

Lab 10 (November 4, 2016)

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We have 33 cyril letters: $I = \{A, B, V, Г, Д, Е, Ё, Ж, З, И, Й, К, Л, М, Н, О, П, Р, С, Т, У, Ф, Ц, Х, Ч, Ш, Щ, ы, ъ, ь, э, ю, я\}$.

	А	Б	В	Г	Д	Е	Ё	Ж	З	И	Й	К	Л	М	Н	О	П	Р	С	Т	У	Ф	Ц	Х	Ч	Ш	Щ	ы	ъ	ь	э	ю	я		
А	1	0.1	0.1	0.1	0.7	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Б	0.1	1	0.5	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
В	0.1	0.5	1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Г	0.1	0.2	0.1	1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Д	0.7	0.2	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Е	0.1	0.2	0.2	0.2	0.1	1	0.8	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ё	0.1	0.2	0.1	0.1	0.1	0.8	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ж	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
З	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
И	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.7	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Й	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.7	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
К	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Л	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
М	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Н	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
О	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
П	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Р	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
С	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Т	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
У	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Ф	0.3	0	0	0	0.3	0	0	0.3	0.3	0.3	0	0.3	0	0	0.3	0.3	0	0.3	0	0	0	0	0	0.3	0	0	0	0	0	0.3	0	0			
Ц	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Х	0.3	0	0	0	0.3	0	0	0.4	0.4	0.4	0.4	0	0.3	0	0	0.3	0.3	0	0.3	0	0	0	0	0	0	0	0	0	0	0.4	0	0			
Ш	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Щ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
ы	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.4	0		
ъ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	
ь	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ъ	0.3	0	0	0	0.3	0	0	0.4	0.8	0.8	0.7	0	0.3	0	0	0.3	0.3	0	0.3	0	0	0.4	0	0	0	0	0	0	0	0	0.4	0.9	0		
ю	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
я	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

After modifying this matrix and replacing all values less than 0.25 and main diagonal by 0 we get such matrix:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		
	А	Б	В	Г	Д	Е	Ё	Ж	З	И	Й	К	Л	М	Н	О	П	Р	С	Т	У	Ф	Ц	Х	Ч	Ш	Щ	ы	ъ	ь	э	ю	я		
1	А	0	0	0	0	0.7	0	0	0.3	0.3	0.3	0	0.4	0	0	0	0.3	0.4	0	0.3	0	0	0.3	0	0	0	0	0	0	0	0	0.3	0	0	
2	Б	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	В	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Г	0	0	0	0																														

1-st cluster

Step 1:

$I = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $26, 27 = 0.9$, put index to $C = \{ \}$: $C = \{26, 27\}$

$C1 = \{26, 27\} \Rightarrow \text{Ш, Щ.}$

Step 5: $I = I - C = \{1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33\}$

2-st cluster

Step 1:

$I = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $29, 30 = 0.9$, put index to $C = \{ \}$: $C = \{29, 30\}$

$C1 = \{29, 30\} \Rightarrow \text{б, б.}$

Step 5: $I = I - C = \{1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21, 22, 23, 24, 25, 28, 31, 32, 33\}$

3-st cluster

Step 1:

$I = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 28, 31, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $9, 10 = 0.8$, put index to $C = \{ \}$: $C = \{9, 10\}$, find index of the columns, where sum is maximum:

Max31 = 1.6

Max11 = 2.1

Max8 = Max24 = 1.6

Max2 = Max5 = Max13 = Max16 = Max17 = Max19 = Max22 = 1.6

$C2 = \{9, 10, 31, 11, 8, 24, 2, 5, 13, 16, 17, 19, 22\} \Rightarrow \text{З, И, Э, Й, Ж, Х, Б, Д, Л, О, П, Р, С, Ф.}$

Step 5: $I = I - C = \{1, 3, 4, 6, 7, 12, 14, 15, 18, 20, 21, 23, 25, 32, 33\}$

4-st cluster

Step 1:

$I = \{1, 3, 4, 6, 7, 12, 14, 15, 18, 20, 21, 23, 25, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $6, 7 = 0.8$, put index to $C = \{ \}$: $C = \{6, 7\}$

$C3 = \{6, 7\} \Rightarrow \text{Е, Ё.}$

Step 5: $I = I - C = \{1, 3, 4, 12, 14, 15, 18, 20, 21, 23, 25, 32, 33\}$

5-st cluster

Step 1:

$I = \{1, 3, 4, 12, 14, 15, 18, 20, 21, 23, 25, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $21, 25 = 0.4$, put index to $C = \{ \}$: $C = \{21, 25\}$

$C4 = \{21, 25\} \Rightarrow \text{У, Ч.}$

Step 5: $I = I - C = \{1, 3, 4, 12, 14, 15, 18, 20, 23, 25, 32, 33\}$

6-st cluster

Step 1:

$I = \{1, 3, 4, 12, 14, 15, 18, 20, 23, 25, 32, 33\}$, $C = \{ \}$

Step 2-4:

find maximum value: $4, 20 = 0.3$, put index to $C = \{ \}$: $C = \{4, 20\}$

$C_5 = \{4, 20\} \Rightarrow \Gamma, T$.

Step 5: $I = I - C = \{1, 3, 12, 14, 15, 18, 23, 25, 32, 33\}$

Only zeros remain, so we divide other letters in separate clusters.

$C_7 = \{A\}$

$C_8 = \{B\}$

$C_9 = \{K\}$

$C_{10} = \{M\}$

$C_{11} = \{H\}$

$C_{12} = \{P\}$

$C_{13} = \{Ц\}$

$C_{14} = \{Ю\}$

$C_{15} = \{Я\}$

So we have final cluster: $C = \{$

$\{Ш, ѿ\}$

$\{ъ, б\}$

$\{З, И, Э, Й, Ж, Х, Б, Д, Л, О, П, Р, С, Ф\}$

$\{Е, є\}$

$\{Ү, Ч\}$

$\{\Gamma, T\}$

$\{A\}$

$\{B\}$

$\{K\}$

$\{M\}$

$\{H\}$

$\{P\}$

$\{Ц\}$

$\{Ю\}$

$\{Я\}$