%	0.0398%	0.0462%	0.0673%	0.0000%
ж	0.0001%	0.0108%	0.0028%	0.0283%	0.0000%	0.0000%	0.0000%	0.0035%	0.0000%	0.0000%	0.0000%	0.0000%	0.0050%	0.0011%	0.0000%	0.0014%	0.0000%
з	0.0259%	0.0194%	0.0079%	0.0336%	0.0003%	0.0006%	0.0011%	0.0084%	0.0016%	0.0000%	0.0011%	0.0492%	0.0190%	0.0043%	0.0001%	0.0578%	0.0000%
и	0.1139%	0.4636%	0.5569%	0.0619%	0.0094%	0.1767%	0.1022%	0.2877%	0.0577%	0.0190%	0.0000%	0.0000%	0.0000%	0.0274%	0.0288%	0.2265%	0.0000%
й	0.0316%	0.1467%	0.0581%	0.0173%	0.0044%	0.0081%	0.0065%	0.0339%	0.0095%	0.0011%	0.0000%	0.0000%	0.0000%	0.0074%	0.0001%	0.0086%	0.0000%
к	0.1740%	0.1620%	0.0730%	0.1814%	0.0009%	0.0101%	0.0017%	0.0198%	0.0031%	0.0010%	0.0000%	0.0000%	0.0000%	0.0109%	0.0003%	0.0105%	0.0000%
л	0.0149%	0.2327%	0.0397%	0.1607%	0.0027%	0.0040%	0.0010%	0.0649%	0.0044%	0.0006%	0.0000%	0.1104%	0.4290%	0.0160%	0.1196%	0.2163%	0.0000%
м	0.0275%	0.0958%	0.0370%	0.3437%	0.0026%	0.0099%	0.0020%	0.0499%	0.0068%	0.0007%	0.0000%	0.1076%	0.0082%	0.0088%	0.0011%	0.0581%	0.0000%
н	0.0222%	0.1974%	0.0727%	0.3131%	0.0026%	0.0092%	0.0415%	0.0497%	0.0027%	0.0183%	0.0000%	0.3542%	0.1482%	0.0052%	0.0193%	0.2061%	0.0000%
о	0.7097%	0.9465%	0.9265%	0.0751%	0.0271%	0.0641%	0.0143%	0.3288%	0.1613%	0.0197%	0.0000%	0.0000%	0.0000%	0.0544%	0.0944%	0.1077%	0.0000%
п	0.7376%	0.0020%	0.0064%	0.0588%	0.0003%	0.0000%	0.0016%	0.0030%	0.0020%	0.0006%	0.0000%	0.0296%	0.0051%	0.0003%	0.0003%	0.0370%	0.0000%
р	0.0035%	0.0300%	0.0556%	0.2661%	0.0014%	0.0122%	0.0031%	0.0088%	0.0247%	0.0030%	0.0000%	0.1437%	0.1029%	0.0006%	0.0129%	0.1108%	0.0000%
с	0.0222%	0.0975%	1.2791%	0.0724%	0.0021%	0.0166%	0.0077%	0.0539%	0.0077%	0.0009%	0.0031%	0.0390%	0.3420%	0.0055%	0.0146%	0.3696%	0.0017%
т	0.3006%	0.1470%	0.0350%	0.1470%	0.0047%	0.0048%	0.0069%	0.0531%	0.0017%	0.0018%	0.0040%	0.1750%	0.7395%	0.0152%	0.0057%	0.0719%	0.0000%
у	0.0828%	0.1936%	0.1660%	0.0136%	0.0054%	0.0391%	0.0017%	0.1511%	0.0870%	0.0241%	0.0000%	0.0000%	0.0000%	0.0085%	0.1069%	0.0262%	0.0000%
ф	0.0310%	0.0016%	0.0030%	0.0031%	0.0009%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0007%	0.0067%	0.0000%	0.0003%	0.0001%	0.0000%
х	0.0162%	0.0377%	0.0101%	0.0276%	0.0010%	0.0023%	0.0010%	0.0047%	0.0028%	0.0003%	0.0001%	0.0000%	0.0000%	0.0026%	0.0004%	0.0035%	0.0000%
ц	0.0004%	0.0034%	0.0011%	0.0281%	0.0000%	0.0001%	0.0013%	0.0004%	0.0000%	0.0000%	0.0000%	0.0173%	0.0000%	0.0006%	0.0000%	0.0007%	0.0000%
ч	0.0088%	0.0098%	0.5316%	0.1115%	0.0000%	0.0004%	0.0001%	0.0017%	0.0193%	0.0000%	0.0000%	0.0000%	0.0190%	0.0001%	0.0000%	0.0031%	0.0000%
ш	0.0004%	0.0003%	0.0075%	0.0322%	0.0000%	0.0003%	0.0003%	0.0001%	0.0003%	0.0000%	0.0000%	0.0000%	0.0602%	0.0004%	0.0003%	0.0001%	0.0000%
щ	0.0006%	0.0003%	0.0000%	0.0103%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0030%	0.0001%	0.0000%	0.0000%	0.0000%
ъ	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0009%	0.0137%	0.0000%
ы	0.0394%	0.1376%	0.1044%	0.0091%	0.0011%	0.1091%	0.0010%	0.0295%	0.0522%	0.0003%	0.0000%	0.0000%	0.0000%	0.0050%	0.0000%	0.0060%	0.0000%
ь	0.0255%	0.2260%	0.0643%	0.0266%	0.0040%	0.0120%	0.0126%	0.0658%	0.0502%	0.0018%	0.0000%	0.0000%	0.0000%	0.0276%	0.0445%	0.0667%	0.0000%
э	0.0009%	0.0004%	0.3400%	0.0000%	0.0003%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
ю	0.0197%	0.0578%	0.0480%	0.0119%	0.0034%	0.0047%	0.0026%	0.0257%	0.0058%	0.0385%	0.0000%	0.0000%	0.0000%	0.0064%	0.0040%	0.0052%	0.0000%
я	0.0332%	0.2245%	0.2156%	0.0259%	0.0041%	0.0330%	0.0074%	0.0551%	0.0101%	0.0249%	0.0000%	0.0000%	0.0000%	0.0184%	0.0133%	0.0289%	0.0000%
ё	0.0000%	0.0004%	0.0000%	0.0001%	0.0000%	0.0003%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%

--- Entropy: 4.122368938570627, Redundancy: 0.8750797291342234 ---

4 Ентропія та надлишковість

4.1 Біграми з пробілами та з перетинами

— Entropy: 3.945625089661013, Redundancy: 0.8804356033436057 —

4.2 Біграми без пробілів та з перетинами

— Entropy: 4.123476319796595, Redundancy: 0.8750461721273759 —

4.3 Біграми з пробілами та без перетинів

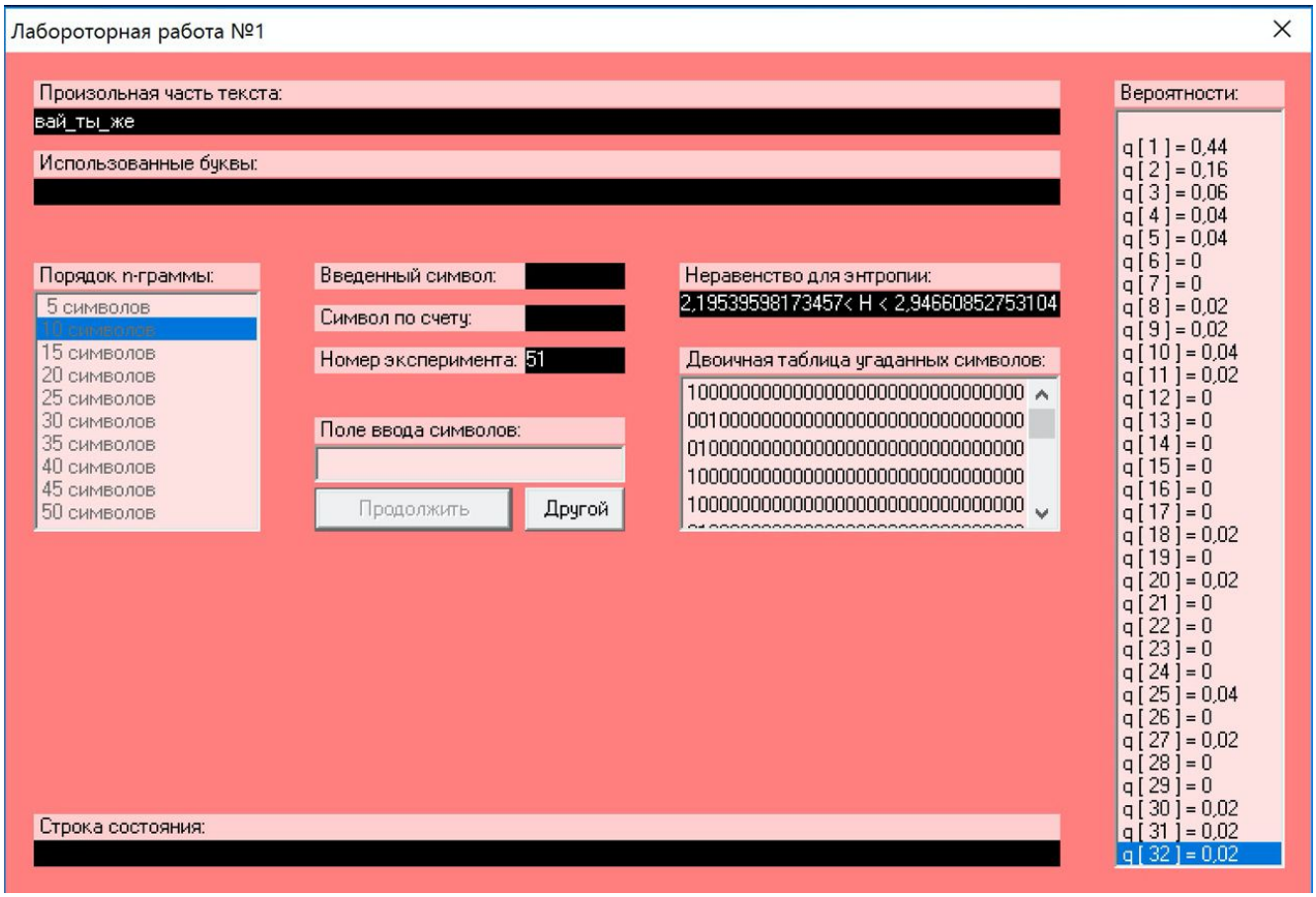
— Entropy: 3.9449776487612955, Redundancy: 0.8804552227648093 —

4.4 Біграми без пробілів та без перетинів

— Entropy: 4.122368938570627, Redundancy: 0.8750797291342234 —

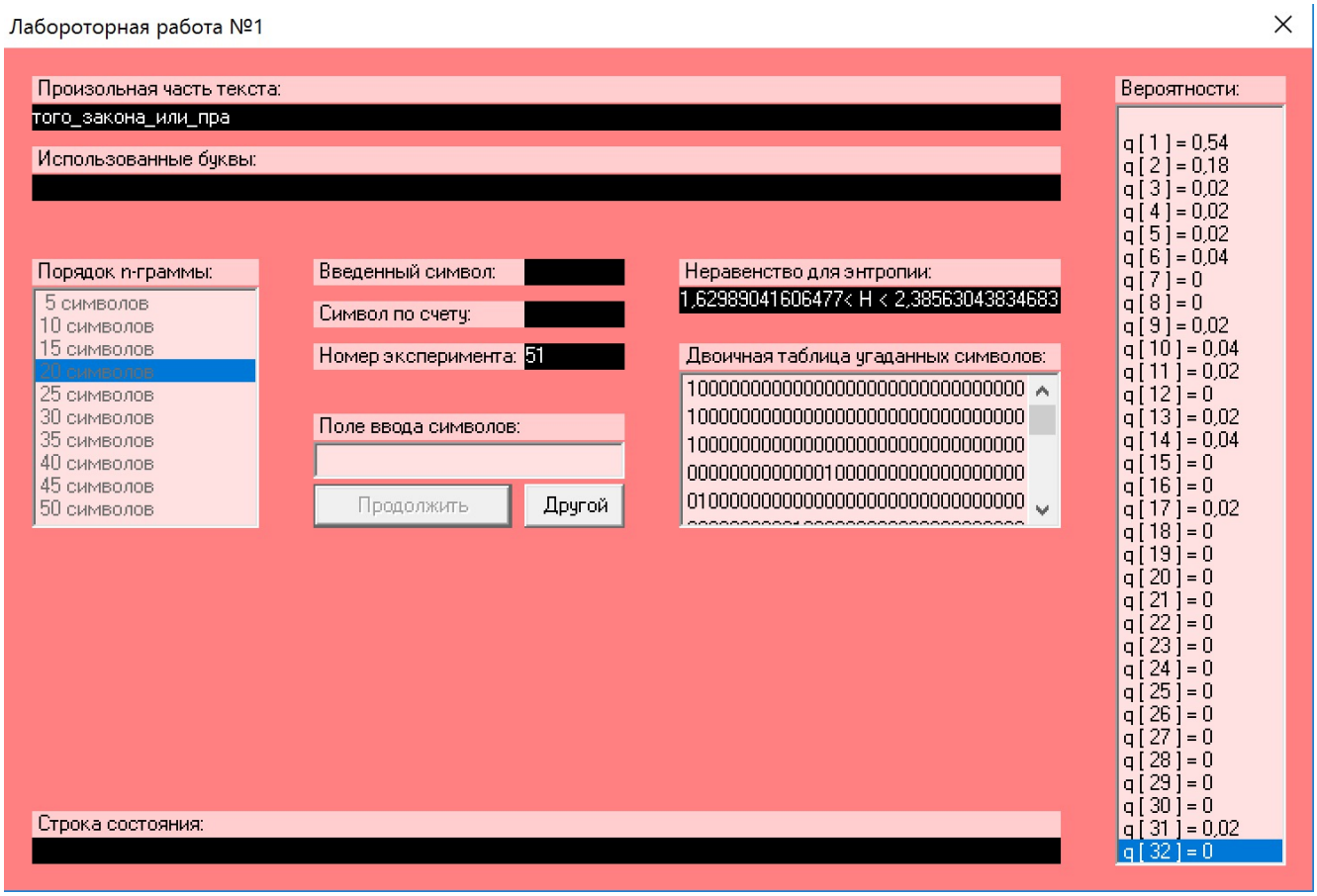
5 CoolPinkProgram.exe

5.1 H10



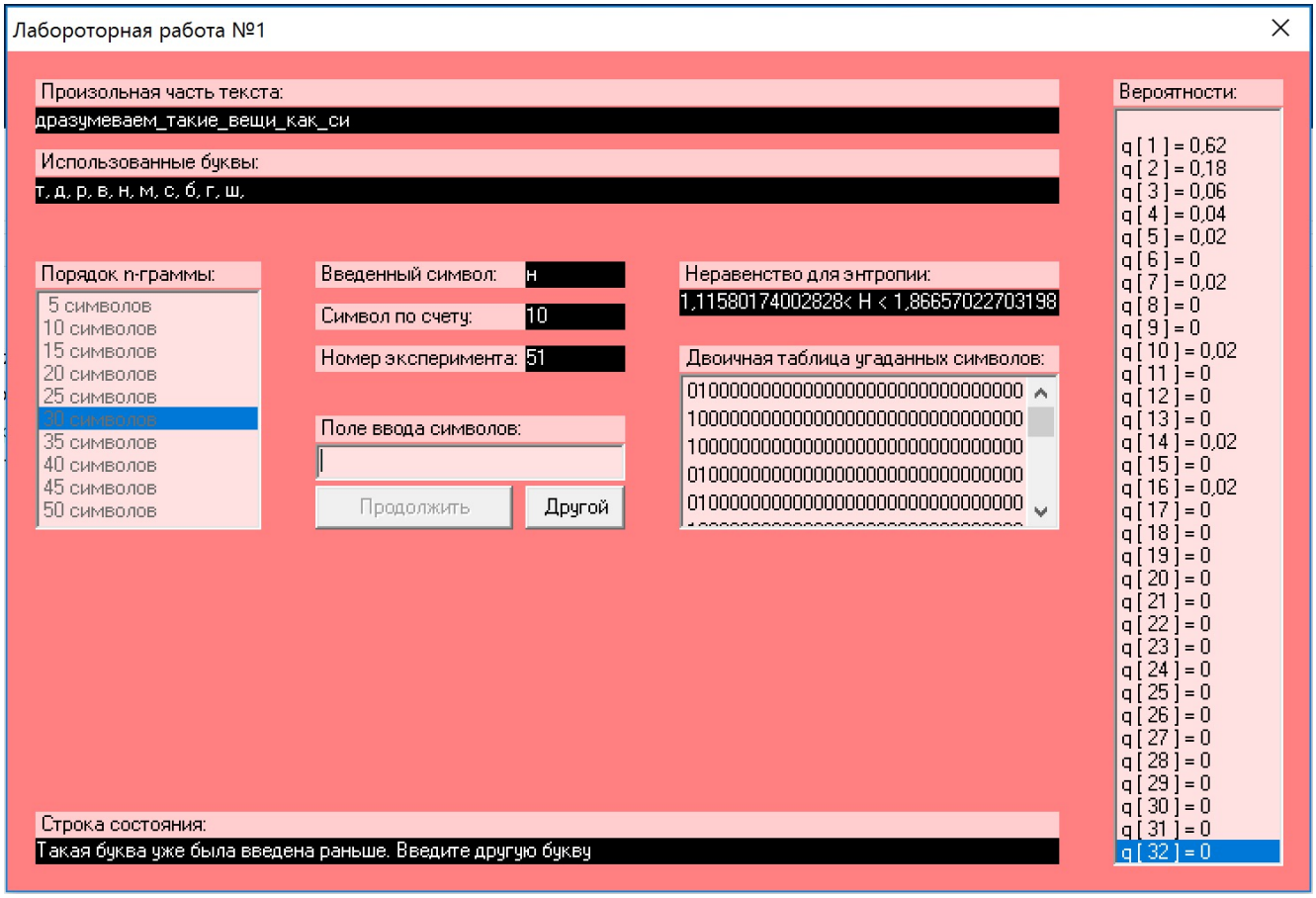
$$0.9079 < R < 0.9313$$

5.2 H20



$$0.9254 < \mathrm{R} < 0.9490$$

5.3 H30



$$0.9416 < \mathrm{R} < 0.9651$$

6 Висновки

Впродовж цієї лабораторної роботи ми засвоїли що таке ентропія символів джерела, надлишковість символів. Також ми порівляли різні моделі джерела відкритого текста для наближеного визначення ентропії, здобули практичні вміння та навички необхідних для досить точної оцінки ентропії.