

МІНІСТЕРСТВО ОСВІТИ І НАУКИ, МОЛОДІ ТА СПОРТУ УКРАЇНИ

НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ

«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ»

ФІЗИКО-ТЕХНІЧНИЙ ІНСТИТУТ

Криптографія

Комп’ютерний практикум №1

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| --- | --- |
|  | Виконали:  студенти III курсу  групи ФБ-82  Ясинський Н.  Кравчук В.  Перевірив:  Чорний О.М.  \_\_\_\_\_\_\_\_\_\_\_ |

Київ 2020

**Робота №1. Експериментальна оцінка ентропії на символ джерела відкритого тексту**

* Мета роботи: Засвоєння понять ентропії на символ джерела та його надлишковості, вивчення та порівняння різних моделей джерела відкритого тексту для наближеного визначення ентропії, набуття практичних навичок щодо оцінки ентропії на символ джерела.
* Дата: 20.09.2020

**Завдання до виконання:**

0. Уважно прочитати методичні вказівки до виконання комп’ютерного практикуму.

1. 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.

2. За допомогою програми CoolPinkProgram оцінити значення (10) H, (20) H, (30) H .

3. Використовуючи отримані значення ентропії, оцінити надлишковість російської

мови в різних моделях джерела.

**Виконання роботи:**

1. Програмний код:
2. import numpy as np  
   import math  
   f = open("text.txt","r",encoding="utf-8")  
   b\_symb = list()  
   b\_bigram1 = list()  
   b\_bigram2 = list()  
   b\_symb\_ws = list()  
   b\_bigram1\_ws = list()  
   b\_bigram2\_ws = list()  
   text = list()  
   text\_ws = list()  
   alf = "абвгдеёжзийклмнопрстуфхцчшщъыьэюя "  
     
   def entropy(symb,n):  
    dict\_text = dict()  
    for i in symb:  
    if i not in dict\_text:  
    dict\_text[i] = 1  
    else:  
    dict\_text[i]+=1  
    for i,k in dict\_text.items():  
    dict\_text[i] = k/len(symb)  
    probs = np.array(list(dict\_text.values()))  
    ent = - probs.dot(np.log2(probs))  
    ent = ent  
    ent \*= 1/n  
    return ent,dict\_text  
     
   for i in f:  
    i = i.replace("\n", "").lower().replace("ё","е").replace("ъ","ь")  
    for k in i:  
    if k in alf:  
    text.append(k)  
     
     
   for symb in text:  
    b\_symb.append(symb)  
     
   for i in range(0,len(text)-1,2):  
    bigram1 = text[i]+text[i+1]  
    b\_bigram1.append(bigram1)  
     
   for i in range(0,len(text)-1):  
    bigram2 = text[i]+text[i+1]  
    b\_bigram2.append(bigram2)  
     
   for i in text:  
    if i !=" ":  
    text\_ws.append(i)  
     
   for symb in text\_ws:  
    b\_symb\_ws.append(symb)  
     
   for i in range(0,len(text\_ws)-1,2):  
    bigram1 = text[i]+text[i+1]  
    b\_bigram1\_ws.append(bigram1)  
     
   for i in range(0,len(text\_ws)-1):  
    bigram2 = text[i]+text[i+1]  
    b\_bigram2\_ws.append(bigram2)  
   def print\_dict(dict\_values):  
    pro = 0  
    string = " "  
    count = 0  
    for i,b in dict\_values.items():  
     
    string += i + ":"+ str("{:.2f}".format(b\*100))+"%"+" "  
    if count == len(dict\_values)-1:  
    print(string)  
    if pro==14:  
    print(string)  
    pro = 0  
    string = " "  
    pro+=1  
     
   redundency = lambda x: 1 - (x / math.log2(32))  
     
   print("symb:")  
   H1,dict\_values = entropy(b\_symb,1)  
   print\_dict(dict\_values)  
   print("H1:"+str(H1))  
   print("R:"+str(H1))  
   print("bigram1:")  
   H2,dict\_values = entropy(b\_bigram1,2)  
   print\_dict(dict\_values)  
   print("H2:"+str(H2))  
   print("R:"+str(H2))  
   print("bigram2:")  
   H2,dict\_values = entropy(b\_bigram2,2)  
   print\_dict(dict\_values)  
   print("H2:"+str(H2))  
   print("R:"+str(H2))  
   print("symb\_ws:")  
   H1,dict\_values = entropy(b\_symb\_ws,1)  
   print\_dict(dict\_values)  
   print("H1:"+str(H1))  
   print("R:"+str(H1))  
   print("bigram1\_ws:")  
   H2,dict\_values = entropy(b\_bigram1\_ws,2)  
   print\_dict(dict\_values)  
   print("H2:"+str(H2))  
   print("R:"+str(H2))  
   print("bigram2\_ws:")  
   H2,dict\_values = entropy(b\_bigram2\_ws,2)  
   print\_dict(dict\_values)  
   print("H2:"+str(H2))  
   print("R:"+str(H2))

Частота монограм:

н:6.59% у:2.85% ч:1.40% т:5.67% о:11.30% к:3.61% я:2.35% з:1.78% ь:2.04% г:2.03% е:8.01%

и:6.68% л:5.03% а:8.35% с:5.20% б:1.76% ш:0.92% п:2.57% м:3.02% ф:0.22% р:4.50%

в:4.56% д:3.00% ю:0.66% ы:1.89% ж:1.02% й:1.16% щ:0.28% э:0.31% х:0.85% ц:0.40%

H1: 4.47015631662864

R:0.12865976124913792

Частота монограм з пропусками :

\_:17.51% н:5.44% у:2.35% ч:1.16% т:4.68% о:9.32% к:2.97% я:1.94% з:1.47% ь:1.69% г:1.67% е:6.61% и:5.51% л:4.15% а:6.89%

с:4.29% б:1.45% ш:0.76% п:2.12% м:2.49% ф:0.18% р:3.71% в:3.76% д:2.47% ю:0.55% ы:1.56% ж:0.85% й:0.95% щ:0.23%

H1:4.3567011937543105

R:0.10596873667427198

Біграми(з перетином, з пропусками)

н:1.44% ну:0.27% у :0.64% ч:0.51% чт:0.34% то:1.27% о :2.05% к:1.08% кн:0.22% ня:0.33% яз:0.15%

зь:0.11% ь :1.02% г:0.49% ге:0.06% ен:0.67% уя:0.01% я :1.11% и:1.05% и :1.75% л:0.25%

лу:0.12% ук:0.09% кк:0.00% ка:0.74% а :1.66% с:1.53% ст:1.02% та:0.53% ал:0.84% ли:0.61%

не:0.87% е :1.61% б:0.73% бо:0.22% ол:0.66% ль:0.34% ьш:0.04% ше:0.22% ак:0.43% к :0.48%

п:1.51% по:0.83% ом:0.48% ме:0.27% ес:0.34% ть:0.51% ья:0.04% ф:0.08% фа:0.02% ам:0.27%

ми:0.35% ил:0.49% ии:0.06% бу:0.14% уо:0.01% он:0.66% на:1.00% ап:0.07% па:0.11% ар:0.24%

рт:0.07% те:0.45% ет:0.36% т :0.45% я:0.15% в:1.46% ва:0.56% м :0.72% вп:0.03% пе:0.23%

ер:0.64% ре:0.58% ед:0.22% д :0.10% го:0.86% ов:0.77% во:0.71% ор:0.60% рю:0.02% ю :0.34%

е:0.38% сл:0.22% вы:0.26% ы :0.41% м:0.58% мн:0.11% ск:0.44% аж:0.12% же:0.35% у:0.37%

ас:0.37% с :0.30% ой:0.35% йн:0.03% оз:0.08% зв:0.07% ит:0.33% се:0.34% еб:0.11% бе:0.19%

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до:0.34% ос:0.61% ти:0.32% уж:0.13% жа:0.14% сы:0.04% э:0.25% эт:0.21% ог:0.44% а:0.28%

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лм:0.00% эш:0.00% эх:0.00% шш:0.00% пш:0.00% лв:0.00% хп:0.00% уц:0.00% хх:0.00% мж:0.00%

H2:3.973237501024201

R:0.2053524997951598

Біграми(з перетином, без пропусків)

bigram2\_ws:

ну:0.35% уч:0.13% чт:0.41% то:1.58% ок:0.32% кн:0.32% ня:0.40% яз:0.22% зь:0.13% ьг:0.04% ге:0.07%

ен:0.96% уя:0.02% яи:0.11% ил:0.62% лу:0.16% ук:0.18% кк:0.05% ка:0.91% ас:0.64% ст:1.27%

та:0.65% ал:1.05% ли:0.78% ин:0.59% не:1.06% еб:0.23% бо:0.28% ол:0.83% ль:0.41% ьш:0.05%

ше:0.26% ек:0.22% ак:0.67% кп:0.04% по:1.00% ом:0.66% ме:0.34% ес:0.62% ть:0.62% ья:0.07%

яп:0.11% яф:0.01% фа:0.02% ам:0.42% ми:0.49% ии:0.20% иб:0.14% бу:0.17% уо:0.05% он:1.05%

на:1.22% ап:0.27% па:0.14% ар:0.34% рт:0.09% те:0.56% ет:0.51% тя:0.07% яв:0.16% ва:0.68%

мв:0.08% вп:0.10% пе:0.27% ер:0.83% ре:0.70% ед:0.36% дг:0.01% го:1.05% ов:1.18% во:0.90%

ор:0.78% рю:0.02% юе:0.01% сл:0.28% ив:0.53% вы:0.32% ым:0.20% мн:0.20% ск:0.55% аж:0.16%

же:0.43% еч:0.16% оу:0.06% ун:0.12% св:0.24% ой:0.42% йн:0.10% ае:0.16% ып:0.06% оз:0.16%

зв:0.10% ит:0.48% се:0.42% бе:0.24% ез:0.21% за:0.64% ащ:0.03% щи:0.08% ищ:0.01% ща:0.05%

ат:0.62% ьв:0.14% вс:0.43% ег:0.45% га:0.12% ад:0.32% до:0.42% ос:0.97% ти:0.42% еу:0.06%

уж:0.16% жа:0.17% сы:0.05% ыэ:0.01% эт:0.26% ог:0.60% оа:0.02% ан:0.78% нт:0.10% их:0.20%

хр:0.02% ри:0.64% ис:0.54% пр:0.73% ра:0.96% ав:0.56% оя:0.11% ве:0.51% юч:0.02% оо:0.23%

сб:0.02% зн:0.20% аю:0.09% юв:0.03% ыу:0.01% др:0.24% ру:0.35% уг:0.17% гм:0.00% мо:0.49%

йв:0.08% ем:0.58% рн:0.10% ны:0.36% ый:0.19% йр:0.04% аб:0.16% бк:0.03% кв:0.07% ыг:0.02%

уз:0.11% зд:0.09% тв:0.31% ву:0.09% уй:0.01% йт:0.07% ея:0.06% ви:0.42% иж:0.06% жу:0.02%

сп:0.22% пу:0.07% юс:0.05% са:0.17% ди:0.32% сь:0.38% ьи:0.10% ир:0.13% сс:0.12% аз:0.53%

зы:0.06% ыв:0.17% ай:0.10% кг:0.02% ла:0.81% ию:0.03% юл:0.01% ле:0.45% од:0.63% да:0.45%

аи:0.16% из:0.25% тн:0.16% ая:0.36% яа:0.04% нн:0.39% вл:0.13% ло:0.84% вн:0.21% аш:0.12%

рф:0.00% фр:0.05% ей:0.26% йл:0.04% ип:0.26% бл:0.08% им:0.40% мп:0.10% тр:0.34% иц:0.17%

цы:0.01% ма:0.34% иф:0.01% фе:0.02% ро:0.79% ча:0.25% жн:0.13% но:1.03% ои:0.24% ич:0.20%

чи:0.15% зя:0.06% си:0.21% ия:0.20% рв:0.04% ие:0.32% ех:0.14% ха:0.11% вш:0.14% ее:0.21%

ев:0.34% че:0.36% шл:0.05% ля:0.21% ял:0.12% ко:1.02% ьк:0.21% дн:0.20% йу:0.02% бы:0.42%

ыл:0.26% лг:0.04% гр:0.16% пп:0.01% пк:0.01% аг:0.16% пб:0.00% лт:0.03% гд:0.11% ое:0.31%

уп:0.13% от:0.89% ся:0.36% ят:0.22% дк:0.03% ки:0.32% иа:0.04% му:0.30% де:0.52% еж:0.14%

ур:0.10% ых:0.10% хо:0.31% ув:0.16% вз:0.08% пи:0.09% со:0.31% оч:0.27% чк:0.03% ах:0.13%

зо:0.08% ху:0.02% ут:0.19% мс:0.11% кр:0.22% сн:0.12% мл:0.03% ке:0.06% мб:0.03% об:0.51%

зр:0.03% зл:0.03% хе:0.01% иу:0.06% сг:0.01% аф:0.07% фи:0.08% ик:0.34% ьн:0.24% вв:0.04%

ид:0.30% ду:0.19% ни:0.85% чш:0.01% рс:0.05% кт:0.07% ау:0.06% уб:0.09% йб:0.04% иш:0.06%

шк:0.04% тт:0.03% яб:0.05% уд:0.25% нь:0.13% ьр:0.02% ын:0.10% нч:0.03% ус:0.22% бя:0.06%

ям:0.08% жд:0.08% уи:0.07% нш:0.01% ео:0.15% лн:0.11% см:0.14% яс:0.22% ьт:0.06% йи:0.06%

ул:0.20% лы:0.14% ыб:0.09% ба:0.13% ош:0.16% дш:0.01% ши:0.22% ий:0.17% йк:0.09% ьс:0.22%

тл:0.04% ыр:0.05% мх:0.01% хи:0.05% ца:0.07% дв:0.11% мш:0.01% мм:0.02% нд:0.15% чу:0.07%

лк:0.18% хб:0.02% шм:0.00% нг:0.04% ыс:0.13% мф:0.00% нц:0.06% цу:0.06% зс:0.03% мя:0.06%

ык:0.06% ум:0.14% ды:0.07% ыи:0.04% ел:0.76% ац:0.01% ци:0.03% ры:0.17% ые:0.12% йс:0.17%

еи:0.15% ач:0.13% ку:0.19% нп:0.07% еп:0.32% оц:0.02% це:0.13% дс:0.05% ою:0.09% юн:0.04%

уш:0.09% ую:0.12% юи:0.04% яю:0.01% ющ:0.05% щу:0.01% юб:0.05% йд:0.07% лс:0.25% ян:0.23%

жи:0.13% вь:0.02% ье:0.20% гу:0.09% зм:0.03% яя:0.04% яг:0.08% вк:0.08% зз:0.01% еш:0.10%

нр:0.02% шь:0.04% ож:0.23% вр:0.08% як:0.12% ьу:0.02% аа:0.04% ею:0.05% ьа:0.07% гл:0.19%

оп:0.35% ср:0.04% ьд:0.04% чь:0.02% ьз:0.04% тз:0.01% зе:0.04% тм:0.03% яд:0.14% шн:0.04%

йп:0.09% еэ:0.03% йе:0.01% рк:0.04% вя:0.02% тс:0.15% ыз:0.02% ох:0.08% кб:0.07% ыо:0.03%

ьп:0.10% ыч:0.03% кз:0.01% ря:0.12% ещ:0.07% лч:0.07% юд:0.05% ьц:0.01% ьх:0.01% мт:0.03%

мч:0.05% сж:0.01% гс:0.02% мы:0.08% ыт:0.08% йг:0.04% лл:0.02% ио:0.21% иг:0.12% пы:0.02%

хт:0.01% мк:0.07% дт:0.05% вт:0.07% хв:0.04% ты:0.19% яч:0.05% чн:0.06% зк:0.03% рр:0.01%

пь:0.08% бр:0.15% хн:0.04% рд:0.05% дц:0.02% кл:0.05% тб:0.03% ао:0.16% ги:0.10% сд:0.05%

рж:0.04% хп:0.04% йо:0.06% бд:0.00% юм:0.02% ту:0.20% ьч:0.05% дь:0.09% ьл:0.02% яо:0.09%

оэ:0.04% ьо:0.08% ша:0.15% зг:0.06% еа:0.02% ью:0.06% юп:0.03% юк:0.03% йэ:0.01% эн:0.01%

зи:0.04% тк:0.08% жк:0.01% вд:0.07% хч:0.01% вб:0.03% ьэ:0.02% бщ:0.02% ще:0.13% бм:0.00%

лю:0.10% йз:0.02% яу:0.03% тж:0.01% зб:0.02% хд:0.02% дл:0.08% рл:0.01% лд:0.07% уэ:0.01%

эз:0.00% кф:0.00% лж:0.05% дп:0.02% кс:0.06% лр:0.03% яе:0.05% нб:0.03% нз:0.02% уе:0.03%

бь:0.01% йм:0.05% сч:0.05% яж:0.07% яэ:0.02% лв:0.08% бн:0.03% шу:0.04% хф:0.00% кч:0.02%

сэ:0.01% оф:0.07% сх:0.02% ыа:0.01% ьм:0.07% дз:0.01% ыд:0.03% вг:0.04% су:0.09% ущ:0.02%

ют:0.06% тп:0.06% юг:0.02% жт:0.00% бж:0.00% вм:0.03% нв:0.06% рь:0.10% дм:0.02% дд:0.01%

уа:0.03% ьб:0.06% би:0.09% зш:0.00% юя:0.01% шб:0.00% йш:0.02% яр:0.03% кд:0.03% шч:0.00%

гн:0.04% юц:0.01% йц:0.01% юа:0.01% рч:0.01% мд:0.04% ух:0.05% сю:0.02% ню:0.02% юю:0.00%

йч:0.03% тд:0.04% рг:0.04% гв:0.02% нс:0.10% пя:0.04% нм:0.01% йф:0.01% иэ:0.02% зх:0.00%

хэ:0.00% эм:0.00% ящ:0.02% шо:0.04% лп:0.09% рц:0.02% цо:0.05% вэ:0.03% бв:0.01% лм:0.01%

зт:0.01% зу:0.03% лэ:0.01% нк:0.05% вч:0.02% лб:0.04% ьж:0.01% фу:0.01% йж:0.01% аэ:0.04%

юф:0.00% нф:0.00% мг:0.04% гп:0.01% уф:0.00% рз:0.01% мь:0.00% дя:0.04% зю:0.01% йя:0.01%

хс:0.04% яц:0.01% йа:0.02% хц:0.00% юу:0.01% тш:0.00% ях:0.03% лз:0.02% юр:0.03% рщ:0.01%

ец:0.03% цв:0.01% ыш:0.06% тц:0.02% мр:0.03% хл:0.02% ця:0.00% шв:0.00% хя:0.00% ыж:0.01%

тч:0.04% юж:0.01% юз:0.01% лх:0.00% юэ:0.01% йх:0.01% хм:0.02% зп:0.02% нж:0.00% уу:0.01%

лф:0.00% сш:0.01% рб:0.02% пл:0.08% тг:0.02% фз:0.00% эл:0.01% нщ:0.02% зж:0.02% хк:0.02%

км:0.03% тх:0.01% рш:0.03% хж:0.00% мз:0.02% дх:0.01% гч:0.00% жв:0.00% жч:0.01% рх:0.02%

кэ:0.01% бс:0.01% гк:0.02% кю:0.00% кх:0.01% яй:0.00% кя:0.01% щн:0.00% жп:0.00% мж:0.01%

мэ:0.01% цк:0.02% цп:0.00% ощ:0.01% щь:0.00% хг:0.02% рп:0.03% яш:0.01% мц:0.00% хь:0.00%

гэ:0.00% пн:0.01% фн:0.00% юш:0.01% чг:0.00% чо:0.01% юо:0.02% фо:0.01% рм:0.03% еф:0.01%

зэ:0.00% зч:0.01% фы:0.00% жо:0.01% тэ:0.01% ыя:0.01% гз:0.01% гт:0.00% ыц:0.00% сц:0.00%

шф:0.00% бх:0.01% цб:0.00% цз:0.00% дч:0.01% пт:0.01% жм:0.00% чр:0.00% цл:0.00% фк:0.00%

жс:0.00% вх:0.01% гя:0.00% шп:0.01% дб:0.01% пс:0.00% пч:0.00% жб:0.01% пм:0.00% нх:0.01%

фл:0.01% чл:0.00% кж:0.02% цг:0.00% жь:0.00% гг:0.00% цт:0.00% бэ:0.00% тщ:0.00% юх:0.00%

гб:0.00% йю:0.00% цс:0.00% эп:0.00% нэ:0.01% цч:0.00% фф:0.00% тф:0.00% щр:0.00% жг:0.00%

цн:0.01% дж:0.00% бб:0.00% ьф:0.00% жэ:0.00% цм:0.00% вж:0.00% кц:0.00% рэ:0.00% эг:0.00%

ыщ:0.00% кш:0.00% сз:0.01% вф:0.00% бг:0.00% шт:0.02% фт:0.00% нл:0.00% чс:0.00% фв:0.00%

зц:0.00% вц:0.01% дю:0.00% фп:0.00% мю:0.01% шс:0.00% чд:0.00% чм:0.00% бз:0.00% тю:0.01%

хх:0.00% сф:0.00% жя:0.00% чп:0.00% уц:0.00% бш:0.00% хз:0.01% жл:0.00% чб:0.00% чв:0.00%

бч:0.00% лш:0.01% шд:0.00% жц:0.00% жз:0.00% гх:0.00% фс:0.00% эк:0.01% эв:0.00% фм:0.00%

эй:0.00% фд:0.00% хш:0.00% фб:0.00% дэ:0.00% ээ:0.00% жю:0.00% эи:0.00% цх:0.00% иь:0.00%

оь:0.00% пэ:0.00% эр:0.01% чэ:0.00% эд:0.00% щз:0.00% мщ:0.00% вщ:0.00% жх:0.00% цд:0.00%

лц:0.00% фь:0.00% бю:0.00% жж:0.00% лщ:0.00% фг:0.00% бт:0.00% йщ:0.00% йй:0.00% чз:0.00%

щд:0.00% бп:0.00% дф:0.00% чя:0.00% сй:0.00% щс:0.00% зф:0.00% шг:0.00% гф:0.00% цэ:0.00%

чч:0.00% эс:0.01% пг:0.00% ыю:0.00% кщ:0.00% бц:0.00% хщ:0.00% шц:0.00% эф:0.00% чх:0.00%

гш:0.00% ыф:0.00% шр:0.00% ьщ:0.00% фя:0.00% эц:0.00% эш:0.00% эх:0.00% шш:0.00% пш:0.00%

щт:0.00% вю:0.00% цр:0.00% пц:0.00% сщ:0.00% тй:0.00% вй:0.00% жр:0.00% цф:0.00% пв:0.00%

H2:4.152531277856013

R:0.1694937444287975

Біграми(без перетином, з пропусками)

bigram1:

н:1.44% у :0.63% чт:0.33% о :2.06% кн:0.23% яз:0.16% ь :1.04% ге:0.06% ну:0.27% я :1.13% и :1.74%

лу:0.13% кк:0.00% а :1.66% ст:1.03% ал:0.84% не:0.88% б:0.73% ол:0.64% ьш:0.04% е :1.62%

ка:0.74% к :0.49% по:0.85% ме:0.27% ья:0.05% п:1.50% ом:0.47% ес:0.34% ть:0.50% фа:0.02%

ми:0.34% ли:0.62% бу:0.13% он:0.64% ап:0.07% ар:0.23% те:0.44% ет:0.36% я:0.15% в:1.46%

ам:0.27% пе:0.23% ре:0.58% д :0.10% го:0.87% во:0.71% рю:0.02% е:0.39% сл:0.23% вы:0.26%

м:0.56% ск:0.44% аж:0.12% на:0.98% с :0.31% йн:0.04% ы :0.41% зв:0.07% ит:0.34% се:0.34%

бе:0.18% з:0.41% ащ:0.02% ищ:0.01% ат:0.45% вс:0.30% га:0.10% до:0.34% уж:0.13% ас:0.37%

эт:0.22% ог:0.46% ан:0.48% ти:0.33% хр:0.01% ис:0.28% та:0.53% ра:0.79% ер:0.64% ю :0.34%

а:0.28% нт:0.06% их:0.15% ри:0.53% :1.63% ва:0.56% бо:0.22% ль:0.33% ше:0.21% зн:0.16%

аю:0.08% д:0.67% ру:0.30% г :0.08% мо:0.36% й :0.76% у:0.36% же:0.35% ве:0.41% рн:0.07%

ый:0.16% р:0.39% аб:0.07% к:1.06% ак:0.44% зд:0.07% тв:0.21% уй:0.01% др:0.20% ав:0.31%

ву:0.07% йт:0.03% ви:0.32% жу:0.02% ч:0.52% то:1.25% уг:0.11% с:1.51% ад:0.19% сс:0.07%

зы:0.05% ла:0.66% и:1.05% юл:0.00% г:0.48% од:0.43% из:0.17% ло:0.61% вн:0.13% р :0.13%

фр:0.04% ей:0.21% бл:0.07% иж:0.03% ен:0.66% им:0.29% тр:0.27% иц:0.13% ма:0.29% фе:0.01%

ро:0.65% еч:0.09% ая:0.27% но:0.83% ин:0.33% ов:0.76% ня:0.32% зя:0.05% ил:0.47% ия:0.14%

м :0.72% пр:0.60% ие:0.22% ха:0.08% вш:0.11% ег:0.33% че:0.30% шл:0.04% ял:0.09% ьк:0.10%

дн:0.15% ее:0.14% ыл:0.21% пп:0.01% о:1.17% ор:0.59% гр:0.13% ип:0.03% п :0.00% бы:0.35%

л :0.75% гд:0.09% уп:0.06% от:0.65% яв:0.02% ко:0.81% ед:0.23% ки:0.23% еж:0.09% ур:0.07%

ых:0.08% в :0.56% за:0.51% пи:0.07% со:0.24% чк:0.03% ах:0.09% аз:0.42% ос:0.61% нн:0.28%

сн:0.06% ым:0.15% л:0.23% з :0.10% зл:0.02% ич:0.11% ех:0.09% аф:0.05% зь:0.10% ид:0.17%

ни:0.69% уч:0.07% рс:0.03% кт:0.05% ив:0.26% шк:0.03% ае:0.08% т :0.45% уд:0.19% оч:0.14%

да:0.38% ны:0.30% нч:0.02% бя:0.05% ду:0.16% н :0.45% ое:0.21% ж:0.18% па:0.11% де:0.41%

см:0.10% ут:0.13% яс:0.09% лы:0.12% ба:0.11% дш:0.01% ий:0.13% тл:0.02% ыр:0.04% хи:0.02%

ца:0.06% дв:0.08% ши:0.18% му:0.23% нд:0.10% ир:0.05% чу:0.06% лк:0.07% аш:0.09% х :0.31%

ез:0.11% ыс:0.07% ф:0.08% нц:0.05% уз:0.07% ке:0.05% т:0.67% ды:0.06% ем:0.38% ок:0.16%

ци:0.02% ям:0.04% ры:0.13% св:0.18% ой:0.34% ся:0.29% чи:0.12% ел:0.61% ек:0.10% ош:0.12%

вл:0.10% оц:0.01% ку:0.15% ою:0.08% уш:0.07% си:0.16% яю:0.01% щу:0.01% жд:0.07% лс:0.14%

вь:0.02% сп:0.15% зм:0.02% яя:0.02% хо:0.24% б :0.02% шь:0.03% ож:0.16% ьс:0.09% мя:0.04%

ув:0.08% сь:0.31% юс:0.01% гл:0.16% ын:0.03% ср:0.02% мн:0.12% ум:0.08% шн:0.03% ик:0.17%

йе:0.00% рв:0.02% вя:0.02% тс:0.08% тм:0.01% ые:0.09% ря:0.10% ещ:0.06% об:0.32% ьт:0.01%

еш:0.08% ча:0.21% ьц:0.01% ев:0.13% х:0.12% щи:0.07% уо:0.01% рт:0.06% сж:0.00% мы:0.07%

чь:0.02% вт:0.02% ты:0.15% чн:0.05% ье:0.13% сы:0.04% дт:0.04% дц:0.02% гу:0.07% ш:0.10%

ои:0.07% еи:0.02% жи:0.11% ыв:0.10% ги:0.08% оп:0.10% ыт:0.05% иу:0.00% еб:0.11% сд:0.03%

бд:0.00% рж:0.03% ую:0.09% ди:0.25% дь:0.07% иш:0.03% ею:0.04% зг:0.04% ля:0.17% бк:0.03%

жа:0.14% ьн:0.10% са:0.14% бр:0.12% ус:0.12% э:0.24% иа:0.01% жк:0.01% вд:0.03% кр:0.18%

ай:0.09% ью:0.05% бщ:0.01% лю:0.09% эн:0.00% ту:0.16% зи:0.03% тк:0.04% ул:0.15% ыб:0.05%

ша:0.13% оя:0.06% тя:0.05% тж:0.00% ян:0.06% це:0.11% ж :0.02% дл:0.06% ще:0.11% рл:0.00%

ии:0.06% уэ:0.00% зс:0.01% уб:0.05% мп:0.02% вр:0.04% нг:0.02% дп:0.01% аг:0.09% ле:0.34%

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ыч:0.01% сч:0.03% рь:0.09% би:0.07% дд:0.00% пу:0.06% яч:0.01% пы:0.02% су:0.06% дс:0.03%

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уф:0.00% тф:0.00% дз:0.00% бю:0.00% лб:0.00% жж:0.00% лщ:0.00% гт:0.00% эз:0.00% жг:0.00%

бт:0.00% дч:0.00% тш:0.00% пс:0.00% фс:0.00% мц:0.00% й:0.00% гм:0.00% эп:0.00% тз:0.00%

мб:0.00% вг:0.00% цг:0.00% дф:0.00% мш:0.00% фк:0.00% кц:0.00% эс:0.01% цт:0.00% зш:0.00%

шц:0.00% юх:0.00% лх:0.00% хт:0.00% йф:0.00% гш:0.00% шм:0.00% цл:0.00% нб:0.00% мю:0.01%

ьщ:0.00% эц:0.00% рф:0.00% йр:0.00% шр:0.00% цн:0.00% лм:0.00% йо:0.00% эш:0.00% шш:0.00%

хп:0.00% уц:0.00% нф:0.00% хх:0.00% мж:0.00% ьр:0.00% юя:0.00% лв:0.00% зц:0.00% йщ:0.00%

H2:3.972747401443976

R:0.20545051971120487

Біграми(без перетином, без пропусків)

bigram1\_ws:

ну:0.36% чт:0.42% ок:0.33% ня:0.40% зь:0.13% ге:0.07% яи:0.10% лу:0.16% кк:0.05% ас:0.64% та:0.65%

ли:0.79% не:1.05% бо:0.28% ль:0.42% ше:0.26% ка:0.90% кп:0.04% ом:0.66% ес:0.63% ть:0.63%

яп:0.11% яф:0.01% ам:0.41% ил:0.60% ии:0.20% бу:0.17% он:1.06% ап:0.27% ар:0.34% те:0.55%

тя:0.08% ва:0.69% мв:0.09% пе:0.27% ре:0.71% дг:0.01% ов:1.18% ор:0.76% юе:0.01% сл:0.28%

ив:0.54% ым:0.19% ск:0.56% аж:0.16% ет:0.49% еч:0.16% то:1.59% ун:0.12% во:0.90% йн:0.10%

ае:0.17% ып:0.07% оз:0.15% се:0.42% бе:0.23% за:0.65% щи:0.08% ща:0.05% вс:0.42% ег:0.45%

ад:0.32% ос:0.94% ти:0.44% еу:0.05% жа:0.16% сы:0.05% эт:0.26% ог:0.60% оа:0.02% нт:0.11%

их:0.21% ри:0.66% ст:1.27% ра:0.95% яв:0.16% ер:0.83% юч:0.03% ан:0.78% хр:0.03% ис:0.55%

сб:0.02% ол:0.82% ьш:0.05% ен:0.98% ез:0.20% на:1.23% юв:0.03% ыу:0.01% же:0.43% др:0.24%

уг:0.17% мо:0.50% йв:0.07% ны:0.36% йр:0.04% аб:0.15% кв:0.06% ыг:0.02% ит:0.48% уз:0.11%

ав:0.57% ву:0.09% йт:0.07% ея:0.06% ви:0.42% жу:0.02% оя:0.11% сп:0.23% аю:0.09% са:0.18%

ди:0.32% сь:0.38% ир:0.13% аз:0.53% ыв:0.17% ай:0.10% кг:0.02% ию:0.03% ле:0.46% го:1.05%

да:0.48% из:0.25% ве:0.52% яа:0.03% нн:0.38% ло:0.86% вн:0.21% аш:0.12% фр:0.06% ей:0.26%

ип:0.27% бл:0.08% иж:0.06% мп:0.10% ат:0.61% цы:0.01% ма:0.34% иф:0.01% ед:0.35% тр:0.33%

ая:0.37% жн:0.13% ои:0.23% чи:0.15% но:1.02% зя:0.06% си:0.22% вы:0.32% ех:0.13% ее:0.19%

че:0.36% ак:0.68% ля:0.21% ла:0.81% ьк:0.21% од:0.64% йу:0.02% еб:0.22% ыл:0.26% гр:0.17%

пк:0.01% аг:0.16% пп:0.01% бы:0.42% лт:0.04% уп:0.13% от:0.89% ят:0.22% ки:0.32% ми:0.51%

уо:0.05% де:0.53% ин:0.57% ев:0.35% ых:0.10% аи:0.15% зд:0.09% ув:0.16% пи:0.09% со:0.31%

чк:0.03% ах:0.13% зо:0.08% ху:0.03% сн:0.13% ке:0.07% ем:0.57% зр:0.03% хе:0.01% иу:0.06%

сг:0.01% фи:0.08% кн:0.33% яз:0.22% ьн:0.24% вв:0.04% ид:0.31% ич:0.19% уч:0.12% ие:0.31%

ек:0.22% уб:0.09% йб:0.05% ой:0.42% иш:0.06% ко:0.99% пу:0.07% га:0.12% яб:0.05% уд:0.24%

нь:0.12% ын:0.10% ус:0.22% ям:0.08% еж:0.13% ду:0.17% иа:0.04% ро:0.81% ча:0.26% лн:0.12%

см:0.14% ут:0.18% яс:0.22% ьт:0.06% ул:0.19% ыб:0.09% дш:0.02% ий:0.16% ьс:0.21% св:0.23%

лы:0.15% ыр:0.05% мх:0.01% ца:0.07% вп:0.10% дв:0.10% мш:0.01% му:0.30% нд:0.15% хб:0.02%

хи:0.05% зв:0.09% хо:0.30% нг:0.04% зы:0.06% мф:0.00% нц:0.06% ык:0.05% ум:0.14% ал:1.06%

ыи:0.04% им:0.41% ац:0.01% ия:0.20% ры:0.17% йс:0.17% тв:0.30% ся:0.37% ку:0.19% по:1.01%

до:0.41% лк:0.18% па:0.14% вл:0.14% це:0.14% ук:0.18% ою:0.10% ую:0.13% ющ:0.04% зн:0.19%

ме:0.36% жд:0.08% ыс:0.14% уи:0.07% оу:0.06% лс:0.24% ян:0.23% еп:0.32% ье:0.20% йд:0.08%

ру:0.34% гу:0.10% еи:0.15% зм:0.04% яя:0.04% вк:0.08% пр:0.72% уш:0.10% шк:0.04% об:0.51%

гд:0.11% еш:0.10% ьр:0.02% оо:0.25% мя:0.06% ьу:0.03% чу:0.07% юс:0.05% ьа:0.07% дн:0.21%

ик:0.34% гл:0.19% оп:0.35% мн:0.20% ьд:0.04% оч:0.27% ьз:0.04% тз:0.01% йи:0.06% зе:0.04%

тм:0.03% ни:0.83% йп:0.09% ьв:0.14% рк:0.04% вя:0.02% тс:0.15% ые:0.12% ох:0.09% кб:0.07%

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кт:0.08% пь:0.08% дт:0.06% бр:0.15% рд:0.05% ба:0.13% рн:0.11% тб:0.03% ао:0.15% жи:0.13%

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ач:0.14% лю:0.10% йз:0.02% иг:0.11% иц:0.16% еа:0.02% шл:0.05% тн:0.16% дл:0.07% ха:0.10%

рл:0.01% эз:0.00% кф:0.00% лж:0.05% ьц:0.01% лр:0.03% яе:0.05% уж:0.16% нб:0.03% ьо:0.08%

бь:0.01% бщ:0.02% мы:0.07% мк:0.08% ый:0.19% ья:0.07% юн:0.04% юд:0.05% лв:0.08% бн:0.03%

чн:0.06% хф:0.00% йл:0.04% сэ:0.01% аа:0.04% оф:0.07% сх:0.03% еэ:0.03% ьм:0.07% зл:0.02%

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мл:0.03% нв:0.06% рь:0.10% ьп:0.11% дм:0.02% кч:0.01% ьб:0.06% кл:0.05% юб:0.05% шу:0.03%

юя:0.01% юм:0.02% пы:0.02% шб:0.00% рю:0.02% юп:0.03% дс:0.05% йш:0.02% вм:0.03% кд:0.03%

шч:0.00% гн:0.04% ьг:0.03% ци:0.03% вь:0.02% юа:0.01% рч:0.01% мд:0.04% ух:0.05% йм:0.05%

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бв:0.01% зт:0.01% хд:0.02% хв:0.04% зу:0.03% вч:0.03% юц:0.01% фу:0.01% нк:0.06% йж:0.01%

фе:0.02% уа:0.03% нр:0.02% мг:0.04% як:0.12% цу:0.06% вд:0.06% гп:0.01% ды:0.07% уф:0.00%

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ты:0.18% рш:0.03% хм:0.02% мз:0.02% рх:0.02% кэ:0.01% мб:0.03% аэ:0.03% лп:0.09% тл:0.03%

ср:0.03% хя:0.01% кю:0.00% ащ:0.03% кх:0.01% яй:0.00% кя:0.01% юл:0.01% мэ:0.01% дк:0.03%

йэ:0.01% нз:0.02% тд:0.04% мж:0.01% цк:0.03% уе:0.03% ощ:0.01% йц:0.01% уя:0.02% рв:0.04%

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тэ:0.01% ыя:0.01% сц:0.00% жо:0.01% шф:0.00% цб:0.00% цз:0.00% дч:0.01% рф:0.00% оц:0.02%

бх:0.01% жм:0.00% зб:0.02% юг:0.02% гз:0.01% щу:0.01% зс:0.03% нш:0.01% еф:0.01% ыа:0.01%

сю:0.02% зз:0.01% жс:0.00% вх:0.01% гя:0.00% дб:0.01% шв:0.00% чш:0.01% жб:0.01% хж:0.00%

ыэ:0.01% нх:0.00% уй:0.01% рм:0.03% аф:0.07% чл:0.00% кж:0.02% цг:0.00% жь:0.00% гг:0.00%

яю:0.01% тщ:0.00% юх:0.00% йф:0.01% дд:0.01% йю:0.00% эм:0.00% цс:0.00% цп:0.00% бм:0.00%

цч:0.00% дх:0.01% тф:0.00% зч:0.00% пн:0.01% чр:0.00% жг:0.00% фо:0.01% рр:0.01% цн:0.01%

дж:0.00% цт:0.00% бб:0.00% бс:0.01% жэ:0.00% пм:0.00% цм:0.00% дп:0.02% вж:0.00% хт:0.01%

жч:0.01% тж:0.01% ыж:0.01% кц:0.00% рэ:0.00% пт:0.01% жп:0.00% эг:0.00% нэ:0.01% лф:0.00%

сз:0.01% нл:0.00% йх:0.01% бг:0.00% шп:0.01% чс:0.00% шт:0.02% рщ:0.01% фв:0.00% вц:0.01%

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гб:0.01% фп:0.00% жя:0.00% тш:0.00% чп:0.00% бш:0.00% уц:0.00% хз:0.00% жл:0.00% гт:0.00%

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цд:0.00% фб:0.00% лц:0.00% лщ:0.00% бт:0.00% жз:0.00% фь:0.00% йй:0.00% чз:0.00% цл:0.00%

бп:0.00% зх:0.00% эп:0.00% дф:0.00% шг:0.00% гф:0.00% фк:0.00% чч:0.00% эс:0.01% пг:0.00%

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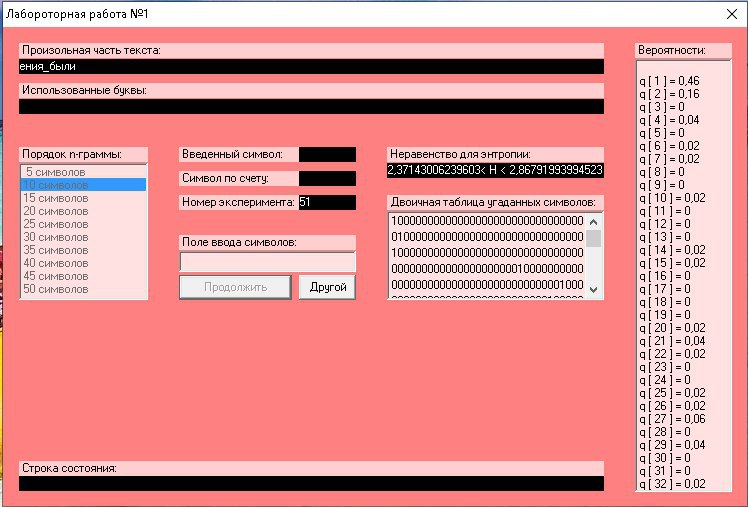
зш:0.00% шр:0.00% чв:0.00% ьщ:0.00% вщ:0.00% ыф:0.00% фя:0.00% жв:0.00% эш:0.00% эх:0.00%

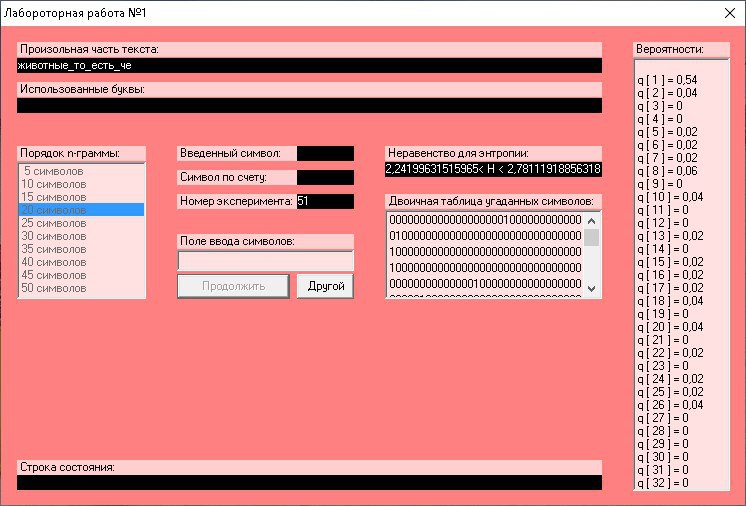
шш:0.00% пш:0.00% эф:0.00% щт:0.00% вю:0.00% гш:0.00% ыц:0.00% эи:0.00% пц:0.00% сщ:0.00%

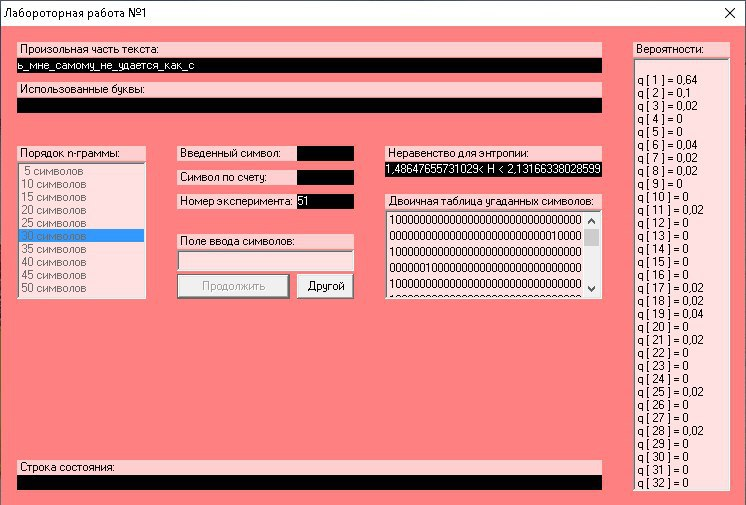
H2:4.152055152416359

R:0.16958896951672808

Оцінки для H(10),H(20),H(30)







Висновки:

В даному лабораторному практикумі ми освоїли поняття ентропії на символ джерела та його надлишковості, вивчили та порівняли різні моделі джерела відкритого тексту для наближеного визначення ентропії, набули практичних навичок щодо оцінки ентропії на символ джерела.